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PREFACE

This book constitutes the proceedings of the First International Conference on Research and Education in Project Management (REPM 2018). This scientific event was held in Bilbao (Spain) on February 22-23 2018.

Project Management (PM) is recognized as one of the best tools to create successful developments. The objective of REPM 2018 was to bring together practitioners and academics who wish to discuss and agree on the best practices in both research and education in the field of PM. The conference had close to 80 participants from academia and industry, so it finally contributed to bridge the gap between the two environments.

Continuous effort into research is the only guarantee to develop advanced techniques and tools. The PM community is being increasingly recognized through their Scientific Journals. Moreover, PM professionals feel the need of deepening in their knowledge when they face daily problems, and the University is the main instrument to educate professionals. Besides, the World needs PMs to be aware of the importance of their role into sustainable development projects. Taking the previous aspects into account, those three thematic areas were selected for this first Conference: Research in PM, Education in PM, and Sustainability and PM.

This publication includes the 21 papers selected by the scientific committee of REPM 2018: the 9 papers orally presented during the conference followed by those 12 shown by poster.

We eagerly look forward to another successful REPM edition in 2019 and forthcoming years.

February 2018 Jose Ramón Otegi

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Shaping the complexity: A multifaceted model of projects' success

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Abstract:

Even if every project manager's main goal is to assure project's success, the scope of such concept differs according to personal and organizational perspectives. This issue adds a chaotic component to the already complex systemic nature of every project. The goal of this paper is to analyze the most recurring project success criteria cited in the literature review and gather them into a simple four-facet model that represents the critical aspects of a project's success. Also, some basic recommendations are provided to use the proposed model both as a project managing tool and as a High-Management decision making tool.

Keywords: project success, systemic approach, modelling

1. Introduction

Traditionally, project success is bounded to the "Iron Triangle" concept, where cost, schedule and scope determine projects' failure or success. However, this idea is nowadays considered as a narrow-scope perspective on the projects' true nature, and over-cost and overscheduled projects may be considered as successful, as they achieve other objectives.

Determining what makes a successful project is a key question, with a complex answer. In his analysis from 2013 regarding most relevant research topics [1], Turner identified an specific research area focused on defining project success and failure and trying to determine project success factors (elements that affect the likelihood of success) and criteria (measures to determine the project's success rate). Similarly, Wateridge [2] emphasizes the need to first, identify the success criteria, and, second, detect which factors affect those criteria, in order to implement an specific project management methodology to cope with the key success factors.

Some authors, like Liu and Walker, point out that the difficulty of identifying project success lies on the perspective of the involved stakelholders [3]. Similarly, based on 1200 questionnaires, Bryde and Robinson state that contractors and clients differ on their idea of project success [4]: contractors set the Iron Triangle as their measure form success, whereas their clients claim for the satisfaction of the stakeholders involved in project development. Furthermore, Davis identifies seven different stakeholders, each with different perspectives regarding the project success [5].

This article provides review on project success criteria to offer a new multifaceted perspective to understand the project success and offers some practical guidelines to use the proposed model.

2. The search for project success criteria

An academic review offers several insights regarding project success criteria beyond the Iron Triangle. Belassi and Tukel cover a detailed state of the art that compiles research works back from 1969 [6]. After such an analysis, they remark the necessity to move forward and establish a new framework beyond the Iron Triangle for an effective project success evaluation. In a similar way, Atkinson uses an statistical metaphor and claims that measuring the project success just against quality, cost and schedule criteria is a clear project management's Type II Error, meaning that several key aspects are not examined by these criteria [7]. Instead, he proposes a Square Route approach where, besides the Iron Triangle, he includes the importance of Information systems, Organizational benefits and Benefits for the stakeholder community and identifies 19 different success criteria. Other authors, like Marzagão [8], define different results of a project as "project performance", "perceived performance" and "measured results" according to different assessments parameters. However, some recent papers like [9] still use the simple schedule-budget approach to classify projects' success.

Much of the traditional project management literature has treated all projects as the same, assuming that a project is a project and, thus, using generic approaches to measure projects' success. However, several studies have recently recommended using project-specific approaches to adequate management styles and success criteria definition to the uniqueness of the project's nature. Among the elements that cause a loss of universality among the projects' success criteria, the following may be listed:

- A recent literature review performed by Sanchez [10] shows the lack of interrelated analysis on the literature, as most of the studies are based upon surveys, and thus, data is only collected at project management level, neglecting other aspects involving the projects' lifespan.

- Several authors like the above-mentioned Davis and Bryde and Robinson emphasize that a project's success lies on the eye of beholder.

Thus, different stakeholders have different perspectives regarding the appropriate metrics to measure the projects' success [4], [5].

- Dvir present an analysis over 101 projects overtaken by the Israeli Defense Department in the 1981-1990 period. After classifying them according to both their nature (Software vs. Hardware) and scope, he defined a check-list of 106 items to collate their accomplishment regarding requirement fulfillment and client satisfaction. Finally, they stated that any project's success is intrinsically bound to its nature and, thus, it is impossible to define a set of success criteria without considering the projects' individuality [11].

- In one of the most frequently cited work among the projects' success criteria references [12], Shenhar presents a multidimensional approach toward the project success evaluation. Their analysis identified four major distinct success dimensions: project efficiency, impact on the customer, direct business and organizational success, and preparing for the future. The article also emphasizes that projects' success is both time and project type dependent.

- Joslin and Müller [13], [14] express in a similar way, and declare that project success should be measured upon five different criteria: project efficiency (thus, meeting scope, cost and budget), provided organizational benefits, the project impact, the stakeholders' satisfaction and the future potential of the project.

- Similarly, Ika makes an extensive state of the art review and expresses that project success criteria have greatly evolved in the last decades [15]. He identified three mayor trends: the first period (dated in the 1960s-1980s decades) assumes project success from an objective point of view and so, explores simplistic, unequivocal formulae to express project success; the second period (from 1980s to 2000s) embraces a situational point of view to find context-specific measures of success for different projects and environments; and the third period (dated on the 21st century) undertakes a subjective point of view in search for symbolic and rhetoric evaluations of project success and failure.

3. Proposed multifaceted approach

Combining different perspectives form the detailed state of the art review, a new multifaceted model is proposed to describe the nature of project success. As a basis, the model suggests that a project may achieve success on one of the proposed facets, while falling to commits with other aspects. This does not directly imply that the project falling in any area is an unsuccessful project. Each of the facets have been expressed by means of several indicators, described to be as objective and measurable as possible.

The model presents four different success facets covering a wide variety of projects. These approach enables a wide-spectrum model, but also a customization process to cover specific projects' success features and needs. These four facets, are aligned with the ones identified in Shenhar's work [12], but cover a wider perspective:

3.1. First Facet: Project performance

This facet reflects the traditional Iron Triangle approach and it is strongly bound with the short-term criteria for project success identified by Shenhar [12]. Its global value is defined by three independent measures which are universally approved in the literature as relevant (and, in some cases, unique) project success criteria:

- **Scope and quality:** This value represents adjustment between the projects real outputs and the previously established technical requirements and features.

- **Cost:** It indicates the cost deviation (over-cost or under-cost) of the project, in reference to the estimated budget.

- **Schedule:** It indicates the positive or negative deviation of the project's duration, in reference to the project's original baseline.

3.2. Second Facet: Stakeholders' approval

According to this facet, a project may only be successful when it fulfills every stakeholders' expectations (mainly, clients'). Several works like [3]–[5], [13], [16], [17] consider this facet as critical success criteria analysis. There are three different indicators to measure this facets' accomplishment:

- **Satisfaction**: All stakeholders, or at least, the mains ones, are satisfied by the outcome of the project, regardless of the possible deviations from the original scope, budget or schedule planning. In short term after the project's end, the stakeholders identify the outcome as a valuable asset.

- **Impact**: This index expresses how valuable the outcome is for the stakeholders, not in a short-term basis, but on a middle-long term (it increases the productivity, enables a new business opportunity, enables significant savings by means of a more efficient energy usage...). It is recommended to perform follow-up actions to elaborate a more precise image of the project's real impact.

- **Bondness with stakeholders:** This index indicates whereas the projects' outcome has impacted in the relevancy of company promoting and/or executing the project towards other implied stakeholders. The higher the value of this index, the project company will handle more strategic positions within the stakeholders' ecosystem, enabling to collaborate in further, more relevant projects.

3.3. Third Facet: Results' exploitability

This facet focuses on a short-middle term benefits for the organization promoting and/or executing the project. It represents the continuous specialization by means of related projects, programs and

portfolios. Works like [18]–[20] endorse the importance of this facet. Three different indexes have been defined to measure this facet's intensity:

- **Alignment:** This index expresses the capability of the project to align itself with other ongoing projects within the company, and so, to create internal collaborations with other members of the organization.

- **Reusable results:** This value measures the capability of the projects outcomes to be integrated in further developments. It summarizes the universality of the solution (whether it can be applied in further areas beyond the original one), it's versatility (whether it requires specific work for a new implementation) and the reusing efficiency (the economical, human and temporal resources necessary to reimplement the solution).

- **Competitivity:** This index indicates the capability of project's outcomes to generate new business models within the company or to renew older technical approaches that were abandoned due to any reason (technical obsolescence, competence breakout, lack of support from High Management...).

3.4. Fourth Facet: Organizational growth

Just as the previous facet leans towards a short-middle term benefit based on specialization, this facet runs towards long terms organizational benefits based on diversification and the chance to grow currently unexploited resources and business opportunities. This facet is considered in works like [18], [19]. The following indicators are defined as independent measures of this facet:

- **Knowledge acquisition:** This index measures whether the organization has gained access to new strategic knowledge. The index indicates whether this acquisition exist, its possible fields of application and its usability in future strategic projects.

- **Technological development:** Positive values of this index indicate that the project team has developed new technologies and tools that may be exploited in future projects, either by the organization self or by external entities. This index it's also related with the capacity of the developed technologies to create even further knowledge, by means of basic investigation (like PhD programs), via patents, or by creating new-generation spin-off companies.

- **Strategic alliances:** According to this index, the mere participation in the project, has led the organization to establish new strategic alliances. These contacts may derive from successful project outcomes, or may be circumstantial, like coming to know strategic stakeholders for future projects.

4. Application of the proposed model

The model's main purpose is to represent the many aspects that influence in a project's results and ease monitoring them. This way, the model may be used to establish a direct relation between the expected multidimensional results and the real outcomes of the project. However, to take full advantage of the model's potential, it should be approached not just in the project's evaluation phase, but from the initial phases of the project. Also, evaluation procedures may be established during the projects' lifespan, allowing the project manager to steer the project according to the expected results. This is common practice when evaluating schedule and budget (for example, using Earned Value Methodologies), but this model enables a wider objective assessment.

The model also allows to quantify the projects' expected results in different independent dimensions. From a High Management perspective, this capacity may be used to tell apart more strategic projects by favouring one of the facets above others. Also, keeping an historical record of the Managers assigned to each project and their outcomes, allows the High Management to identify which of the facets of the project's results is more sensitive to each director of projects of the organization. Considering that the criticality of each facet varies according to each project's nature, this information allows a more suitable matching (in terms of expected project results) between projects and available project managers, in future project assigning processes.

5. Conclusions and discussions

This section discusses the main contributions, potential limitations and future research directions of the proposed model and application method.

5.1. Contributions

The article proposes a new model to represent the project's success according to four different objective facets. It indicates the need to measure project success far beyond the Iron Triangle and considers several other facets regarding client and organizational vision of the project results.

The facets described in the model cover the majority of the project success criteria listed in the literature review, but offers them in a simple structure to ease the comprehension and usability of the model.

The suggested model provides a usable tool to express projects' performance by representing the expected and obtained results along different facets. This favorizes both the tactical management (performing a more detailed project control) and strategic decision-making (by favoring projects or linking most suitable manager to each project).

5.2. Limitations

The main weakness of the proposed model lies on the apparent subjectivity of some of the suggested indexes. However, understanding the model's existence since the definition of the project's objectives, it is possible to establish certain assessment criteria to evaluate every index. For instance, "Knowledge acquisition" (an index of the Organizational growth Facet) may sound ambiguous at the beginning, but it may be measured as "The number of employees who are capable of using X

technology by the end of the project". This concretization process should be performed at the very beginning of the project.

Besides, it is important to note that some of the proposed indexes are long-term measures and so, their real values are not available by the end of the projects' management lifespan. In order to cope with this situation, the author suggest to establish the project's results by a top-down three level hierarchy (outcome-purpose-goal) following the logical framework proposed by Baccarini [21]. This method helps identifying the expected organizational alignment of the project's results. However, this approach implies that a follow-up of the projects' results is necessary even beyond the projects' execution timespan.

5.3. Future research

The next step into the research presented in this paper is the definition of a specific methodology to implement the presented model and allow an quantitative measurement of the projects' performance, both regarding specific facets and a global perspective.

Also, a data collection process is necessary to determine whether some of the proposed indexes may contain interdependencies, and so, the model should be corrected to reflect that reality.

This works should be implemented considering that the suggested indexes may vary, and thus, the evaluation methodology should be flexible enough to adapted without issues to the usage of new and more complex indexes. This way, the suggested model may evolve, accommodating whichever project success factors that may be considered as critical in the future, or according to the specific needs of any organization.

6. Conflict of interest

To the best of his knowledge, the author does not have any conflict of interest in pursuing the research that is present in this paper.

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Multi-dimensional Framework for the Categorization of Collaborative Research Projects

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Abstract:

In an environment of globalisation, intense competition and rising R&D costs, collaboration has become an essential means of survival and relevance for organisations. Collaborative research projects bring industry, academia and public partners together to face the challenges of rapid changes, disruptive innovations and transitions towards a digitalized world. However, these projects are not "typical" in their characteristics and therefore pose a challenge in their management and in the definition and evaluation of their success. This paper is a conceptual effort, based on analysis of project-specific literature and on established models for project management contingency theory in literature, that aims to offer a multi-dimensional framework for categorizing a collaborative research project in order to facilitate the decision on which project management approach fits it best. It is among the first of a series of publications with the intention of offering project management solutions to collaborative research projects.

Keywords: project management; collaborative research projects; characteristics.

1. Introduction

Given the increasing spread of collaborative research projects in the recent years, their management has become of increased interest to the community of scientists and practitioners in the fields of project management and research management. According to the European Commission, collaborative research produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation [1][2][3]. However, „high level research is complex, costly and interdisciplinary. Individual organizations often need partners to be able to respond to these challenges" [4]. From a different angle, collaborative research projects can be seen as a temporary, project-based organization based on cross-disciplinary, joint research [5]. They also represent "a system of research activities by several actors related in a functional way and coordinated to attain a research goal corresponding with these actors' research goals or interests" [6]. This collaboration is challenged by a diversity of actors whose organizational, national, and disciplinary backgrounds differ [7,8], and is often constructed as a response to highly-competitive calls by public funding agencies [9,10].

This unique project organization leads to a deviation from the typical project definition and project characteristics. The diversity of actors, the uncertainty in goal definition and in methods to reach the goals, in addition to the need for innovation add to the complexity of research projects. In addition, from one research project to another, the degree to which a certain characteristic is present (e.g. ambiguity in work plan) affects the management, the prioritization of tasks and the competences needed for the project. In this paper, we will use a number of established models in literature for categorizing projects based on their characteristics and the degree to which those characteristics exist. We focused on models that consider project management and contingency theories to draw emphasis on the unique characteristics of collaborative research projects. We will use those models as basis to build a multi-dimensional framework applied to a collaborative research project to categorize them based on their characteristics.

2. Related Work

2.1 Goals & Methods Matrix

In 1993, Turner & Cochrane [11] published their cornerstone work on "coping with projects with ill-defined goals and/or methods of achieving them". In this paper, they classified projects into four types projects (*See Figure 1*).

The paper suggests that any project has three essential features: unique work (represented by the product breakdown structure), novel organization (represented by the organization breakdown structure), unitary change executed through a sequence of tasks (represented by the work breakdown structure). With this, the decision regarding the methods for achieving project goals depends on how well and straightforward the definition is of those three structures, in other words how much certainty there is when it comes to goals and methods for the project. According to this model, Research projects fall into type-4 projects for which "neither the goals not the methods are well-defined". For such projects, specific strategies are needed at the startup of the project; such as creativity to define methods, negotiation to define goals and higher iteration; and during the implementation of the project. The strategies are aimed at moving type-4 projects into type-2 or type-3 projects in order to have a basis for milestone planning and configuration management during the implementation of the project.

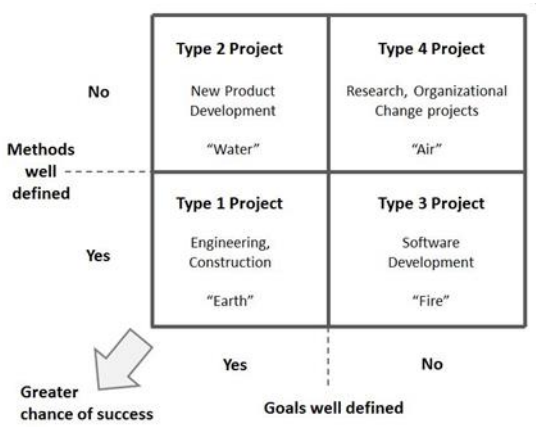

Figure 1. Goals-and-methods matrix [11].

Sauser et al. [12] focus on project management contingency theory to address (un-)certainty of goals and methods when it comes to space research projects. They base their work on three major previous models/frameworks: (1) Henderson and Clark's framework for innovation and change [13] (2) Shenhar and Dvir's NTCP diamond framework [14] (3) Pich, Loch and De Meyer's coping strategies model [15]. The authors argue that those three frameworks are better used collectively and not independently to comprehensively highlight the important aspects of a project with difficult-to-define goals and methods, with each of the three frameworks emphasizing a different point of view. As all these frameworks combine aspects of project management contingency, we will use those three models [13-15] for the framework to be developed in this paper.

2.2 Henderson & Clark's Framework for Innovation & Change

Henderson and Clark [13] present a matrix to support project management methodology decisions by categorizing innovation based on the level of change. They use two axes to represent the components of the final product (component knowledge) and the way they are integrated into the system or product architecture (architectural knowledge) (*See Figure 2*). They deal here with projects whose products would require incremental, modular, architectural or radical innovation. Since innovation projects are often connected to research projects in funding programmes (e.g. [1, 3, 4]), we found this framework to be very useful for our analysis of collaborative research projects.

2.3 The NCTP Diamond Framework

Shenhar and Dvir [14] propose a four-dimensional categorization framework, with the name diamond framework (representing the resulting shape after applying the framework to a project) based on novelty, complexity, technology, and pace (*See Figure 3*). The goal of the framework is to present a scheme for categorizing projects and based on the categorization show how different projects are managed in different ways.
This framework can be applied to collaborative research projects, since the categorization on the basis of technology, complexity, novelty and pace fits well into this type of projects. We also aim to use the method of representing this framework for the representation of our resulting framework.

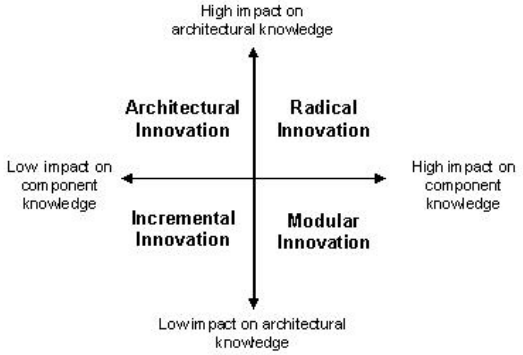

Figure 2. framework for innovation and change [13].

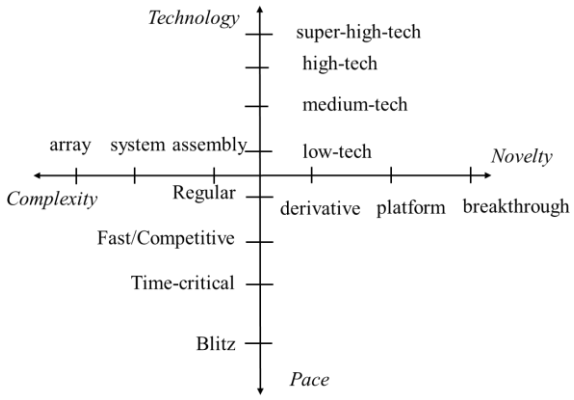

Figure 3. The NCTP diamond framework [14].

2.4 Matrix for Strategies to cope with Inadequacy of Project Information

Pich et al. [15] present a matrix for strategies to cope with inadequacy of project information. Those strategies define a project's style and leadership approach. The authors define inadequacy of project information as uncertainty, ambiguity and complexity in project information. They aim with this matrix to overcome those difficulties by focusing on decisions about learning within projects, selecting projects or using an instructionist approach within the project (*See Table 1*). Since information (in-)adequacy is a common issue for collaborative research projects, we include this model in the analysis leading to our framework development.

	Optimization	Selectionism
Learning	Learning Strategy	Learning & Selectionism
No Learning	Instructionist Strategy	Selectionist Strategy

Table 1. Simplified Summary of Instructionism, Learning, and Selectionism [15].

2.5 The Adapted Pentagon Model

Rolstadås et al. [16] published an adaption of the Pentagon model to link project management approach to project success. In order to define the right approach, they based the analysis on five different aspects of the project; the formal aspects – structure and technologies and the informal aspects – culture, interaction and social relations and

networks. Although the projects used in the paper were mainly mega-projects, due to uncertainty and complexity connected to both mega-projects and collaborative research projects, we will take the five aspects of the Pentagon Model into consideration for our framework.

2.6 Situation-based Analysis Framework for Collaborative Research Projects

Finally, and in contrast to the models discussed above, Lippe & vom Brocke [17] focus their analysis on collaborative research projects. They go beyond viewing the project as a whole and argue that the selection of the right project management approach should be situation-based. For this purpose, they describe and analyze project situations after conducting structured interviews with project team members. The authors identify four indicators to help identify situations and a number of items under each indicator (See Table 2). We add these indicators and sub-indicators to our analysis.

Management target	People
	Finances and effort
	Legal aspects
	Content
Management demands	Criticality
	Level of cooperation efforts
	Management position
	Politics
	Cause of situation
Level of consensus-building	Success criteria
	Ambiguity of work plan
	Task dependencies
	Agenda of stakeholders
Predictability and structure of work	Clarity of results
	Clarity of working steps
	Tangibility of working steps
	Time-pressure
	Occurrence
	Governance

Table 2. Indicators and sub-indicators for the high-level assessment of collaborative research project situations [17].

3. Impressions from Related Work

As can be seen from the related work, a wide range of criteria/dimensions exist to describe the characteristics of projects and it is important to adapt the understanding of the characteristics to the specific project type. Application of the right project management approach and the increase in the likelihood of success that stems from it rely highly on an adequate description of the characteristics of the project being managed. Comparing the discussed models shows that some project characteristics are repeated, e.g. uncertainty, complexity and criticality of a project. However, there are also aspects that are considered by one model and excluded in another, e.g. the innovation and change model focuses on describing the deliverable of the project and less on the project itself, whereas the Pentagon Model lays value on the interactions and networks within the project. This emphasizes the need for a comprehensive view of the different aspects to be considered for describing the characteristics of a project. We believe that all these aspects need to be brought together into a single framework, with multiple dimensions, in order to inform the decision towards the right project management approach for a project.

4. Developing a Multi-dimensional Framework for Categorizing Collaborative Research Projects

To develop this framework, we compiled a list of previously discussed dimensions and values falling under them. Then we applied thematic mapping to those dimensions in order to assign higher level themes, re-organize the content and avoid overlap. The process was lengthy and the number of items in the list exceeded 60 and therefore are not to be presented in the scope of this paper. Instead, we describe one example and we list the resulting themes based on the thematic mapping.
For example, we mapped the items “pace” [14], “criticality” and “time-pressure” [17] under the higher-level theme “Pace”. For each high-level theme, a set of values were defined. Going back to the previous example, for “Pace”, the values “regular”, “fast-competitive”, “time-critical and “blitz” were assigned. When applying to an actual project, the themes represent the dimensions under which the project characteristics can be assigned and the values represent the actual project characteristics.

The result was 8 dimensions that fall into two categories:

a. *Project Result-related (See Figure 4)*
    1. Goals: this includes the characteristics related to the definition of project goals.
    2. Structure of work: this includes characteristics related to the definition of project activities and task interdependencies and the ways to achieve project goals.
    3. Innovation: this includes the characteristics related to change, novelty, technology and innovation in the results of the project.
    4. Pace: this is focused on the time-criticality of the project.
b. *Project Organization-related (See Figure 5)*
    5. Vision & culture of stakeholders: refers to the extent to which the vision, working culture and values of the stakeholders align with each other and with the project goals.
    6. Governance: refers to the level of rules and regulations regarding the interaction, communication between project partners, the management position of the project coordinator, the roles and responsibilities and the formal organization of the project. This also influenced by the funding schemes that the project falls under.
    7. Cooperation: refers to the extent of willingness of the project partners to work together despite the heterogeneity in backgrounds, disciplines, working methods and agendas.

8. Learning capacity: describes the level of aptitude for learning and knowledge sharing within the project organization and between partners.

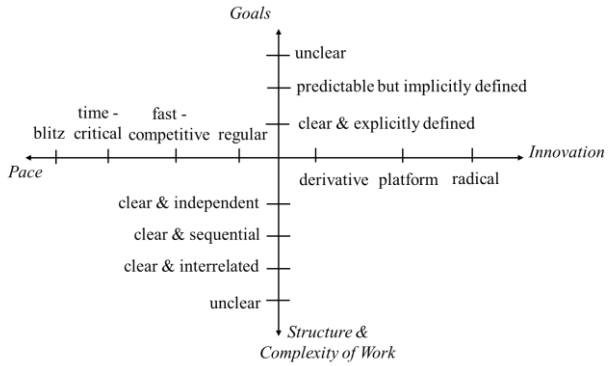

Figure 4. The diamond framework for categorizing collaborative research projects based on project result-related dimensions

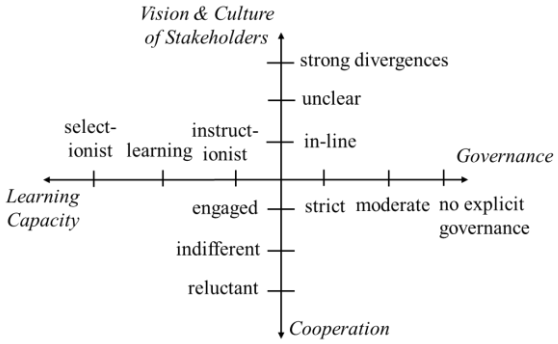

Figure 5. The diamond framework for categorizing collaborative research projects based on project organization-related dimensions

With these dimensions, a collaborative research project can be evaluated at its start, during implementation and at different project situations to determine where it stands on those different dimensions and determine how to adapt the project management approach based on this input. The smaller the diamond is, the less challenging the project is and vice versa. It also helps determine whether the challenges are connected to the project results, the project organization or both.

5. Conclusion & Further Research

This paper offers a conceptual multi-dimensional framework that helps members involved in collaborative research projects categorize their projects in terms of characteristics and adjust their project management approach according to them. However, further research and empirical data are needed to determine whether more dimensions exist or whether those dimensions differ in real-life. The authors aim to extend their research to include recommendations for the right project management approach based on the different shapes of diamonds resulting from applying this framework to collaborative research projects.

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Project prioritization in portfolios with financial constraints

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Abstract:

This paper highlights the relevance of considering limited funds during the scheduling process of a project portfolio. The currently existing algorithms for multi-project scheduling are normally limited to obtaining a feasible schedule in which time and resource constraints are met. The approach that we propose in this paper goes one step further and allows the portfolio manager to choose what project (or projects) are a priority for the company. To this aim, we propose a market-based mechanism that determines what activities should receive preferential treatment during the scheduling process in accordance with the funding limitations of the portfolio.

Keywords: Project Scheduling, Portfolio Scheduling, RCMPSP, Project Prioritization.

1. Introduction

Project Scheduling aims to find a date for all the activities of a project so that its execution is feasible. The first tools for Project Scheduling (e.g. Gantt charts [1], [2], PERT (Program Evaluation and Review Technique) [3] or CPM (Critical Path Method) [4] assumed that all the resources required by the activities would be available at the times they were needed. This situation does not normally occur because resources are frequently shared between several activities. Consequently, considering only the precedence relationships of the activities does not guarantee obtaining a feasible schedule for a project.

Obtaining a schedule in which all the constraints derived from the limited number of resources is such a complex process that it gave rise to the so-called field of research Resource-Constrained Project Scheduling Problem, hereafter RCPSP [5].

The RCPSP was proven to be a NP-Hard problem, which implies that obtaining the optimal solution with the classical approaches in the field of Operational Research is not possible [6]–[8]. This is the reason why some authors proposed applying linear techniques such as Integer Linear Programming, ILP [9]–[15] or Mixed Integer Linear Programming, MILP:. [13]–[20] to solve the RCPSP.

In a more realistic situation, companies do not normally manage a single project with shared resources (i.e. RCPSP), but a set of projects whose execution requires sharing some of the company's resources between activities from several projects. In other words, the company needs to decide how to allocate its limited number of resources to the projects they are managing simultaneously (i.e. a project portfolio). This multi-project problem increases the difficulty of the scheduling process far beyond the RCPSP. The research on scheduling techniques for the multi-project case was given the name Resource-Constrained Multi-Project Scheduling Problem, hereafter RCMPSP [21], [22]. Several authors proposed using Integer Linear Programming, ILP [23] or a Mixed Integer Linear Programming, MILP [24], [25] to solve the RCMPSP. However, as in the single project case, it not possible to find an optimal solution as it also belongs to NP.

Given the difficulties in finding the optimal solution, more recently some researchers explored new resolution methods for the RCMPSP by means of heuristics and metaheuristics, which provide a sufficiently good solution in a reasonable computational time [26], [27]. These methods have normally been divided into two categories: centralized approaches (C-RCMPSP) and decentralized approaches (D-RCMPSP).

In the centralized approaches, proposed by [28] and [29], there is only a single entity who decides the scheduling for all the projects [6], [30]–[32]. To put it simply, the C-RCMPSP tackles the RCMPSP as 'project of projects' which is solved with the same techniques used to solve the RCPSP. Consequently, in the centralized methods, once the 'mega-project' is built, the activities cannot be treated in a different way depending on what project they come from. As a result, centralized methods normally try to optimize a global feature of the whole portfolio (such as minimizing the portfolio duration or the average project delay) but they are not able to optimize the features of an individual project in the portfolio (for example, by favoring the scheduling of one project over the others).

The decentralized methods, however, consider several decision entities: one for the whole portfolio and one for each project [33], [34]. This allows for maintaining certain control over the scheduling of each single project during the scheduling process for the whole portfolio. Consequently, this approach allows for optimizing individual project performance measures at the cost of a greater complexity [35].

In this paper, we present a hybrid approach to solve the RCMPSP. It is inspired by centralized approaches in the sense that a 'mega-project' with activities from all the projects is built before the scheduling process starts. However, at the same time, each activity will maintain the information about what project it belongs, which will permit optimizing the performance of some projects in the portfolio (is it occurs in decentralized methods). Concretely, this information will be used to prioritize some projects over others depending on the needs of the portfolio scheduler.

2. Description of the market-based approach

In every scheduling problem, whenever the availability of a resource is not enough for the execution of all the activities requesting it, a criterion must be established to decide what activities get the resource (and therefore can be scheduled in the original dates) and what activities are delayed until that resource is released. In order to make this decision, the approach that we present in this paper creates an artificial market that allocates each resource to the activities that value them the most.
The items traded in this market are the project resources. The price of each unit of resource at a specific time will depend on the resource's demand and supply at that time.
The resource supply per time unit is defined as the number of resource units available (i.e. the number of resource units that have not been yet allocated to other project activities). The resource demand per time unit is calculated as the number of resources required at that time by the portfolio's activities. As one can expect, the greater the difference between the demand and the supply at a particular time, the higher the price of that resource at that time.
This market mechanism will be working during the whole scheduling process. Since the supply and the demand for resources change as the activities are scheduled, the prices will be recalculated at the beginning of every scheduling step. Therefore, the prices of the resources will change dynamically along the scheduling process.

In order to allow for prioritization, each project in the portfolio is provided with a budget that will be used to purchase the resources needed by their activities. A price will be generated for each unit of resource. The higher the number of projects requiring that resource (i.e. the higher the demand for that resource) and the lower the availability of the resource (i.e. the lowest the supply of that resource), the higher the price of that resource and, consequently, the higher the cost of scheduling the activities that require that resource at that time. Therefore, the projects with a higher budget will find it easier to have their activities scheduled without any delays. With this idea in mind, before the scheduling process starts, the portfolio manager is to define each project's funding curve (i.e. the budget that can be spent on resources over the whole duration of the project, Figure 1).

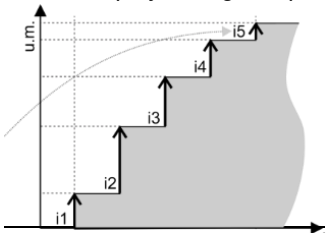

Figure 1. Defining a funding curve for one of the projects

This budget does not need to be the real amount of money available for each project. Since the prices generated in the scheduling process are artificial, the idea is to provide a higher budget to those projects with a higher priority so that they have better opportunities to get the resources they need, whereas other projects with a more limited budget will have to wait until the resources they need have a more affordable price. In other words, our approach generates a portfolio schedule in which the priority of the projects are taken into account: the project funding curves provided by the portfolio manager are used to determine the priority of the projects for the company.

The functioning of our approach is based on the scheduling steps shown in Table 1.

Table 1. The scheduling process

1	Generate a tentative schedule for the activities that have not been yet scheduled
2	Calculate the current price of each resource unit based on its demand / supply
3	Obtain each project's current balance
4	Try to schedule the activities that fulfill the following three conditions: all of their predecessors have been scheduled; all the resources needed for their execution are available during the entire duration of the activity; the project to which the activity belongs has enough credit to pay for the resources required by the activity (at the prices generated by the artificial market)

3. Experimentation: Simulation Results

In this section, we present the results from simulation experiments. We will consider a portfolio composed of 5 projects, each of with 30 activities. This portfolio has been taken from MPSPLib (Multi-Project Scheduling Problem Library), a well-known public library that currently holds the most accepted collection of multi-project problems that can be used by the scientific community to test RCMPSP algorithms [36]. Concretely, the problem used to test our algorithm is given the name mp_j30_a5_nr1_set. Although this problem contains a portfolio of 5 projects (a5) with 30 activities each (j30), it is actually a combination of the same project repeated five times with different starting dates.
The combination of this basic project five times with different starting dates yields the portfolio that we will schedule in this section. Taking project 1 as reference, the starting date of the other four projects are delayed 4, 9, 16 and 20 time units. For space reasons, Figure 2 shows the information of this portfolio in a schematic form.

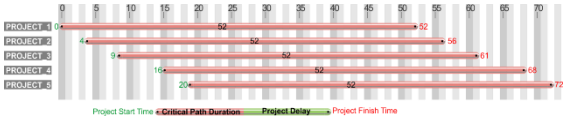

Figure 2. Portfolio summary.

The aim is to obtain a feasible schedule for the whole portfolio at the same time we bear in mind that some of the projects are more urgent than others for the company. As we have previously discussed in this paper, the portfolio manager is to use the projects' funding curves to set a profile that is compatible to the company's priorities. In order to test the algorithm, we will perform two experiments, in each of which we will assume different priorities for the company. We will use our algorithm to schedule the project activities in both cases and finally we will compare the results.

In the first experiment, we will assume that project 3 is a priority for the company. This is why we will assign a higher budget to this project against the other projects. Figure 3 shows the funding curves used in the first experiment for projects 1 and 3.

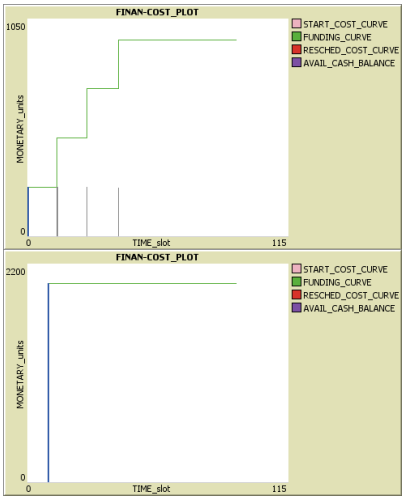

Figure 3. Funding curves defined for the first experiment.

In the second experiment, we change and move the prioritization to the project 4. The other projects in the portfolio have the same financial constraints that applied in the first experiment.

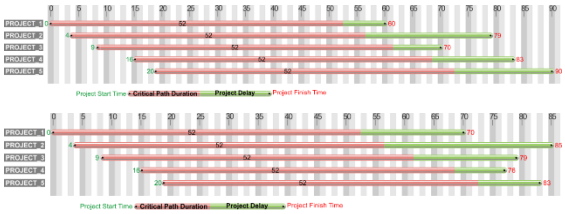

Figure 4. Resulting schedule in the first experiment (top) and second experiment (down).

In Figure 4 we present the results, which are compatible with the rationale of the algorithm. In both cases, we obtain a feasible schedule for the portfolio, as it occurs with any RCMPSP algorithm that can be found in the literature. The novelty of our algorithm is the fact that, depending on the budget allocated by the portfolio manager, the market-based mechanism favors the scheduling of some activities over others thus achieving the prioritization of projects in the portfolio according to the specific needs of the company.

4. Conclusions

Algorithms to solve the RCMPSP attempt to generate a feasible schedule at the same time they try to optimize a global feature in the portfolio (e.g. total makespan or average project delay). The public online library MPSPLib collects the results of the benchmarks of some of these algorithms and they are precisely ranked according to these criteria. However, since these objectives are global, the priority of each project within the portfolio is not taken into account during the scheduling process.

In this paper, we have presented an approach that, like many other algorithms for the resolution of the RCMPSP, generates a feasible schedule for the portfolio in which both time and resource constraints are met. The peculiarity of this algorithm is that it also incorporates project prioritization during the scheduling process. Before the scheduling process starts, the portfolio manager determines what projects are more urgent for the company. With this information, the algorithm uses a market-based mechanism that permits scheduling the activities that belong to those projects with a higher priority.

An advantage of this algorithm is its flexibility. On the one hand, it can be easily incorporated to other RCMPSP algorithms, as it simply adds a third condition for the scheduling of a project activity (i.e. having enough budget) to the two traditional constraints (precedence relationships and resources availability). On the other hand, if the portfolio manager sets an arbitrary sufficiently high budget for all the projects, the third condition will always meet: the project prioritization feature will not be taken into account and the resulting schedule will coincide with that of the original algorithm in which this market-based heuristic is incorporated.

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Open Ecosystem for Innovation: Antifragile Approach

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Abstract:

"Innovation" concept achieve a capital significance on sustainable growth. Public and private agents interact on all kind of Innovation Ecosystem all around Europe. In this socio-economic context, innovation Project Management, must deal with complex projects together with actual global world conditions: uncertainty, randomness, chaos... This paper analyse how an original framework can be build around innovation goals and conditions, and allow for achieve them. This proposal outlined attempt to be creative, and contemporary at same time that looking into next future. This paper present "Antifragile" concept as a real and practical alternative for Project Management. Ideas developed around it make possible define the key working rules that allow to an antifragile innovation team play inside an Antifragile Ecosystem for Innovation. Finally, we propose a field study where its target is find these "antifragile key working rules" situation, and its possible evolution, on current innovation organizations.

Keywords: antifragility; innovation ecosystem; innovation teams; gender diversity; Q-Methodology.

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1. Introduction

XXI Century characteristics are globalization, disorder, uncertainty, randomness... Project Management (PM) must change and adapt to current world, because new complex problem arisen. NASA conclude that:

"*addressing future challenges in aeronautics is not simply to do what we know how to do now better: **we need to do things we currently do not know how to do**. What is needed to address these challenges is a transformation of engineering practice that infuses new methods being developed in the discipline of Complex Systems*"[1].

Part of these new methods is Antifragility concept to engineering practice[1].

How PM and research & innovation teams can improve its performance, together with how deal with current world characteristics, is the author's research target. And as in NASA, we deploy antifragility concept approach as innovative non-deterministic tool.

Thus, present paper contribution is try to develop ideas around antifragility concept for team performance, where PM can find methods and ideas that help to deal with current complex world.

2. Antifragile: Literature review.

"Antifragility" scholar research is open to all science and technology fields. But, from 2012 where Taleb's[2] book appear, scholar approach to this idea is relatively reduced. Indeed, an open Google Scholar search under "*antifragile*" concept gives us 2220 results (2018-05-01). However, under "*innovation ecosystem*" search show more than 600.000, or "open innovation" some millions. Thus, we conclude that research field is open to new contributions.

Finally, main result of literature review is that researchers' focus is on engineering systems design, ideas about evolution from "resilience" up to "antifragile" that will create better systems. Similar analysis around software development.

Authors that work with "Antifragile social organizations" are not so much. And this is present paper target: first how we can define an Antifragile Innovation Team (AIT) that create and work into an Antifragile Ecosystem for Innovation (AEI), and second how we can measure antifragile characteristics into current innovation organizations.

All literature review details are explained on this paper annex, with all related references.

3. AEI: Hypothesis

Designing innovation organizations, we must take as premise Ayestarán's[3] critical question: "innovation (eco)sytem engine is always innovation team, question is how transform an expert group into an innovation team".

We would go a step ahead: how transform an innovation team into an antifragile innovation team.

Antifragile concept characteristics and principles are not teleological: on our current chaotic world doesn't works cause-effect prescriptions, such as traditional "*Problem – $X_P \Leftarrow\Rightarrow$ Strategy – X_S".* Concepts as serendipity, do it yourself, hormesis, simpleness, diversity, learning, openness, good-enough solutions for complex problems, etc. must be present in a new transdisciplinary[8] culture.

After literature review, and compare with original Taleb's ideas, we conclude that if today an antifragile innovation team exists, we must find as main characteristics next ones:

- Innovation as main activity,
- Diversity management, fundamentally gender diversity,
- Self-management team as main team behaviour,
- Free knowledge as source of team knowledge,
- And project-based management as main technique for project management.

Thus, our research hypothesis is as follow:

If exist an antifragile innovation team, or if doesn't exist but evolution from current status up to antifragile position will be possible, we must find as its main characteristics these five explained above.

Authors of this paper are deploying a survey along innovation and research centres around Basque Country, just to see if we can demonstrate (or reject) this paper hypothesis. On next points we are going to explain this field study characteristics.

4. Field Researh: Q-Methodology study.

Find real data in our innovation infrastructure for study, for example, if *self-management team* is a normal or real characteristic, or if team management is really progressing from any old step to this point is really difficult, impossible we can say. There are not statistics data, official parameters, etc.

Also, we can see that study hypothesis, all of them, are *subjectives*: there are not a "*physics units of measurement*" that allow us, for example, control *how much gender diversity* there is present in some innovation organization.

Thus, we decide use Q-M as recognized tool for study of subjectivity. On next points we are describing what is Q-M and how we are deploying this field study.

4.1 Q-Methodology approach.

What is Q-M?:

"*Q methodology provides a foundation for the systematic study of subjectivity, a person's viewpoint, opinion, beliefs, attitude, and the like (Brown 1993). Typically, in a Q methodological study people are presented with a sample of statements about some topic, called the Q-set. Respondents, called the P-set, are asked to rank-order the statements from their individual point of view, according to some preference, judgement or feeling about them, mostly using a quasi-normal distribution*"[4].

Study deployment consist in interview, fooling Q-M techniques, certain number of people that are working in different R&D&I centres, and obtain their opinion about hypothesis situation and their possible evolution on next years.

4.2 Study Design

Performing a Q methodological study involves the following steps: (1) definition of the concourse; (2) development of the Q sample; (3) selection of the P set; (4) Q sorting; and (5) analysis and interpretation[4].

Result of steps 1 and 2 is Q-Set definition. Between 40 to 50 statements is drawn to be presented of participants.

Q-M study requires only a limited number of respondents[4]. Thus, P-set is what have been defined as OBI (good informed opinion, from its initials in spanish: *opinión bien informada*). There are different people selected, which are carry out their professional activities into innovation and research centres, or in private companies development departments.

Q-set is given to each P-set respondent. This is instructed to sort them following Q-M general rules and always under researcher help in interviews that enable him (to the researcher) to understand the results better. Other Q-sots methods, like mail or computer based, only may be desirable if sample has a wider geographical distribution.

Finally, the analysis of the Q sorts is a purely technical, objective procedure. Nowadays many software packages are available to perform the analysis. For this research, we will use Q-sortware[6] for collect the Q-sort results, and for analysing an application called "qmethod"[5][7].

5. Conclusions

We summarize paper key findings on table 1.

Table 1. Paper key findings.

Antifragile Ecosystems for Innovation (AEI) mean most appropriate and affective innovation activity framework.
Such innovation activity must be perform by teams: Expertise Innovation Team (EIT).
Nevertheless, randomness, uncertainty and many other complex problems have arisen and EIT must deal with these conditions. Thus, new ideas and methods must be developed: our proposal is **Antifragile** concept. PM must learn and adapt their methods to this new situation.
Antifragile*: Things That Gain From Disorder*[2]. When subjected to stress, there are things not only resist change, they actually grow and get stronger. They actually get better when subjected to stress, and remain better after the stress is removed.
Paper's proposal is show ideas and methods that allow EIT transform into **Antifragile Innovation Team (AIT)**. Thus, PM must learn and adapt themselves to these new situation.

Main target is show how much antifragile is innovation and research infrastructure around basque R&D centres. *Q-Methodology* (Q-M) study will use as research tool for this purpose.
We present a separate annex complementary to this paper where is detailed our literature review.

Q-M research is now under deployment. First P-set respondents are been interviewed, but not finished this precess until now. Final results will be published as soon as analysis will be finished.

Target is find, as explained above, the relation between antifragile factors and research hypothesis. We look for the subjective opinion of OBI, as much as we know that there is not real data of all of them.

For example: if some company and/or research centre have gender diversity program, and is deployed in its company strategy, and OBI agree with that, we will consider that this organization is more antifragile than other that has not such characteristic.

New research papers with results and analysis will be published as soon as Q-Method research will be finished.

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Unveiling the Opportunities of Using Blockchain in Project Management

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Abstract:

The distributed ledger technology that blockchain provides can potentially disrupt every field in where value is involved. Since the appearance of cryptocurrencies as Bitcoin in 2008, it has been seen as a new business opportunity generator for emerging companies and a possible threat for the established ones. Its intrinsic features like veracity, transparency and disintermediation, will change the rules of several business models and will open new ways of doing value transactions.
The project development can be seen as a process of sharing and exchanging value. Here, value should be seen as a whole, including every asset meaningful to different players that should be protected. This paper makes an analysis of the possible use of this new technology in the different parts of Project Management, bearing in mind two complementary perspectives: the project lifecycle and the different knowledge areas.

Keywords: Blockchain; Project Management; distributed ledger; smart contracts

1. Introduction

Blockchain is seen as a real disruptive technology because it has the potential to change the rules in every process in where value or trust is involved [1]. It means that it can change the way the businesses and economy work [2], having a deep impact in different areas and opening new opportunities and threats in many sectors [3].

The best-known application of the Distributed Ledger Technology (DLT) that blockchain exploits, is the cryptocurrency Bitcoin [4]. At first, it has been seen as a threat from the banking sector and financial institutions, but nowadays the potential of creating new opportunities in these markets, and the new business models that blockchain technology (BCT) can enable, have prioritized its study inside leading institutions [5].

Blockchain is a technology [6], a new tool, not an end in itself. The novelty in each market will arrive when the application of the BCT establishes a new and better way of doing things. Currently it is being a revolution in the financial sector [7] although it is only in an early stage. In other areas, the people is wondering about how it could be used and leveraged, and what could be the impact in their current activities [3][2][8]. Project Management (PM) will not be an exception and, due to the widely fields and knowledge areas it gathers, the benefit from this new technology could be high.

During the development of a project there are many activities in where value and trust are involved. PM have to take advantage of this new technology, tailoring it to suit the specific needs of each part present in the project lifecycle. Throughout this document, a identification of some of the opportunities BCT offers to PM has been proposed, based in real case applications and in a literature research.

2. What is blockchain

Blockchain, in general terms, could be defined as a secure distributed ledger of transaction history, stored across participating computers, that allows trusted transactions without the need of a central authority [6][1].

The traditional ledger has been used for centuries to keep records of ownership (i.e. land titles), or transactions (banks). For making It work, it is required that everyone involved trusts the manager of the ledger.

The BCT allows establishing a trusted network of value exchange without anybody in the middle, with the following three main features: security and trust, transparency and disintermediation [3].

From its beginning blockchain has evolved. Blockchain 1.0 was designed to save and use the Bitcoin cryptocurrency safely. Its following version, blockchain 2.0, adds the concept of “smart contract”, enabling its use in wider applications [6].

Technically in the literature two main categories of blockchain are distinguished: permissionless and permissioned [6]. However it is also common to divide the blockchain network depending on who manages it, giving rise to distinguish between public, private, and consortium blockchains [5].

The DLT used in blockchain can be meaningful for almost every type of transaction involving value. Its potential uses are nearly limitless. Besides their known cases in the financial sector, it is currently applied in: trade finance [9], securities trading, insurance industry, supply chain management [10],

clearing and settlement [9], closed economies [11], Internet of things [12], health information management [13], government operations [14], etc.

Now that the real potential of the technology we are speaking about is known, it is in our hand and imagination the challenge to find applications in where it can be leveraged.

3. Blockchain in Project Management

According to PMBOK [15], PM can be differentiated by its process groups and its knowledge areas. During this study both approaches have been taken into account in order to find where and when the BCT can be harnessed.

3.1 BCT and PM Process Groups

The PMBOK guide [15] defines five process groups: initiation, planning, execution, monitor and control, and close. The possible advantages of using blockchain in each one of the project phases are listed below:

Initiation:

In this phase the definition of the project occurs [15]. BCT can be introduced to bring all of these characteristics to the project by means of:

- A trusted network: in where every stakeholder is involved and assures the validity of the shared information at all times.
- Smart Contract and agreement tool: removing the need of several meetings and the involvement of trusted third parties, thus facilitating to reach agreements over the initial requirements.
- Specification change record database: being able to register every modification from the initial specification, and telling what to do when it happens from the beginning of the project.
- New financial ecosystem support: helping the economically weaker project members to fulfill their tasks without financial institutions or guarantee agencies.
- Risk management: insurance tool between parties without an intermediary institution. Making the stakeholders to feel comfortable and to share the project risk.

Planning:

The main target of this phase is to develop and agree the project management plan [15]. BCT could be a perfect tool for reaching the agreement over the plan from every stakeholder, and for adding to them smart predefined actions. So it can be used as a:

- Settlement tool, in terms of time and cost based in the scope previously agreed.
- Boundaries definition: the Smart Contracts present in the project's blockchain could include actions depending on the fulfillment of each arranged task in time/cost/quality with incentives or penalties. It will lead to have well defined and settled project boundaries.
- Risk identification: BCT can also include the risk present in each task and how it can influence others; consequently, it could modify dynamically priorities and critical parameters in other related project items.

Execution:

During the execution phase planning updates are done [15]. A BCT network can be the trusted based tool for streamline these actions by:

- Increasing the flexibility for decision making, removing bureaucracy and intermediaries.
- As 'on the go' contracts and agreements enabler tool. Making easier and practical the use of flexible contracts.
- A base for reliable and trusted communications, providing the state of the project updated up-to-the-minute in a transparent way. It could become a key element in the project information flow.
- Workflow management [16]: Activating the agreement over the finalization of some tasks required for starting others.
- Component tracking and authenticity database [17]: assuring that the material and components present in the requirements are the ones they should be.
- Requirements management and acceptation tool. Holding not only the change for agreement but also how it impacts globally the project (feasibility, time, costs, risk…).

Monitor and control:

Here are placed all the processes required to track and review the progress and performance of the project [15]. The capability of being a distributed trustworthy ledger of blockchain, makes it interesting for:

- Traceability and fulfillment of the validation and test of each WBS component.
- Source of real time and trustworthy information. It can be valuable for the stakeholder management and also for the internal use of the project manager as an information gathering tool.
- Historical registry of every meaningful indicator.

Close:

The main function of this stage is to formally complete the project, phase, or contractual obligations [15]. Here BCT could bring:

- A smart contract fulfillment tool: only when every part have validated that all the requirements are met the project can be closed.

- A valuable source for lessons learned and future analysis: it records the project evolution.

- Auditing database: the owners of the project can use the data inside the blockchain network for audit and evaluation purposes.

The advantages of using the blockchain network could be extended beyond the project lifecycle, exploiting its functionality for warranty, maintenance, or product management purposes among other things. The blockchain network can promote the continuity of project consortium teams drawing on previous successful collaborations

3.2 BCT and PM Knowledge Areas

The PMBOK guide in its 5 edition identifies ten knowledge areas that are used broadly and frequently in projects [15]. For each one, it provides a set of processes, tools and techniques to handle them properly. Hereunder can be seen how the use of BCT can benefit them:

Project Integration Management: BCT can serve as a trustful information database [6] of the project evolution and as an agreement ledger among all the stakeholders. It can register the settlement of the requirements, time, costs and evolution and would be used for the project's monitor and control.

Project Scope Management: BCT could gather all the features and characteristics that the project will have and will not have. It has the validity of a trustful third party, but using DLT the bureaucracy will be reduced and the required time will be shortened.

Project Time Management: the time plan at the beginning of the project could be agreed and registered in the blokchain network, as well as the time changes during the project execution. Its Smart Contract capability could help in meeting the deadline.

Project Cost Management: the expenses could be registered inside the blockchain just in time they are done. The accountability advantages that BCT contains could fit really well during the project development, using it also as a distributed and transparent economical transactions ledger.

Project Quality Management: the BCT could act as a registry for the test and validation activities required to accept the fulfillment and finalization of a work package [16], enabling automatically the execution of the following dependant one (smart contract capabilities). Using it inside the supply chain management processes can make it possible to check and track every component employed inside the project [17], making it especially useful in cases where the quality and acceptance requirements are high (aerospace, military…)

Project Human Resource Management: currently, the technology of blockchain and its applications in human resource management are being studied deeply. Its capability in the field of identity management and the possibility to add the particular characteristics of each resource (worker, machine, service…), can lead to a better knowledge of the profiles required for each task and could bring to achieve better time/cost/quality estimations depending on their characteristics.

Project Communications Management: BCT provides a trustworthy, transparent, shared and common information channel for every participant in the network [6]. Furthermore the information updates are done in question of minutes depending on the network configuration.

Project Risk Management: like in the management of the scope, time and cost, BCT can help here storing securely all the risks identified for each task to perform, as well as their mitigations and circumventions. The actions to be taken can be agreed in real time for all the blockchain network participants. Using smart contracts, some automated actions can be programmed when a certain risk emerge or cannot be avoided.

Project Procurement Management: the use of BCT in supply chain management [10] can help broadly in this knowledge area. Integrating suppliers, project sponsors and end users inside the BCT, could facilitate the changes management and their global impacts in the project. Its communication capability will make any modification, missing components, resource changes, etc. to be shown up in every participant node, and could be required a common agreement in the solution for moving ahead. BCT can handle this with trust, transparency, and security in a distributed way.

Project Stakeholder Management: the BCT could bring a new way of managing the stakeholders, integrating them at different levels in the network. Setting a transparent information channel in the project, and making them participant in some of the decision processes and agreements, could enhance their view of the project [15].

4. Discussion

This article introduces the potential of BCT in PM, but its downsides have not been addressed. Before a wide adoption of this technology is done, it should be found a solution for at least the following challenges:

Complexity: in terms of scalability, computer power and technological architecture [18].

Regulatory, legal and security: there is no framework ready to face these issues [19].

Interoperability: without standardized protocols and models will not be possible to make BCT interoperable, hindering the data exchange and blocking the collaboration between platforms.

Cultural: it is a new way of doing things, so it should be overcome the fear of change.

Resources: the deployment of a blockchain network will require time and investment and, in some cases, could make useless the money spent in traditional infrastructure.

Rewarding System: in systems that doesn't deal with money, it will not be easy to find volunteers for validating transactions (i.e. information management etc.)

Private blockchain will be less affected in the complexity, interoperability, regulatory, and rewarding terms. So it could be early adopted in different fields, including PM, bringing them all of its advantages.

Future research should make a deeper analysis on its implementation and the degree of impact in applying this technology in each one of the PM processes and knowledge areas. The utilization of blockchain can also vary depending on the project type or the managerial style employed, so its use can be different according to the PM area or sector to be applied.

5. Conclusions

Thorough this article some of the possibilities of applying BCT in the field of PM has been shown. This new technology enables a new way of doing that makes it disruptive in several fields. Now the real challenge is to identify how BCT is able to deliver real value inside the PM considering it as a whole, not only as a new tool.

The characteristics that BCT provides are transforming the existent business models by authenticating traded goods, facilitating disintermediation and improving operational efficiency. All of these advantages can be transferred to the PM world, and the project managers should be aware of the new opportunities that the use of BCT can bring to them.

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Risk Management: an increasing matter of concern in Sustainable Project Management literature?

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Abstract:

According to some authors such as Carvalho and Rabechini (2015) or Brones et al (2014), risk is identified as one of the most critical processes and knowledge areas of integrating sustainable aspects into Project Management. However, literature research shows that, despite the processes approach has been the most used by the main authors to introduce sustainability in Project Management (Marcelino et al, 2015), risk is not one of the more frequently mentioned processes. This work explores the points of intersection between sustainable risk management and project management by means of a systematic literature review.

Keywords: sustainability; risk management; project management.

1. Introduction

Sustainability, as defines the APM Body of Knowledge, describes an environmental, social and economically integrated approach to development that meets present needs without compromising the environment for future generations [1]. This is a time of great challenges to sustainable development. Our way of living consumes more resources than the planet can supply. In 2017, humanity needed 1.7 planets to support its demand on Earth ecosystems. We use more ecological resources and services than nature can regenerate through overfishing, overharvesting forests, and emitting more carbon dioxide into the atmosphere than forests can sequester [2]. However, thanks to rapid advances in technology, medicine, dissemination of information and knowledge, among others, this is a time of great opportunities too, and sustainable project management is one of these opportunities to face the sustainable development challenge.

Results of a recent study carried out by Schoper et al. [3] suggest that in advanced economies around one third of all economic activities is project work. The study also reinforces the hypothesis of an increasing projectification over time. Organizations are increasingly keen on including sustainability in their business, and project management can help make this process a success [4]. According to Silvius [5], the integration of the concepts of sustainability into processes, standards and practices of project management is an emerging field of study and is picking up momentum. Based on his analysis, it was concluded that sustainability emerged as a new school of thinking in project management.

Previous literature reviews show an upward trend in the number of academic publications on the topic of sustainability and project management, especially since 2010 with a peak in 2016 and 2017 [4]-[7].

Many publications found in these literature reviews focus on the integration of sustainability into the processes of project management and delivery. For instance, the review of Marcelino-Sádaba et al. [4] reports that the processes approach is the most used by the main authors to introduce sustainability in project management and the processes more frequently mentioned are: Stakeholder management, Life cycle management, Assessment and Decision-making. According to some authors such as Brones et al [8] or Carvalho and Rabechini [9], risk is identified as one of the most critical processes and knowledge areas of integrating sustainable aspects into project management.

The main objective of this paper is to explore the state of the art for the integration of sustainability into risk management, one of the fundamental components of every project, programme and portfolio.

2. Background

Some authors identify risk as one of the most critical processes and knowledge areas of integrating sustainable aspects into project management. Brones et al. [8] carried out a case study which results indicate that environmental issues may affect not only technical issues but also the main knowledge areas of project management. According to them, the most critical aspects for integrating environmental issues into the discipline of project management are the supply chain, quality, deadlines and risk. For Carvalho and Rabechini [9] particularly relevant is introducing sustainability in the project management areas of scope, human resources, stakeholder, communication, procurement and risk.

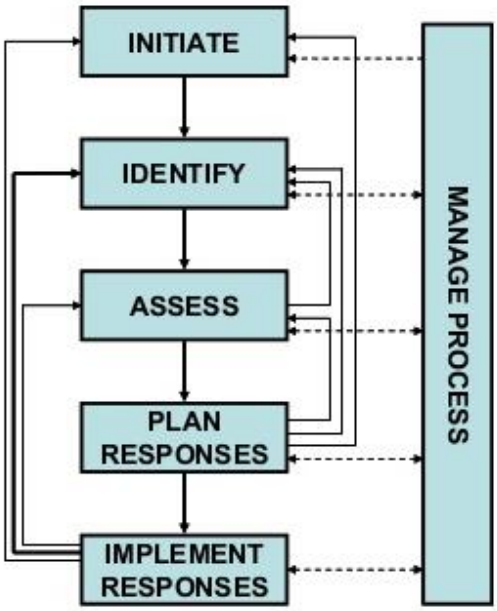

Figure 1. The PRAM Guide risk management process [10]

Risk is one of the fundamental components of every project, programme and portfolio, along with scope, schedule, finance, quality and resource [1]. Thanks to the integration of the risk management process with other project management processes, the risk information, including environmental and social aspects, arrives to project planning, estimating, resource planning or change management, among other parts of the project process.

The most recognized project management standards (PMBOK Guide, PRINCE2, ICB4, ISO 21500:2012, etc) include risk management as an essential part of project management. Some of them have even developed specific standards for risk management. For instance, the Association for Project Management (APM) has developed the Project Risk Analysis and Management Guide (PRAM Guide) [10], which describes a systematic and disciplined approach to controlling risk that can be used to improve the success of projects.

The risk management process must fit to the specific requirements of the project, so the introduction of sustainability aspects in the project requirements should cause an evolution in potential risk identification and assessment. For example, not only economic risks but environmental and social risks must be considered. It must be ensured also the consideration of long term risks, including that related with the project product decommissioning or disposal phase. And all stakeholders must be identified, with the aim of involve them in the risk management process and be able to detect and consider all potential risks for them.

The plan responses phase is also affected by the integration of sustainable aspects in the process. Threats (risks with adverse consequences for the objectives of the project) can be avoided, reduced, transferred or accepted. From an economical approach, responses are implemented that avoid or reduce the effects of threats to the extent that the invest on response actions do not exceed the likely value of consequences from accept the risk. Besides, an economical threat can be transferred by means of insurances, compensations, penalties, etc. But from a sustainable approach, irreversible damages such as depletion of aquifers, for example, only must be avoided or reduced, regardless the economic response costs, and not transferred or accepted.

The work hypothesis for this paper states that if risk is one of the fundamental components of every project, the integration of sustainability in project management will be boosted by integrating sustainability in risk management.

3. Research method: literature review

First, a bibliographic search was carried out in Scopus, a leading scientific database. On the one hand, “Sustainability” and “Risk Management” were used as basic search words. The search words were applied to the titles, abstracts and keywords obtaining 1.292 documents (including all types of documents). Figure 2 shows the temporal distribution of the publications, which reveals a clear growing evolution from 1991 to 2017.

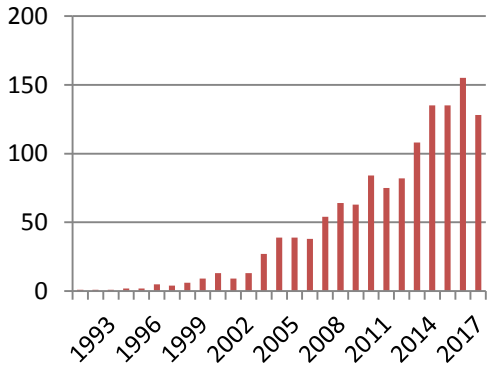

Figure 2. Documents on sustainability and risk management.

On the other hand, a new search using “Sustainability” and “Project Management” as basic search words was made. The search words were also applied to the titles, abstracts and keywords obtaining 1.682 documents. Later, adding the word “Risk” to the search, the result is reduced to 214 documents. A first observation from these data is that approximately 90% of the publications on sustainability in project management do not address the topic of risk management at all.

Document type	Sustainability & PM	Sustainability & PM & Risk
All	1.682	214 (12,72%)
Conference paper	726	95 (13,09%)
Article	691	86 (12,45%)
Review	139	13 (9,35%)
Book/book chapter	55	7 (12,72%)
Other	71	13 (18,31%)

Table 1. Publications on sustainability in project management and those focus on risk.

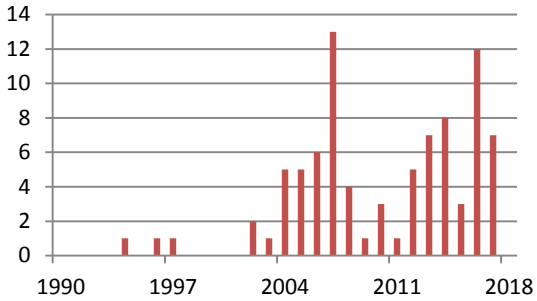

Figure 3. Articles on sustainability, project management and risk.

In order to analyze the most homogeneous set of publications approved by a peer review system, scientific articles were selected from the whole documents previously obtained. Based on the group of 86 articles identified at the intersection of the three fields of knowledge of sustainability, project management and risk, content analysis was used to assure that the articles address the topic of the research.

4. Results from the literature review

Content analysis reveal that a very few number of articles deals with the integration of sustainability in risk project management. The main approaches and conclusions of the five most representative articles are summarized below.

Fernandez-Sanchez and Rodriguez-Lopez [11] develop a methodology to identify, classify and prioritize sustainability indicators based on risk management standards. The authors tried to evaluate the possible viability of applying the existing risk management techniques (techniques from Project Risk Analysis and Management Guide and PMBoK standards were used) to the identification of sustainability indicators in construction project management.

Focusing in the minerals industry, [12] and [13] highlight practical ways for incorporating sustainability into project management. Both papers present SUSOP® (Sustainable Operations), a systematic framework for identifying and evaluating sustainability opportunities and risks. The aim of this framework is to provide a standard approach to translate sustainability principles into operating practice and design without compromising financial rigour. SUSOP® framework consists of three key elements: Identification of sustainability opportunities and risks (including familiarization with sustainability concepts and project context, goal scoping and identification, analysis and prioritization of opportunities and risks); sustainable development assessment; and decision support.

In the area of advanced technology facilities, Chasey [14] explains how the use of BIM (Building Information Modeling) can reduce risk and integrate sustainability thanks to early detection of errors. Risk reduction comes through improved understanding and coordination in the management of a project by decreasing construction conflicts, eliminating construction waste and reducing project cost. Besides, facility models can be used to investigate sustainability ideas, such as shading, acoustics, daylighting, and energy usage with less risk during the preconstruction phase.

On the other hand, Dominguez-Gomez [15] examines the main reasons why weaknesses like deficiencies in the integration of environmental and social analysis of development projects remain, despite the increasing interest in risk and impact analysis showed by scientific and business communities in recent years. Specialists and professionals have noted that their studies need the knowledge of the social to plan and carry out their projects in a sustainable way, but they lack awareness of how to integrate the social into the forms, models and methods that they habitually use. According to the author, this is where Social Impact Assessment (SIA) can offer more as a discipline.

5. Conclusions

A bibliographic search on the intersection of sustainability and risk management fields shows a growing number of publications in the last three decades. Given this trend, one might expect a similar evolution of sustainable risk management into the field of project management.

However, a systematic literature review exposes that the publications found in Scopus, one of the main databases of scientific articles, are very limited in the number of papers on the topic of integration of sustainability in risk project management (86 articles, only five of which are more consistently linked to the topic). Considering that risk is one of the most critical aspects for integrating sustainable issues into the discipline of project management, it is surprisingly so little attention in this topic by the project management researchers.

From the selected articles dealing with the integration of sustainability in risk project management we can extract two main ideas: First, the integration of sustainability in project management should try to use the current tools, methods or procedures to work with the entrenched project management systems. And on the other hand, sustainability requires to take into account the diversity of information sources to effectively address the interests and needs of all the stakeholders.

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Project Controlling in the Automotive Industry: A Critical Evaluation of Methods and Tools for Suppliers' Engagement

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Abstract:

Due to consumer pressure, government regulations, and stakeholder demands, companies face challenges in identifying the most useful practices and learning how these practices are related to each other [1]. When approaching project management methods and tools in relation with a specific industry, it is important to be able to extract necessary information from existing standards. This paper offers a preliminary study on how relationships between OEMs and numerous suppliers are dealt with during project monitoring and controlling process in automotive projects according to the standards and available researches.

Keywords: project controlling process; automotive industry; OEM; standards

1. Introduction

The development of the project management methods and tools in the automotive industry caused significant changes in approaches to relationships between carmakers and their subcontractors. From the perspective of project management methods and tools, existing in automotive industry studies have defined concepts and organizational frameworks for effective ''projectification" of product development processes in the following areas: concurrent engineering and involvement of major number of suppliers [2] [3] [4] [5]. These two areas have emerged from the need to continuously keep developing new products and shortening car production cycle. The increasing role of suppliers in the automotive industry is supported by statistics on value added development in the automotive industry (see *Figure 1*).

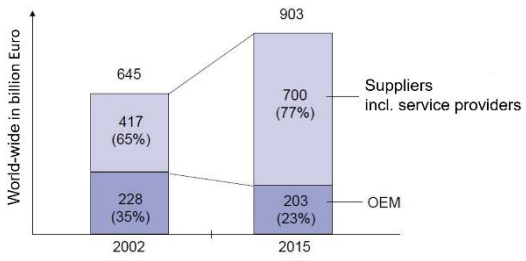

Figure 1. Value added development in the automotive industry [5]

According to a Guide to the Project Management Body of Knowledge (PMBOK® 6) [6], project management offers five project management process groups; initiating, planning, executing, monitoring and controlling, and closing. This paper offers a preliminary study on how relationships between OEMs and numerous suppliers are dealt with during project monitoring and controlling in automotive projects according to standards and available researchers.

2. Project controlling in project management standards

2.1. PMBOK® approach

PMBOK® describes controlling as a "process of tracking, reviewing, and reporting the overall progress to meet the performance objectives defined in the project management plan" [6]. This standard directly specifies benefits of the controlling process group for stakeholders. It allows "to understand the current state of the project, to recognize the actions taken to address any performance issues, and to have visibility into the future project status with cost and schedule forecasts" [6]. PMBOK 6 outlines the importance of data analysis and its tools that are as follows:

- Alternatives analysis
- Cost-benefit analysis
- Earned value analysis
- Root cause analysis
- Trend analysis
- Variance analysis

One of the processes in the controlling group is "Monitor Stakeholder Engagement". This process is meant to monitor project stakeholder relationships and tailor strategies for engaging stakeholders. It can contain the following tools [6]:

- Expert judgment
- Communication skills
- Interpersonal and team skills
- Ground rules
- Meetings

Furthermore, the amount of communication channels that is directly dependent on the number of stakeholders is mentioned. The total number of potential communication channels is n*(n – 1)/2, where n represents the number of stakeholders. For example, a project with 10 stakeholders has 10(10 – 1)/2 = 45 potential communication channels. [7]

The only direct mentioning of the automotive industry can be found in the fifth version of this standard. Design of experiments (DOE) is a statistical method used to identify factors that may have an influence on specific variables of a product or process. DOE is suggested to be applied during the plan quality management process in order to determine the number and type of tests and their impact on cost of quality. Furthermore, it is stated that automotive designers use this technique to determine which combination of suspension and tires will produce the most desirable ride characteristics at reasonable cost.

2.3. P2M approach

P2M is the Japanese version of project and program management, whereas the so called Kaikaku Project Management (KPM) is an advanced version of P2M [8]. P2M/KPM involves a big deal of innovation management and has been successfully applied in the Japanese automobile industry. Siang and Yih [9] have conducted a comparative study of P2M/KPM, including its application in the automobile industry.

In the automobile industry, development projects focus on deliverables, aiming at efficiency improvement through reduction of the size of projects and the maximum use of similarity and relevancy. An example is the strategic sharing of parts, which “greatly cuts man-hours for projects, ensures the quality of shared parts and increases their reliability, making a strong contribution to enhancement of corporate competitive power”. In addition, automobile manufacturers experience the two-boss problem and the Development Program Management of P2M/KPM is adopted to highlight the roles of the team members in a project. [9]

Companies that exercise the P2M/KPM methods have well-designed systems and well-equipped devices to accommodate the two following areas: responsibility for quality control and backwards operation process planning system with a focus on securing delivery [10].

3. Project Controlling in other standards

System development in the automobile industry is required to comply with functional safety standard ISO26262:2011. Quality management is extensively described in ISO/TS, bringing together respective standards from Europe and the US and providing well-structured points of reference for design and manufacture of products for the automotive supply chain. Furthermore, ISO/TS 16949 is made on the basis of the internationally recognized quality management system standard, ISO 9001. Its main purpose is the promoting of continual business improvement through focusing on defect prevention and reduction of variation and waste in the supply chain. This standard is very important, as it has been developed by the International Automotive Task Force (IATF). IATF consists of nine most renowned automotive manufacturers, such as BMW, Chrysler, Daimler, Fiat, Ford, GM, PSA Peugeot Citroen Renault and VW.

ISO/TS 16949 uses the term “control plan” as documented description of the systems and processes required for controlling product. The element 7.5.1.1 Control plan is presented in Table 1.

The organization shall
□ develop control plans (see annex A) at the system, subsystem, component and/or material level for the product supplied, including those for processes producing bulk materials as well as parts, and
□ have a control plan for pre-launch and production that takes into account the design FMEA and manufacturing process FMEA outputs.
The control plan shall
□ list the controls used for the manufacturing process control,
□ include methods for monitoring of control exercised over special characteristics (see 7.3.2.3) defined by both the customer and the organization,
□ include the customer-required information, if any, and
□ initiate the specified reaction plan (see 8.2.3.1) when the process becomes unstable or not statistically capable.

Table 1. Control plan according to ISO/TS 16949 [11]

ISO/TS 16949 prescribes to an organization the following elements of the control plan (see *Table 2*).

a) General data
− control plan number,
− issue date, and revision date, if any,
− customer information (see customer requirements),
− organization's name/site designation,
− part number(s),
− part name/description,
− engineering change level,
− phase covered (prototype, pre-launch, production),
− key contact,
− part/process step number,
− process name/operation description.
b) Product control
− product-related special characteristics,
− other characteristics for control (number, product or process),
− specification/tolerance.
c) Process control
− process parameters,
− process-related special characteristics,
− machines, jigs, fixtures, tools for manufacturing.
d) Methods
− evaluation measurement technique,
− error-proofing,

− sample size and frequency,
− control method.
e) Reaction plan and corrective actions
− reaction plan (include or reference),
− corrective action.

Table 2. Control plan elements according to ISO/TS 16949 [11]

Overall, ISO/TS 16949 describes general processes of quality management in the automotive industry. It offers few points on relationships with a supplier that contribute to the understanding how project controlling process can be done in relation to suppliers. For example, "when required by the customer, the organization shall have a prototype programme and control plan; the organization shall use, wherever possible, the same suppliers, tooling and manufacturing processes as will be used in production" [11]. Another instance "when there are mergers, acquisitions or affiliations associated with suppliers, the organization should verify the continuity of the supplier's quality management system and its effectiveness" [11]. Therefore, stable relationships with suppliers contribute to the quality of the product and important for effective controlling processes.

4. Project Controlling in other sources

In the English literature, there is a lack of solid books and researches on project management in the automotive industry. There are some on quality management, operations management, etc. For this reason, in this chapter, findings from the German works of Wagner are presented, due to their specific information on project management and controlling in the automotive industry. The researcher has published several books (in cooperation with other authors) on project management in German with a holistic approach to its matters.

Wagner emphasizes on the importance of a culture that provides optimal cooperation between the partners over the duration of the project. Moreover, long-term partnerships should be based on "mutual commitment to the agreed objectives and rules of the game, through a fair distribution of opportunities and risks, and through mutual respect for the partner's autonomy". The author states that suppliers must be involved much earlier in the project for the clarification of objectives than before.[5]

Hab and Wagner [12] state that the principal controlling activities are repeated periodically (controlling loop), e.g. in a monthly rhythm, so that at every audit, the data is up-to-date; and, in general, project controlling includes all measures ensuring to keep the project "on track" in terms of the defined goals. The so-called system of project controlling is aimed "to show the link between the individual methods from variance analysis to reporting". The researchers refer to the role of the controller, too. In many cases, it includes providing planning and controlling data and maintaining the respective systems. Furthermore, the project controller is responsible for "gathering information and the analysis of causes in case of deviations between plans and the documented results".

The first essential point to analyze is the information about the project status (target and actual dates, target and actual costs, target and actual quality, and product maturity) and project progress (completed work packages and an outlook to the end of the project). Then, deviations from the project plan are analyzed, decisions about corrective actions are made and activities for their implementation are initiated. The authors also state that customer changes and their control of the project (change management) and also the resulting additional cost claims (claim management) reside in the area of project controlling too. [12]

Hab and Wagner offer the following main instruments of project controlling [12]:

- Deadline- und progress control, Milestone-trend analysis
- Cost control/Earned Value Management (monthly)
- Maturity degree controlling for product and process
- Variance analysis
- Controlling measures
- Discussion of the project status
- Reporting and accordingly the project status report
- Change management und claim management

In general, their work provides a very wide view on project management in the automotive industry as well project management in general. Still, the book provides some automotive specific insights such as maturity degree controlling method.

5. Conclusions and discussions

The subject of controlling is relatively underexplored in the English literature on project management. The most extensive instructions on controlling can be found in ISO/TS 16949. However, they are almost purely related to quality management, offering only few points on project controlling processes in relation to suppliers. Companies that exercise the P2M/KPM methods have well-designed systems and well-equipped devices to ensure responsibility for quality control and backwards operation process planning system. Wagner and Hab's work can be said to provide the most holistic view on project management in the automotive industry.

All studied sources highlight the importance of stakeholders, namely, suppliers. According to PMBOK, it is important to monitor stakeholder engagement and in this area the amount of communication channels have to be taken into account. Project management scholars state that inefficient communication is proven to be the biggest reason for project failure [13] [14] and cooperation and interaction are important success factors [5]. Although there are quite some project controlling tools mentioned in the project management literature, projects are still difficult to track and some issues are brought to bear only when they already have a big impact. Therefore,

further research is suggested to provide evidence on how exactly communication channels with stakeholders can be controlled and analyzed within the project controlling processes and how their amount influences project success.

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Teaching Risk Management in Projects Using Monte Carlo Simulation and Excel

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Abstract:

Although the term 'risk management' on the first sight suggests only the management of negative effects, it comprises all kinds of uncertainties, let them be chances or risks. The treatment of uncertain events however quickly becomes too complex to be handled analytically. As a project is complex by definition, this always holds true especially in this context. Monte Carlo simulation on the other hand offers the advantage to capture probabilistic behavior and allows to estimate key statistics that cannot be derived analytically. Furthermore, a lot of students developed a high level of expertise in the use of spreadsheets, which leads to the very fruitful combination of using Excel as a tool to introduce Monte Carlo simulation into risk management in projects.

Keywords: risk management, Monte Carlo simulation, Excel.

1. Introduction

Risk management is an integral part of project management and even one of the ten knowledge areas described in PMBOK [1]. Furthermore, the term 'risk' not only covers negative risks, but also positive risks – normally described by terms like 'opportunities' or 'chances'. This means that risk management in projects really implies the management of all kinds of uncertainties – let them be in costs, in time, or in quality. And as a project is characterized by attributes like uniqueness, complexity, temporariness, etc. no project can be risk-free in that sense.
The teaching of risk management in projects therefore should include a section about the handling of such uncertainties, particularly in the 'quantitative risk evaluation' phase of the PMBOK risk management framework.
Not only that the attitude/relationship to uncertainties depends on the culture (c.f. [2], [3]) and that most people have major difficulties in the interpretation and application of probabilities (c.f. [4], [5]), one has to face the fact, that an analytical approach is only possible in quite trivial cases. Therefore, we need a differing access to problems of that kind.

2. Monte Carlo Simulation and Excel

Monte Carlo simulation (c.f. [6], [7], [8], [9], [10]) is a general approach to calculate even very complex models that contain only assumptions about the distributions of some parameters. It is possible to simulate the behavior of such a system by generating a huge quantity of random numbers that follow exactly the assumed distributions.
The way to achieve this is quite elementary: A lot of computer programs/languages contain random number generators that create random numbers uniformly distributed in the interval (0,1). If the density of a distribution is known, you can easily transform these uniformly distributed random numbers to the wanted distribution by transforming them with the inverse of the cumulated distribution function.
Let us illustrate this procedure with a quite simple example: Assume that we estimated the costs of an activity to be between 50 and 100 with a probability of 20%, between 100 and 150 with 40%, and between 150 and 250 with another 40%. Then we get the density and the cumulated distribution given in figure 1.

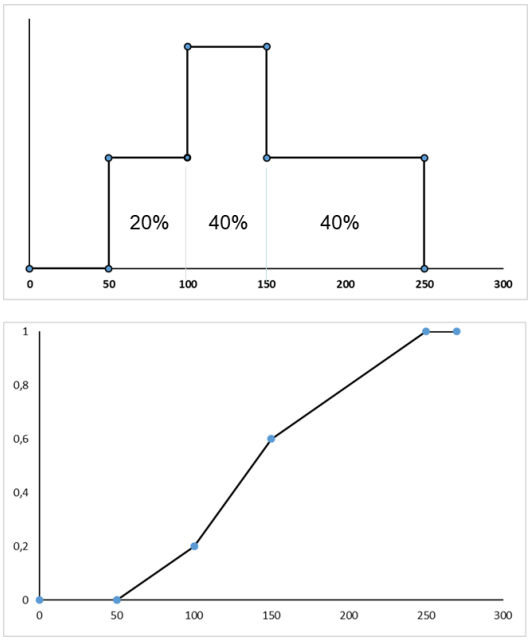

Figure 1. The density and the cumulated distribution

If we now generate a number of uniformly distributed random numbers out of the interval (0,1) (on the vertical axis) and transform it with the inverse of the cumulated distribution (to the horizontal axis), we obtain random numbers that match the wanted distribution (c.f. fig. 2).

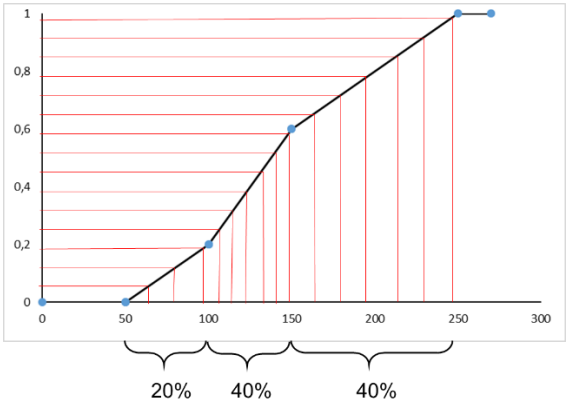

Figure 2. Transformation of random numbers

Although there are a lot of commercial simulation packages like GPSS, SIMSCRIPT or SIMUL8, that offer a lot of powerful features, we believe that spreadsheets provide essential advantages especially from the pedagogical point of view.
First of all, we want to avoid that the students have to acquire special knowledge just for a particular application. Most of the students are quite familiar with Excel and developed a high level of expertise in the use of spreadsheets, which range from the use of simple cell formulas to sophisticated VBA programming. This enables a rapid start with the main topic without teaching the use of tools in advance (c.f. [11).
On the other hand, we also prefer to show that Monte Carlo simulation has no black box character in the sense that an average student can easily comprehend the way the simulation works. Working with Excel comprises the implementation of the basic ideas of Monte Carlo simulation into the spreadsheet and by this additionally offers the opportunity to take advantage of the high flexibility of this tool.
Furthermore, the well-known features like the integrated graphics, the magnitude of internal functions, and the availability of add-ins and add-ons constitute a tremendous support in the approach to the topic (c.f. [12], [13]).
The internal functions cover a lot of the above mentioned inversion of distributions like normal, beta, gamma, and chi-square distributions. More inversions can easily be generated by cell formulas – noteworthy triangular or (the above illustrated) frequency distribution.
Add-ins or add-ons – like Crystal Ball, XLSim or @Risk – are useful supplements that can leaven the application, but on the other hand bear the danger of generating the black box impression again.
In our lectures we offer the students a small set of example files that contain solved realizations of triangular, frequency, and normal distributions and additionally of correlated normal distributions. We made the experience that with the involvement of these files, the students have no great problems to solve even quite complex cases (shown afterwards).
In this context we also have to state supplementary the modular character of Excel, that enables to share the data between different sheets and even different files, and by this supports the process of modelling complex situations (as illustrated in figure 3).

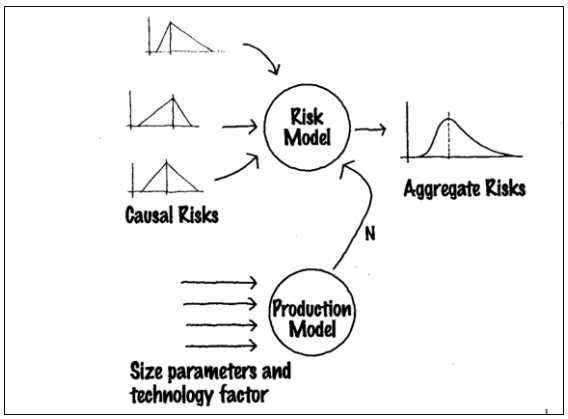

Figure 3. Risk modelling concept (source [14])

3. Examples/Cases

Let us now look at three cases: One for each of the three objective criteria costs, time, and quality. These cases belong to a set of cases that the students have to solve during the semester as some kind of homework.
Figure 4 describes a situation with uncertainties in costs. A typical question that can immediately be answered with a Monte Carlo model can be: „Which amount of money do we need to cover the entire costs with a probability of 95%?". And the answer in our case is 650 T€.

Activity	Distribution of Costs (T€)
A	50 - 100 20 % 100 - 150 40 % 150 - 250 40 %
B	normal $\mu = 70$, $\sigma = 10$
C	triangular distributed - optimistic value (ov) 60 - most probable value (mv) 100 - pessimistic value (pv) 120
D	normal $\mu = 120$, $\sigma = 20$

Risk	Probability of Occurrence	Distribution of Impact (costs in T€)
1	10%	normal $\mu = 100$, $\sigma = 20$
2	15%	triangular ov = 40 mv = 80 pv = 100
3	5% / 20%	normal $\mu = 150$, $\sigma = 10$

- additionally there is an assumed correlation of 0.3 between the cost of activity B and D
- for the third risk we assume that the probability of occurrence is 5% if risk 1 does not occur, otherwise 20%
- all the other distributions are assumed to be independent from each other.

Figure 4. Uncertainties in costs

Figure 5 gives us the situation with uncertainties in time. In this case you have to create the net structure and then model all the predecessor/successor relations and of course the additional conditions. Here a typical question might be: „What is the probability of finishing the whole project within 40 days?". The answer in this case is about 92%.

Activity	Predecessor	Distribution of Duration (days)
A	-	normal $\mu = 9, \sigma = 2$
B	-	triangular OD = 8, MD = 10, PD = 14
C	A	normal $\mu = 5, \sigma = 1$
D	A, B	if the start of D is before day 10, then normal $\mu = 8, \sigma = 2$ otherwise normal $\mu = 12, \sigma = 3$
E	B	if the duration of B is less or equal 10 days, then normal $\mu = 8, \sigma = 2$ otherwise normal $\mu = 14, \sigma = 3$
F	C,D,E	normal $\mu = 10, \sigma = 3$

There is an estimated correlation of -0.5 between the durations of activity A and C. All the other distributions are independent from each other.

Figure 5. Uncertainties in time

The tree structure given in figure 6 shows uncertainties in quality. This is a typical situation that you have to face in R&D project. The probability that the whole project fails is about 16%.

In a R&D project you have to overcome three different phases. In each phase several tasks have to be performed and for every task there is the probability to fail. Whereas in the first two phases **at least one of the tasks** needs a positive outcome to overcome the phase, in the third phase at least **three of the four tasks** got to be successful to overcome this phase. The question here of course is the **probability that the whole project fails**.

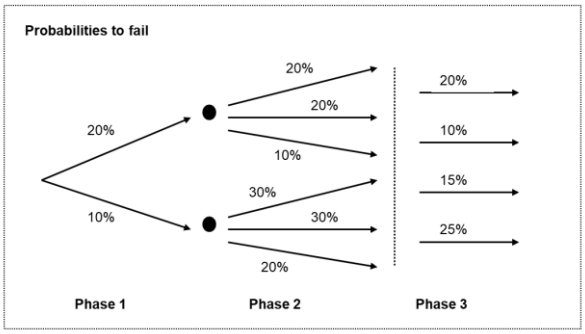

Figure 6. Uncertainties in quality

Details about the solutions of the 3 cases can be found in [15].

3. Conclusions and Remarks

The longtime experience in teaching risk management in projects has clearly shown the benefits of using Monte Carlo simulation in connection with Excel. The students have little problems in rapidly solving cases like the 3 shown above. Apart from the fact that this provides a positive motivation, this also gives reason to claim that by applying these methods the students understand the whole procedure quite easily.
But Monte Carlo simulation in combination with Excel should not only be seen as a teaching tool: It is also a valid tool for practical applications. Especially in the discussion about agile approaches with little necessary effort, this is an adequate line of action. An Excel model can also be updated very easily and fast and therefore be a helpful tool during the whole lifespan of a project.

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Gamification of Agile Project Management for Software Development Projects

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Abstract:

One of the key success factors for projects is a high motivation of the team members. On the other hand, especially the usage of administrative tools is often tiring and demotivating for the users. Gamification is a recent trend in user interface design, which aims to motivate users to use a software, adding game elements to non-game software tools, utilizing their mechanics to keep up motivation and interest. Gamification is currently widely used, for example, in software for forums or education software. Such concepts ensure especially a high long-term motivation to keep using the software and perform well. In this paper, we present our approach to gamify a project management system for agile software development, to ensure a high motivation of the team members to work towards the common goals. For this, we added gamification elements to a task management system for software development, in particular, for the development tasks and studied their impact on the developers' behavior.

Keywords: Gamification; Task management systems; Agile project Management.

1. Introduction

Project Management is defined as "the application of knowledge, skills, tools and techniques to a broad range of activities in order to meet the requirements of a particular project" according to The Project Management Institute (PMI). One can realize that the main challenge in project management is the achievement of the project's goals under some constraints that can, for example, be constraints in time, quality, budget, etc. [1]

There are many aspects that should be considered to have a successful project, some are more important than others. One of the crucial aspects of success is having an engaged, motivated team, which is the focus of this research and project. Human resources are the key to the success of any project, having unmotivated employees in a team, makes working a heavy burden and is something to avoid whenever possible. [1]

The aim of this project is to approach the problem of unmotivated employees, which will consequently help in offering a healthy working environment. This paper offers a method to motivate particularly a team of developers working on Software Development projects. It studies the addition of Gamification elements to the work environment, and the consequent effects on performance and productivity.

Gamification, as defined by Werbach and Hunter, is" the use of game elements and game-design techniques in non-game contexts". It focuses on the use of game concepts in non-game contexts, in order to engage and motivate people to achieve some goals, which can be both, one self's goals and the project's goals one is working on. [2]

Gamification has been added to many aspects of life, one can find gamification in education, such as Duolingo, which is an application that motivates people to learn new languages, other applications are in health, business, and many other sectors. Researches shows that gamification has positive effects on people, taking into consideration the differences from one person to another. [3]

Tasks in software development can often get tedious and demotivating, moreover, the use of administrative tools is tiresome for developers to do. Unmotivated developers can put projects in jeopardy, as the human resource is very important to the success of projects.

This paper studies the addition of Gamification to the work environment, through developing a plugin that is added to task management systems. This plugin will help in motivating the developers by showing them some game elements like points and badges they gain depending on their performance and productivity. It also offers some periodic challenges between the developers. This motivation will have a good impact on the workers themselves who will be more motivated to develop themselves, and thus a good impact on the project as a whole. Moreover, this plugin keeps track of all of the developers' activities, which makes it possible to add another feature for the use of the management team as a recommendation system, which will recommend some developers to some tasks depending on their skills, status, and other aspects as well.

In the rest of the paper, related work will be shown, followed by an overview of the project and the contributions it adds to the gamification research topic. The game design concepts and mechanics will then be explained, finally ending with a conclusion

2. Related Work

Besides the manifold work on gamification in general and for specific applications, e.g. in education, there has also been research on gamification in software development.

M. Trotzek et al. provide in "Gamification Fundamentals and State of Research and Development" [4] an overview, in which the concept of Gamification is thoroughly explained from different aspects, including more application-wise explanations as well, as some further future work.

One of the specific solutions is offered by the scientific work on "Gamifying Software Development Environments Using Cognitive Principles", which was based on categorizing the users into pre-defined categories: the creators (architect, programmer, customizer), and the reviewers (architecture reviewer, code reviewer, tester). Creators are responsible of their work, and the reviewers give points for them.

This approach adds more work to be done by the developers, whether they are creators or reviewers, which makes it more troublesome and time consuming to them. This also reduces the developer's concentration on the main work. Our approach is to let the system handle all of this added effort, and change nothing on the regular project methodology and processes. [5]

Another related work is the "Turning Real-World Software Development into a Game" paper. It covers the concept of adding gamification to the software development process by analyzing the number of tasks individually and per team. The focus is more on easily measured quantitative metrics, like lines of code, etc. In contrast to those often for the programmer meaningless metric about the quantity of achievements, we incorporated in our approach also measures that mirror the quality of the work more closely than the quantity to encourage and motivate the developers more. [6]

The "MDA: A Formal Approach to Game Design and Game Research" paper offers the general concepts for game design and mechanics, on which we based our own solution. [7]

3. Overview and contributions

The main purpose of this research paper is to study the effect of adding gamification to software development processes, and how this reflects on how motivated the developers get to enhance their skills and abilities, thus having a direct effect on their productivity.

The research project offers many contributions to the gamification research topic, it offers a solution by the addition of Gamification as a plugin to the already used task management systems; it enhances these systems by adding the game element to them; through some challenges and interactive game elements that will help in motivating the developers and keeping them on a good track, while still leaving the core task management system intact.

Another contribution is the integration between version control systems and task management systems, which will focus not only on the amount of work done by the developers, but also on the quality of each one's work, through code analysis and quality assurance processes. This will enhance the gamification element, which will then offer a more relevant solution to each developer, tailored based on their achievements from a broad variety of aspects.

Moreover, a recommendation system is being offered, in particular for the use of the management team. This system will offer recommendations of the best choice of developers for a certain task, depending on a variety of factors, like the availability and workload of the developer in accordance with their skills and work efficiency.

In Agile Software Development, work is done in several iterations and continuous feedback in the process of developing a system. Every iteration of the project contains several tasks which are divided between the team members.

In this project, gamification is being tailored to the tasks that involves coding. For that, many aspects of the work done should be taken into consideration; the gathered data should focus not only on the quantity of the work done but also on the quality of it and whether it is effective or not, thus, some data sources were initially chosen:

- Task Management Systems: which will provide details about the tasks, their timings, complexity, the developers assigned to each task, etc.
- Version control systems: from which the code and bugs will be provided.
- Code analysis systems: which will analyze the code based on many factors like complexity, best practices, etc.

4. Game Design Concepts and Mechanics

In this section, the methodology used in adding the gamification element to the software development will be explained.

One of the important aspects of this project is that it does not offer a new software, but rather a plugin to the task management systems usually used in companies like Jira or Asana. In this way, developers will not be required to use an additional software, thus there will not be any change to the regularly undertaken project processes. The offered plugin will rather enhance the experience of the users, mainly developers, by adding the gamification element, which will be used for offering ways to improve their performance by motivations, challenges, etc.

4.1. MDA Framework

One can understand a Game, by looking at two main groups. One group being the designers or developers that create the game and another is the group of people who will purchase and use this game, or in another word, Players.
In this project, the company's developers are the addressed players in this game. It is of a great importance to fill the gap between the designers of the game and its players, because a game without players wanting to play is irrelevant. Thus, filling the gap between designers and players is a crucial aspect, which should be regarded by the game's designers, through, for example considering both sides' perspective, seeing the game from the player's perspective and understanding what makes them want to use it.

For that reason, the MDA framework [7] will be used, which is a formal approach to understand games and create a link between game design and development, game criticism and technical game research.

The MDA framework stands for Mechanics, Dynamics, and Aesthetics framework, which correspond to Rules, Systems, and Fun consecutively.

- **Mechanics**

It represents the basic components of the game; it defines the rules and the actions that can be done in a game based on some algorithms.

Applying that concept on our project, we have specified some initial rules, for example, the system will be based on the challenge aspect in which developers will be able to gather points and move from one level to another.

There will be different categories that will measure how well the developer is doing, depending on different metrics, these metrics reflects the developers' skill improvements, ability of working in teams, delivering the tasks on time, number of tasks that were finished, and many others.

- **Dynamics**

Dynamics addresses the run time behavior of the system, acting upon the systems inputs and outputs.

In the software development process, the developers contribute with the work they do in the project. Our system will use this data as a source of input and develop an algorithm to keep track of their achievements, to always motivate them to become better.

As explained in the Mechanics section, there will be categories that measure the developers' performances in different areas. For each category, the developers will win badges, which will show the level they are in, and how well they are doing. Lagging developers will be given assistance and direction in which they can improve themselves.

For that purpose, a dashboarding system is introduced to keep the developers updated about their performance and to give them immediate feedback; it will show them their results, points and levels, In addition to an overview of the performance of the whole group.

- **Aesthetics**

This part deals with how the players will perceive the game when they interact with it. It describes the desired emotional aspects of the experience of playing the game. In this case, a fun part, that is desirable by the players, should be added to make the game more interesting and fun.

For that, periodic challenges will be provided between developers to add a source of competitive fun away from the seriousness of the working life. Developers with remarkable achievements will be shown on the dashboard. Incentives will be offered, in addition to advices and tips for self-improvement.

One of the important things about motivation is to distinguish between intrinsic and extrinsic motivations, in other words, the difference between wanting to do something and having to do it. Extrinsic motivation comes from outside the activity, when a person is obliged or has to do a task. It can use the classical way of reward and punishment to get people to do their work. However, intrinsic motivation starts from the people themselves, and their need to self-achievement which is on the top of Maslow's hierarchy of needs. [2]

In Gamification, it is important to keep the motivations intrinsic, to let people improve because they want to do so, and not because they have to. This is also referred to as the Self Determination Theory (SDT), which is based on Human needs, which include the needs for competence, autonomy, and psychological relatedness. [8]

4.2. Metrics of Achievements

One important aspect in measuring the achievement of the developer is not only measure upon the number of tasks done, but also to focus on the quality of the code through for example, some code analysis algorithms, or by comparison with best practices. Thus, different aspects were considered when estimating achievements divided into many categories. Therefore, the focus was divided on both quality and quantity, the following table shows some of the rules and the different categories they belong to in addition to stating the source of this information:

Rules	Category	Source
Task is done;	Time	Task Management System
Time of the task depending on the average time of same type tasks within the project;	Time	Task Management System
Number of completed tasks per period of time;	Achievement	Task Management System
Number of tasks developers work on / comment on/ involve in;	Teamwork	Task Management System
Number of bugs in code/ after testing stage;	Code Quality	Task Management System Version Control System
Task is done before / after the deadline;	Time	Task Management System
Code Complexity;	Code Quality	Code Analysis System
Code Practice, Code reuse;	Code Quality	Code Analysis System
Improvement per period of time;	Achievement	All Systems

Table 1. Metrics of Achievements

5. Evaluation

The current version of the gamification portal that was developed was validated by a first pre-test with five software developers, to evaluate if the overall usability of the software is sufficient to start a bigger field test. The test subjects were asked to perform a number of different tasks to cover all of the portals functionality. The test done under lab conditions with data from a mock-up development project. So the test subjects just had to perform the administrative tasks with the portal and/or the task management system, but did not do any real coding during the test as this would have made the test unnecessarily long and complicated.

The results and feedback were positive. All users were able to perform the given tasks without major problems and liked the provided feedback from the gamification portal.

Nevertheless, this pre-test only showed a first impression of the overall usability and was thus not able to provide fully detailed inside into the effectiveness and efficiency of the gamification elements themselves, as this would require a larger longer field study with real software development projects.

6. Conclusion & Outlook

Motivation of the team members is crucial for project success. In this paper, we have shown an approach for gamification of a task management system for agile software development. Unlike the related work, the proposed system is working fully automatic in the background, even leaving the existing task system fully intact, by providing the game elements for gamification in an additional portal for the user. We have shown the different game mechanics, dynamics and aesthetics, as well the used metrics of achievements. The usability of the created gamification portal could be validated in a pre-test under lab-conditions.

The next step for this research work would be to validate the portal further in a bigger field, especially the effects of the provided gamification elements. For this the portal will be used by ten to fifteen teams of students of four to six persons each, during the development of a semester software project in their computer science bachelor program. The students will be interviewed once during and once after the project. In addition, usage data of the portal will be gathered and also used for evaluation of the gamification elements.

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Antifragile Ecosystem

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Abstract:

"Innovation" concept achieve a capital significance on sustainable growth. Public and private agents interact on all kind of Innovation Ecosystem all around Europe. In this socio-economic context, innovation Project Management, must deal with complex projects together with actual global world conditions: uncertainty, randomness, chaos... This document describes an Open Ecosystem Antifragile for innovation, based on the anti-fragile concept as a real and practical alternative for Project Management. The ideas and work rules make it possible to define a type of anti-fragile innovation. Finally, next step is a field study where its target is find these "Open Ecosystem Antifragile for Innovation" situation, and its possible evolution.

Keywords: Antifragile, Complex system, multidisciplinary team, Ecosystem

1. Introduction

The concept of antifragile comes from Mr. Nicholas Nasim Taleb in 2012 [1]. It is a neologism that Taleb uses to define the opposite of "fragile. Anything under stress will at least deteriorate, and depending on the intensity of the 'stressor' it will break down and / or be destroyed. Therefore, the opposite will be that which not only does not deteriorate, is broken and / or destroyed, but on the contrary, improves.

The European institutions propose the creation of an intelligent specialization strategy [5,6], in which universities, companies and innovation and research centers coordinate and join forces. The development of smart specialization strategies should involve the participation of national or regional management authorities and stakeholders, such as universities, industry and the social partners in the entrepreneur discovery process. The involvement and participation of all these agents in the creation of a society of Innovation and Imagination is what we call **the Open Ecosystem for Innovation [7]. (OEI)**

At NASA, for example, they have come to the conclusion that "directing future challenges (...) is not simply doing what we know and how we know how to do it better now, but we need to do things that normally do not We know how to do them or how to do them " [8]. This is where, as in NASA, we will make a presentation of the anti-fragile concept: an approach from a new and different point of view, to the possible actions that help to define a new field of work and a new way of working in the future **Open Ecosystem for Innovation (OEI)**. In this context, we intend to create a vision that enriches, that brings freshness and novelty, and that is revealing and useful for future research.

The aim of this study is to implement the philosophy antifragil current **Open Ecosystems for Innovation (OEI)** and define **Open Ecosystem Antifragile for Innovation (OEAI).**

This philosophy helps organizations to function more efficiently, with a participatory culture, shared leadership, with a growth of knowledge, avoiding weakness in times of stress and strengthening their skills at all times.

2. Antifragile

As defined in the introduction the concept of antifragile is a neologism that Taleb uses to define the opposite of "fragile. Anything under stress will at least deteriorate, and depending on the intensity of the 'stressor' it will break down and / or be destroyed. Therefore, the opposite will be that which not only does not deteriorate, is broken and / or destroyed, but on the contrary, improves.

This first definition is not, surprisingly, intuitive. We tend to think that the opposite of fragile is something resistant, perhaps robust, but it is not like that: the robust resists the efforts and the stressors, and remains as it is and as it was, it does not change, much less improves.

But there is much more: the second definition, according to its author, is a mathematical idea. Literally, in Taleb's words:
"Fragility can be defined as an accelerated sensitization to a harmful stressor: this response traces a concave curve and mathematically culminates in more harm than benefit starting from a random event. Antifragility is just the opposite, producing a convex response that leads to more benefit than harm. "
he graphic expression of this statement is represented in the figure 1 and figure 2.

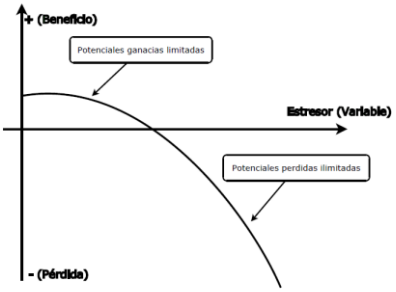

Figure 1. Concavity: curve of fragility versus Convexity:

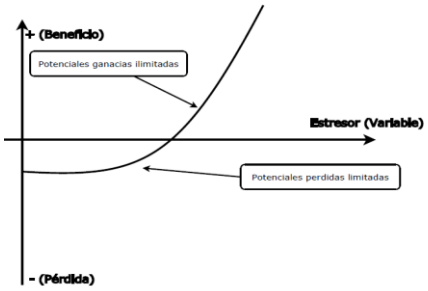

Figure 2. Anti-fragility curve (Source: N.N. Taleb [1], translated and adapted by the authors)

The anti-fragile philosophy is based on the following properties [1,9,10,11]:

Optional property

We can define optionality as the vector of convexity. Greater optionality implies greater convexity. Creating optionality in innovation plans and actions renders obsolete the actions of monitoring future probable events. Eliminate the errors of deterministic cause-effect models. It should not be confused with flexibility, as it is implicit. It is not so much a plan and the narrative that it carries implicitly, as the social network of knowledge and experience behind it. Achievements in innovation involve investing in people, in ideas, and in a timely manner, changing between the different options created

Dispersion property (alteration strategy):

Also called "1/ N strategy". Consequence of the previous point, the deployment of innovation and research should be attempted through multiple attempts. That is, try to reduce the cost of each trial and assign each 1/ N of the potential investment to each of them. It is completed and complemented with the option of altering: dividing the efforts between an option and its complement, balancing the high risk with the low (or moderate) that each option represents.

Cliquet property (serial opportunities)

In consequence with the two previous ones, it is about the planning of the activity: focus each trial in the short term, with flexibility in the possible new options that are presented depending on the response obtained. The rigid plans in the medium-long term invariably present a scenario that, in case of failure, does not offer opportunities to readjust scenarios in search of new options. Practically: flexible plans with frequent departures, in addition to these plans are short-term, but with enough vision to "capture" the long-term objectives.

Heuristic: theories are born of experimentation, and not vice versa.

Innovation, and success in it, has its origin in experimentation. In the history of science and technology, there is more evidence of achievements achieved through unexpected random experimentation than by a predetermined deterministic plan (except perhaps in sciences such as Physics and Mathematics). At this point, we recover the concept of Trott [12] equally used by Taleb: serendipity, or positive unforeseen event. Creating optionality, planning short, experimenting, and paying attention to what may happen in an unexpected way and that offers us a success option.

Heuropropiness of simplicity (less is more).

The practice is little friend of the complexity. Many times, the simplest solutions and the simplest technologies are ignored.

It is, therefore, already known since the Middle Ages as "economy principle" or "Ockham's razor", originally formulated as "pluralitas non est poneda sine necessitate", that is, "the essential things are not due multiply without need.

Property of "the negative way".

Failure is a source of learning. Innovation and research based on "trial and error" is the source of knowledge and experience. Each essay ending in error teaches us, at least, what does not work.

Explored by Clark and Thompson [13], this idea of associating two antagonistic concepts (failure ~ success) is interesting. Successful failure, as they promote, fosters collective learning, a reflection of a good research practice: trial-error in search of the objective, and attentive to the alternative ways that serendipity can show us.

And precisely the anti-fragility principles allow to affirm that, considering this learning of error as one of the main stressors, the research team will improve, promoting the organization of learning, excelling [2].

Interaction between all of them: DIY and spirit «flâneur».

These principles should be considered as general rules, heuristics, and not as laws. We have explained the boundary conditions: complex systems, and relationships between them, forming ecosystems that interact. Therefore, we speak of

randomness, serendipity, options ..., not of rules or deterministic principles and cause-effect relationships.

The use of these principles requires, however, two more essential ingredients. We speak of DIY and spirit «flâneur». Acting as catalysts of the antifragile system, we can describe them as:

The first defines the combination of the principles described, insofar as they are valid to solve the problem that is being addressed. One does not exclude another, nor must they all necessarily be.

And precisely the second, that spirit of "curious stroller" and attentive to the opportunities that arise, is the agent that allows us to value the options that are detected and / or intuit and take advantage of them

Ayestarán [14] formulates in its work the critical question: if the engine of all (eco) innovation system is the innovation team, «the key issue is how to transform a group of experts into an innovation team expert". The proposal that is exposed in the following point, to finish this article, is how to transform a group of experts into an anti-fragile innovation team.

3. Open Ecosystem Antifragile for Innovation

The basis of any OEAI is, as has been explained, the anti-fragile innovation team. It is the essential core around which we can create concepts and guidelines for action.

Using the definition of antifragility, an anti-fragile team will be able to improve during and after stress situations. Therefore, it will be a team of learning [2].

A team capable of managing diversity [14], the involvement of senior management up to the maximum "C suite" direction, open innovation, open knowledge, freedom of communication and exchange of ideas [15,16].

The construction of the open OEAI must be simple (we already know, KISS): using the principles described in the previous section, and with the two basic catalysts as practical elements. DIY in the management of the principles to respond to each situation and problem, and flâneur attitude to capture every opportunity that presents itself and take advantage of it.

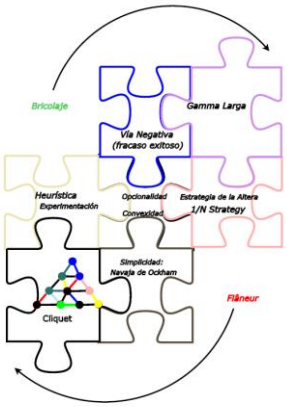

Figure 3. Antifragile main properties

A comparison has been made of the properties of an Open Ecosystem for Innovation, and Open Ecosystem Antifragile for Innovation and an intermediate state, can be seen in Figure 4.

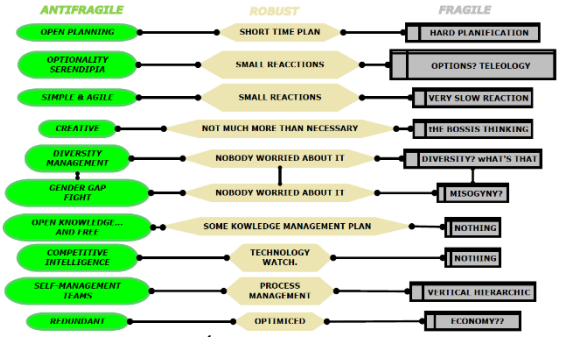

Figure 4. Comparative analysis of different ecosystems

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How to manage innovation projects?

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Abstract:

In the present changing environment, a way to keep the competitiveness of companies is through innovative projects. However, in order to manage and ensure the success of the innovation projects, we should take into account its specific characteristics to determine how to apply best practices of project management (e.g. PMBOK©).It is suitable for every organization, depending on their characteristics, degree of uncertainty and risk to assume, to select the lifecycle (iterative, linear, or a combination of both), as well as most appropriate tools and techniques for its projects. The presentation deals with the specific characteristics of the innovation projects, as well as the models and trends, and some decision criteria that have proven to be useful.

Keywords: Innovation Management; Project Management; Risk; Stage-Gate; Product Development

1. Introduction

It is evident that Innovation Projects have to be managed, but we should take into account their specific characteristics.

First of all, it is necessary to clarify what is the meaning of “Innovation Project”. We can use the following definition: "an Innovation Project is a group of activities focused on generating knowledge, product, processes, different from those existing in our organizational structure".

Even though these projects can be quite different, they have some common features:

- At the beginning, we don’t known in detail the result or the solution we are looking for, therefore there is always a part of exploration, creativity and experimentation, discovery and learning.

- The results, which are the measure of the project success, in many cases differ from the initial objectives, or simply, those objectives are not achieved. This does not always mean a failure for the Organization, since the process of learning and other discoveries and not pursued results, may still be useful and valuable for the company.

- They often involve more elements of risk than in conventional projects (market, technology, internal capabilities, associated knowledge, operational, financial, etc.).

- In many cases, it is useful to apply the scientific method (hypothesis, design, test, measure, learn), in order to verify assumptions, or discard risks through experimentation. We must know how to pivot objectives and the approach, when we are gathering more information and new findings are arisen.

- Phases of the project should not always follow a linear model (such as when the desired solution is well defined). The phases of Initiation, Planning and Control overlap in many cases. This overlap/rethinking of many aspects (problem, solution, development) may be desirable and useful in innovation projects.

2. Life Cycle

It is appropriate to establish clear decision points throughout the project life, mainly at the beginning, when we are defining the scope/solution, and in other phases which are considered key, in such a way that it will allow us to decide on its continuation, or swing to adapt the project according to the hypothesis confirmed or discarded risks. It is recommended to establish decision points just before the allocation of significant resources/expenses to the project.

Furthermore, it is suitable for every organization, depending on the degree of uncertainty in its projects, to select the life cycle more appropriate (iterative, linear, or a combination of both) for the type of project they tackle, for example the Stage-Gate model for the development of new products.

A Blended Life Cycle (Figure 1) is a very successful method, but it is important to adapt it to each organization.

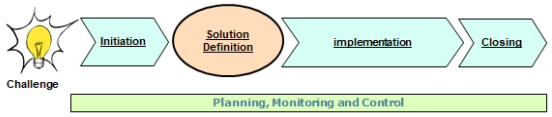

Figure 1. Blended Life Cycle

Given the uncertainty that involves this projects, and the possible iterations between the phases after

each decision point, it is recommended only to plan in detail the next steps, and more generally the rest of phases of the project. This can mean frequent changes in cost and duration estimations.

In each of the activities of project management, we should be made special emphasis on various aspects:

3. Initiation phase

Their purpose is the validation of the feasibility of the project. It is a preliminary study that establishes clearly the problems, challenges and benefits to obtain, as well as their connection with the Organization's strategy. In case of the development of new products/services, it requires a preliminary analysis of the current and future preferences of the market to which are oriented, trends in consumption, etc.

It is also necessary to have a knowledge of the State of the Art where we act (existing technologies that we can use, skills needed, other associated innovations, etc.)

In addition, it is necessary to identify the main risks and difficulties (skills, technology, reaction to the change, etc.). All this elements prepares the team to define the most appropriate solution.

Estimate an initial budget (order of magnitude), which along with other decision criteria (risk..), allow the organization to analyze its feasibility and priority based on the cost incurred.

These elements are part of the Initiation Act (or preliminary study), so with limited resources and efforts, helps the organization to make the decision to continue or not with the project. It constitutes a first control gate before putting more resources in the project.

4. Solution Definition phase

Once understood the challenge (Initiation Act), it is necessary to define the most appropriate solution to tackle it. This is not a trivial issue. It is not just enough to get the customer's requirements as in other types of projects, there in not an obvious solution, so it is necessary to perform activities of exploration, simulation, contrast to discover / define the most appropriate solution (desirable, feasible, aligned with the strategy) (Figure 2).

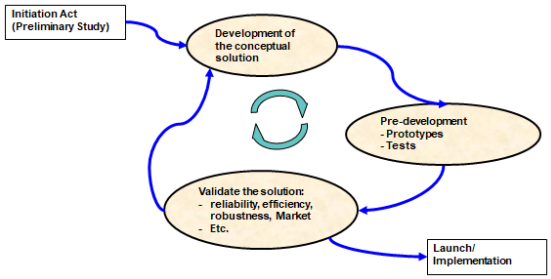

Figure 2. Solution Definition phase

Those activities can involve an interactive cycle, are difficult to plan, and each organization should set appropriate maturation limits and the budget to manager this process.

In this phase could be suitable to apply an agile approach.

4.1. Development of the conceptual solution

In addition to good understanding of the problem/challenge, we should take into account all the elements involved.

Since they are projects that tend to work in unknown areas, it is convenient a deep analysis on the State of the Art in the areas involved (technology, processes and products, patents, market, benchmarking, etc.).

In this phase, the creativity and the collaboration of multidisciplinary teams are essential for establishing the solution requirements to develop (functional and operative).

4.2. Pre-development/tests

It could be necessary the construction of prototypes, models (3D printers), simulations, and trials, which allow us a quick and cheap way to test the solutions.

This allows to valid assumptions and hypotheses, to eliminate risks, and to acquire more expertise within the sphere of activity.

4.3. Validate the solution

The defined solution is contrasted against the problem/challenge, and proved that meets the established criteria (reliability, efficiency, robustness, cost savings, ease of use, etc.).

In the case of several solutions, we need to analyze and select the most suitable alternative.

In the case of new products to launch into the market, the validation of the solution may involve the contrast with the market and the analysis of its commercial feasibility:

- Identification of the niche market,

- Quantitative evaluation in relation with the key factors and criterion of purchase,

- Position with respect to the competence solutions,

- Advantages that could add our solution,

- Contrast with pilot customers, etc.

All of this provides information to decide whether the solution is accurate and we can produce it, or it is necessary to refine the solution, or directly, to cancel the project.

Each of the iterations, provides more information, so we can validate hypothesis and remove uncertainties, before committing more resources (investment team, etc.) to advance in the next phase.

Throughout this iterative cycle, the agility, creativity and passion of the team should dominate over the detailed planning of tasks.

5. Implementation Phase

At this stage we are carrying out the "construction" of the validated solution. Here we can use a linear structure of activities (waterfall life cycle) , with a detailed planning, that will allow to improve efficiency through the establishment of the resources, timelines and budget required.

In addition to the activities associated with the generation of the validated solution, that is to said, the creation of deliverables that make up the solution (which could apply PMBOK best practices), we should enhance some activities and key deliverables in this kind of projects:

- Plan of launch/industrialization of the solution in the organization.

- Identify and analyze new associated risks of the solution (commercial, technological, economic, regulation, etc.).

- Plan results protection,

- Plan to register for use (where required),

- In new products, create the business and marketing plan to define the way of exploiting/ implement the results,

- Search for funding (Investment Plan, public financial assistance, etc.),

6. Monitoring and Control the project

Apart from the typical monitoring and control activities, deliverables, time and costs (the baseline), it is advisable to take into account:

Especially in the definition of the solution, it is more important to focus on the encouragement and motivation to the team, that the control of deviations in efforts and costs.

Track of the identified risks, the assumed scenarios, and watch out for new risks, in order to adopt quickly and flexibly the necessary changes in the project:

- Continue aligned with the strategy?

- Are maintained the expected benefits?

- Other projects are pressing for resources?

- Legal changes?

- Is still there an opportunity in the market?

- Positioning of competitors?

- Product substitutes?

- Technology surveillance (watch for changes in technology that can leave obsolete our solution,). For example, to anticipate and address new technology in order to react with the minimum loss

- Effects on other products/items of the company,

- Problems of supply, etc.

7. Closing

In addition to the traditional tasks of closing a project (delivery of the solution, lessons learned, etc.), and although they are sometimes considered outside the project, the project team can have an important role after the project:

- Support in the manufacture, launch and marketing of new products,

- When appropriate, protect the results obtained, etc.

8. Conclusion

In many innovation projects, where there is an initial lack of requirement definition and when abundant changes are expected (adaptive environments), it is necessary to understand and analyze carefully their specific context and characteristics.

The Project Manger must know and adapt good project management practices to the unique nature of the project. This implies establishing the most appropriate life cycle, identifying the decision-making points, exhaustive risk analysis, and using the techniques that have proved to be useful for this type of projects.

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Bibliometric analysis of worldwide scientific literature in Project Management Techniques and Tools over the past 50 years: 1967-2017

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Abstract:

The Project Management (PM) is being seen as a core activity in business, science, education or any field in which the realization of a set of interrelated tasks has to be achieve over a fixed period and within certain cost and other limitations. PM aims to apply knowledge, skills and techniques and tools to deploy and implement projects effectively and efficiently. PM is a strategic competency for organizations; the professionals involved in this area of knowledge are seeking to develop a culture of result orientation, of effective decision-making and of collaboration through the use of PM Techniques and Tools. In this respect, bibliometric reviews and analysis are developed to evaluate the performance and evolution of the authors and publications that are directly related to the Techniques and Tools of PM. It can also enable the recognition of new and trustworthy Techniques and Tools relevant to the Project Manager.

Keywords: Project Management; Project Management Tools; Project Management Techniques; PM Techniques and Tools; Bibliometric Analysis.

1. Introduction

The Project Management Techniques and Tools are precisely what make managing projects efficient and more effective. These can be described as the ways that we gather information, communicate, and generally get things done. With this in mind, it is interesting to analyze the link between the Techniques and Tools and the knowledge areas of the PM to understand the full impact of these in the Project Management Process: Initialing, Planning, Executing, Monitoring and Controlling and Closing.

In this way, the main objective of the present article is to analyze the link between of the Techniques and Tools of Project Management and the PMBOK 6 Knowledge Areas (Project Integration Management, Project Scope Management, Project Schedule Management, Project Cost Management, Project Quality Management, Project Resource Management, Project Communication Management, Project Risk Management, Project Procurement Management and Project Stakeholder Management) using bibliometric tools. To do that, we target to quantify the main indicators related to bibliometric performance: published publications, received citations, most cited articles, most cited authors, data on geographic distribution of publications, among others. Lastly, using a bibliometric analysis software based on a bibliometric network, we will review the connections.

Bibliometrics can be defined as a set of methods and tools for evaluating and analyzing academic publication and citation in order to explore its impact on a specific field and how it contributes to the progress of science in the main areas of research [1, 2].

2. Methodology and Dataset

Based on a prior review of the state of the art, we focused the analysis according to the terms included in the PMBOK® Guide 6th Edition released on September 2017. In addition to carry out the bibliometric performance and network visualization map analysis, the publications related to the Techniques and Tools of PM have been collected.

The data pertaining to Techniques and Tools of PM were retrieved from Web of Science™ Core Collection using the following advance query: *TS=("Project Management Tool" OR "Project Management Tools" OR "Project Management Technique" OR "Project Management Techniques" OR "Project Tool" OR "Project Tools" OR "Project Technique" OR "Project Techniques"*). In addition, the knowledge base was further refined and limited to Articles, Proceedings and Reviews published in English.

This advance query retrieved a total of 548 publications, of which 405 are directly related to use of the Techniques and Tools of PM. To accomplish this, we downloaded all the publications and reviewed each abstract.

3. Performance Bilbiometric Analysis of the Project Management Techniques and Tools

To understand how the Techniques and Tools of PM have evolved in terms of publication, citations and impact, we evaluated their performance through analysis of the following bibliometric indicators: published publications, received citations, most cited articles, most cited authors, data on geographic distribution of publications and h-index [3, 4].

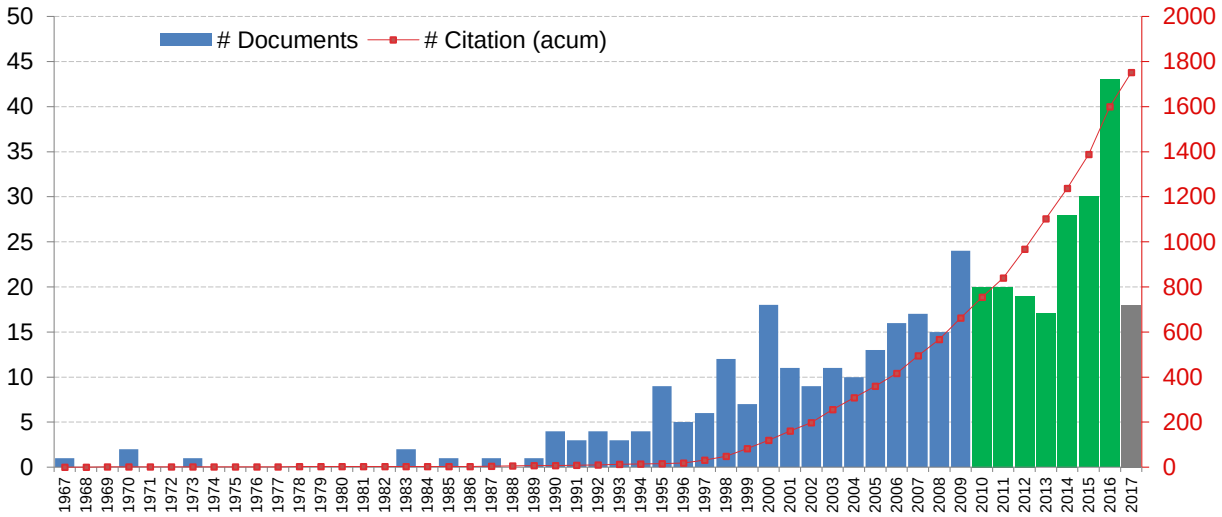

Figure 1. Distribution of Publictiosn by year (1967-2017)

The bibliography performance analysis is structured in two parts: (1) evaluation of the publications and their citations with the aim of testing and evaluating scientific growth; and (2) analysis of the authors, publications, journals and research areas to assess the impact of the publications.

3.1. Publication and Citations

The distribution of publications and citations related to Techniques and Tools of PM per year are shown in Figure 1. It shows that the number of publications has increased in the last years. Since the first publication related to the use and application of Techniques and Tools of PM, we can highlight three milestones in the evolution of this knowledge area. The first was at the beginning of this century, where the number of publications increased fifty percent in comparison to the last maximum year production. The second milestone was on 2009, when the number of publications reaches a new maximum value. Finally, like the previous milestone, the third was on 2016 when the number of publications reaches the maximum from 1967 and 2017. This evolution reveals the growing interest in the Project Management knowledge area and use and research of Techniques and Tools.

On the other hand, the distribution of citations per year is shown in the Figure 1. As with the case of the publications, the citation distribution showed a positive developmental trend in the period 1967-2017. Based on the results of the advance query applied in the Web of Science™ Core Collection of Thomson Reuters™, the citation performance is summarized in the following indicators: Average citations per publication: 4,32; Sum of Times Cited (without self-citations): 1.753 (1.726) and Citing articles (without self-citations): 1.683 (1.659).

Period	# Publications	% N=405	Citations
1967-1976	4	0,99	1
1977-1986	3	0,74	2
1987-1996	34	8,40	16
1997-2006	113	27,90	398
2007-2016	233	57,53	1182
2017	18	4,44	152

Figure 2. Total publications/citations (1967-2017)

3.2. Most Productive and Cited Authors, Geographic Distribution of Publications, Research Areas and h-index (Citation Classics)

It is also important to know which are the most productive and cited authors, along with the geographic distribution of publications and research areas. It complements the bibliometric performance analysis of the Techniques and Tools of PM and allows for an evaluation of where developments have occurred within these fields. Consequently, the most productive authors are shown in Figure 3.

Authors	# Publications
Goncalves, R.Q.	5
Von Wangenheim, C.G.	5
Baina, K.	3
Benali, K.	3
Godart, C.	3
Kayis, B.	3
Kostalova, J.	3
Tetrevoya, L.	3
Miranda, S.	3

Figure 3. Most productive authors (1967-2017)

Along these years, the most cited authors are shown in Figure 4.

Authors	# Citations (% N=1753)
Isakowitz, T., Sthor, E. A. and Balasubramanian, P.	252 (14,38%)
Eppinger, S. D., Sapsed, J. and Salter, A.	107 (6,29%)
Demaio, A.Verganti, R. and Corso, M.	61 (3,48%)

Figure 4. Most cited authors (1967-2017)

It is important to mention that the most productive authors are not included in the list of most cited. It is important mention that these authors are related to the query used to obtain the publications and these don't have to be prominent authors in the PM's field.

The most productive countries related to the Techniques and Tools of PM during the last 50 years are shown in Figure 5.

Countries	# Publications	%
USA	104	25,61
England	29	7,14
Peoples R. China	24	5,91
Australia	20	4,92
Canada	16	3,94
Germany	16	3,94
Italy	16	3,94
India	13	3,20
Spain	13	3,20

Figure 5. Most productive countries (1967-2017)

On the other hand, the journals with the largest number of documents published and their citations are shown in the Figure 6. It highlights that host the main publications, covering sectors as: Construction, Engineering, Information Technology and Project Management.

Name	# Publications	# Cites
International Journal of Project Management	7	107
Project Management Journal	5	84
Automation in Construction	4	105
International Journal of Information Technology Project Management	3	55
Journal of Construction Engineering and Management	3	0

Figure 6. Journals with the highest number of Publications (1967-2017)

Still on the subject of this point, the most relevant WOS Subject Categories are shown in Figure 7.

WoS Categories	# Publications	%
Management	87	21,42
Computer Science Software Engineering	67	16,05
Computer Science Information Systems	56	13,79
Engineering Electrical Electronic	49	12,06
Computer Science Interdisciplinary Applications	45	11,08
Computer Science Theory Methods	44	10,83
Operations Research Management Science	40	9,85
Business	35	8,62
Computer Science Artificial Intelligence	31	7,63

Figure 7. Most relevant WoS Categories (1967-2017)

Finally, the search query used in the database Web of Science™ Core Collection has an h-index of 20. Using as reference the h-index value, we could identify the relevant publications to this research.

To effectively analyze, the next step is to determine the link between the PMBOK 6 Knowledge areas and the main Techniques and Tools of PM using VOSviewer (software tool for constructing and visualizing bibliometric networks) [5].

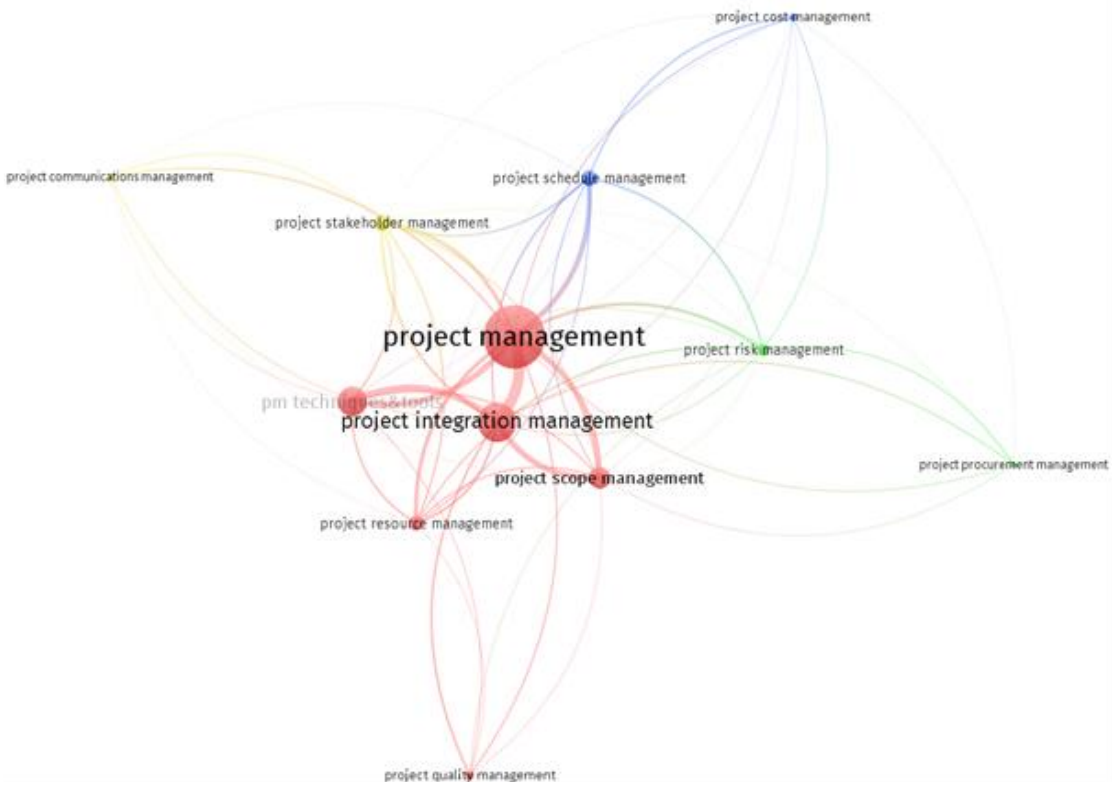

Figure 8. Network visualization map of Techniques and Tools of PM based on the PMBOK knoweldge areas

Cluster	Items	Links (Total link strength)	Occurrences
Cluster 1 (6 items)	Project Management	11 (131)	121
	Project Integration Management	11 (109)	72
	Project Scope Management	11 (59)	37
	Project Quality Management	6 (21)	14
	Project Resource Management	10 (49)	24
	PM Techniques&Tools	10 (62)	53
Cluster 2 (2 items)	Project Risk Management	10 (36)	20
	Project Procurement Management	6 (15)	8
Cluster 3 (2 items)	Project Schedule Management	9 (48)	26
	Project Cost Management	9 (19)	13
Cluster 4 (2 items)	Project Communication Management	7 (18)	7
	Project Stakeholder Management	10 (49)	26

Figure 8. Network visualization map of Techniques and Tools of PM based on the PMBOK knoweldge areas

4. Network visualization map of Project Management Techniques and Tools

The Network visualization map of Techniques and Tools of PM based on the PMBOK knowledge areas is shown in Figure 8. The concepts with minimum occurrences of 5 times were shown in the map. The concepts with the same color were commonly listed together (Cluster). For example, concepts with red color such as PM Techniques&Tools, Project Integration Management, Project Management and Project Scope Management existed in Cluster 1 and had the highest percentage of links within this cluster. The thickness of connecting line between any two concepts indicates strength of relation. For example, the link strength (relation) between Project Management and PM Techniques&Tools is 17 and it represents a thick line. On the other hand, the line between Project Management and Project Integration Management had link strength of 32 [1, 6, 7].

It is important to mention that three items (Project Management, Project Integration Management and Project Scope Management) are related to all other items. In addition, the entire Cluster are interrelated.

5. Conclusions

The size of literature related to techniques and tools of PM showed a noticeable increase in the past decade. Given the large volume of citations received in this field, it is expected that the use of techniques and tools of PM will be seen as part of the projects.

Research in techniques and tools of PM needs to be encouraged, particularly in the new industrial sectors and collaborative projects.

Techniques and Tools are related mainly to the Project Integration Management and Project Scope Management, but has interaction with all of the knowledge areas of PM.

Keep in mind that the focal point of reference for all the items are the Project Management and Techniques and Tools, we identified four Cluster interrelated that group the knowledge areas based on the use of the use and application of Techniques and Tools of PM.

Acknowledgment

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Two decades of studying the impact of Lean in Project Management: A Systematic Literature Review of scientific journals

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Abstract: Nowadays, complexity, uncertainty and the lack of flexibility make projects more difficult to manage. Research on new forms of Project Management methods have being done to face these problems. Lean Thinking is a well-known improvement strategy for creating value and for reducing waste out of processes. During the two last decades, it has been studying the approach of Lean Thinking in 'white collar' areas including Project Management. The objective of this paper is to analyze the available theoretical evidence about this methodology applied in the management of projects found in scientific journals. A Systematic Literature Review was carried out for this purpose.

Keywords: Lean Thinking; Project Management; Lean Project Management; Systematic Literature Review.

1. Introduction

In a competitive environment, projects with complicated supply chains and many stakeholders involved are difficult to manage [1,2]. It has been asserted by a number of researchers [3,4] that project managers need to improve the management of their projects, using different tools and methodologies from the traditional ones.

Projects can be defined as "temporary based production systems" which need to be designed, produced and delivered within a specified time [1,5,6]. This new project approach leads to a Lean Thinking (LT) practice in Project Management (PM) [5]. The application of LT is presented as a suitable methodology to complement PM practices [7] by focusing on creating value for the costumer and eliminating waste (project's timeline and costs) [8]

Gabriel (1997) provided an early definition of Lean Project Management (LPM) [9]. In his research, he shows through case studies (complex building projects) the development of this concept. Ansah et al., 2016b and Ballard et al., 2007 noted that LT philosophy is a culture with application to any industry, business divisions, and specific processes or even on projects [1,2]. There have emerged other studies that correlate LT with PM. Reusch and Reusch (2013) state that "lean management is a management of values" and that it can improve the concepts and standards on PM [10]. In the last decade, studies have continue to explore the link between LT and PM in various types of projects [5,11,12,13]. According to Issa (2013), LT can be applied to the management of all project's processes, including the project delivery system, production control, work structuring, design, supply chain and project controls [14].

This paper presents a Systematic Literature Review (SLR) of scientific journals with articles about LT methodology employed in PM from the past two decades.

2. Methodology

In order to include relevant studies regarding the applicability and suitability of LT principles and tools in projects and PM. A SLR is used as a valid approach in terms of research transparency and replication [15]. The methodology chosen was inspired on the method applied in the papers of Cherrafi et al, (2016) and Laursen and Svejvig, (2016) [16,17]. This article was organized into three main steps (1) definition of review scope, (2) material collection and selection and (3) literature descriptive analysis.

2.1 Definition of review scope

Initially, a selection of databases was identified covering peer-review papers and conference proceedings to identify the relevant data sources, time frame and key words. To identify papers related to the themes a keyword search was performed in the following databases: Web of Science (WoS), Scopus, ScienceDirect and Google Scholar. To develop a robust review and to ensure that all relevant articles the table of contents of the International Journal of Project Management (IJPM) and Project Management Journal (PMJ) were scanned. These are considered the most representative PM-focused journals [17]. The literature review includes peer-reviewed journal articles, conference papers, proceedings and book chapters. The period for the data analysis was from 1993 to June 2017. The reason for selecting 1993 as the starting point was that documents linking LT and PM could be traced to this period. Only papers in English and Spanish were considered.

2.2 Material collection and selection

The content of the first literature review terms led to the application of LT to specific type of projects to be considered: Lean AND Construction AND project, Lean AND IT OR software OR information technology AND project, Lean AND Healthcare AND

project since these terms are related to the application of LT in projects. This comprehensive search yielded to 170 hits.

The exclusion process started with a first selection to eliminate duplicated documents. The second step was to read the titles to identify whether or not the publications were related to the topic. Publications were not included if: the topic was related to lean implementation projects; and lean term used as a synonymous of "slim" or "thin". The following step was to analyze and to classify the abstracts. If LT principles or tools were mentioned but without further explanation or information in the text were classified as not relevant documents. The final step was the full text analysis. In order to be included in the review, an article must focus on the application of LT principles and tools in projects or in PM.

2.3 Literature descriptive analysis

Figure 1 displays the amount of articles about LT applied in PM. It is clear an increasing trend defined from 2006 as of 2017. Overall, results indicate (Figure 2) that the majority of the publications came from journal articles, mostly from Conference Proceedings of the International Group for Lean Construction (IGLC) (36 papers) followed by the International Journal of Project Management with 6 articles.

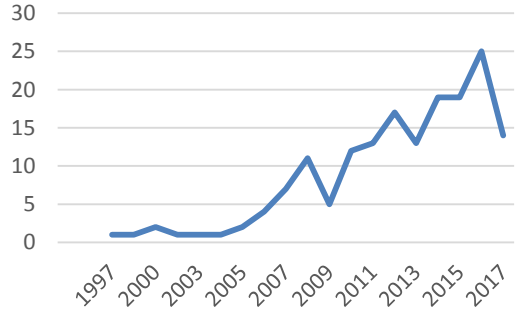

Figure 1. Number of publications per year.

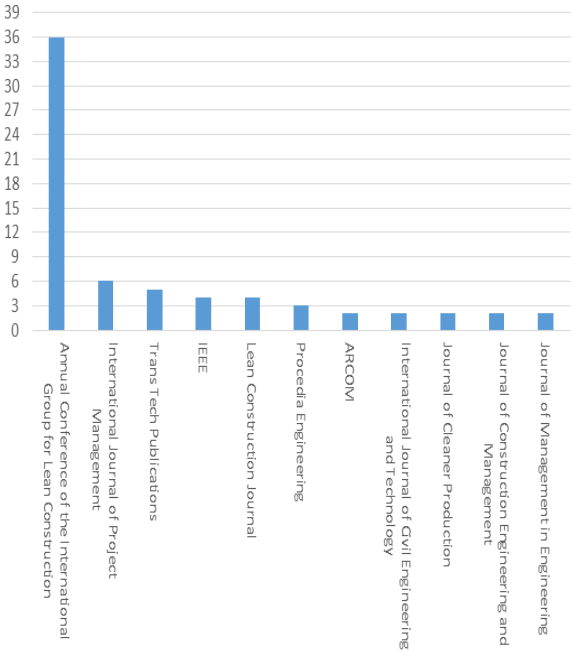

Figure 2. Number of articles by journal.

The selected articles were categorized based on three types of studies as suggested by Brackett et al., (2013) [18]. The purpose of this categorization is to classify the actual evidence from rhetoric based on general experience and knowledge. The three article types are as follows: Type 1) articles based on the experience or general knowledge of the authors (34%), Type 2) empirical articles based on actual case studies (50%) and Type 3) literature reviews (16%) (Figure 3)

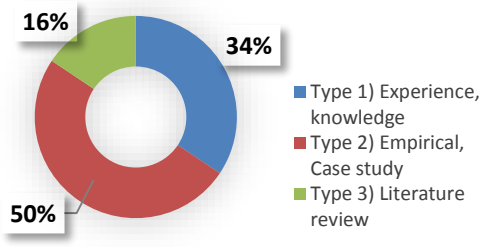

Figure 3. Papers categorization (based on Brackett et al., 2013).

Most of the studies (60%) referred to LT applied to construction projects, 25% in general type of projects, 10% used in software projects and very few in healthcare (3%), mining (1%) and aerospace projects (1%) (Figure 4).

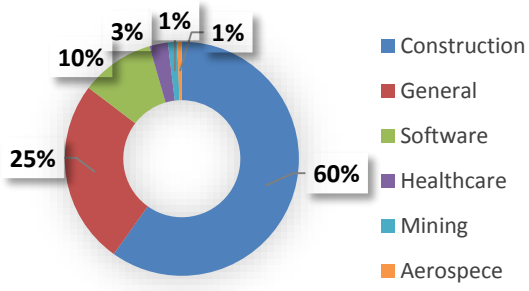

Figure 4. LT applied in projects from different fields.

4. Result and Conclusions

This paper analyzed through a SLR the available theoretical evidence (scientific journals) about LT methodology applied in PM. The literature review was limited to articles available to the researcher.

The findings show an increasing trend of papers about this topic defined from 2006 as of 2017. During the last decade most of the articles regarding LT used in PM came from Conference Proceedings of the International Group for Lean Construction (IGLC) (36 papers) followed by the International Journal of Project Management with 6 articles. The type of article was mainly (50%) empirical based on actual case studies. 34% of the documents analyzed were based on the experience or general knowledge of the authors and the 16% were literature reviews.

In the literature analyzed, the application of LT techniques was mainly found for construction projects. LT applied to construction has led to development of planning and control systems and other improvements [13]. This lean approach is called Lean Construction (LC) and uses a set of tools to improve projects performance [1,12] by increasing its value and minimizing the waste [11].

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Some job demands in global virtual teams

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Abstract:

In an increasingly globalized world the differential factor between operational success or failure is people. The physical barriers for accessing talented resources are removed thanks to technology and the use of global virtual teams. Companies don't need to limit their growth based on their local pool of knowledge since virtuality allows them to hire or cooperate anywhere, faster and with lower costs than ever before. But operating with remote teams is not free from challenges. Companies embracing these changes need to make sure their leaders and human resources management understand and are capable to deal with the demands virtual team members are facing. This is the first step towards employee wellbeing and job performance.

Keywords: Global Virtual Team; job demands; intercultural communication; team politics; affective conflict.

1. Introduction

During the past decades one of the most relevant changes in the work environment is the growing tendency to organize around projects participated by multifunctional teams and the importance of a specific programme management function within organizations. Along with internationalization and globalization many organizations have responded to their dynamic environment by introducing virtual teams, in which members are geographically dispersed and coordinate their work predominantly with electronic information and communication technologies (e-mail, video-conferencing, etc.) [1]. The future is clearly marked by the growing virtuality, which is directly related to the advances in new information technologies and the possibilities of digital communication at an increasingly lower cost. These technologies have changed the traditional work environment that placed all the members of a project team in the same physical space. These virtual teams are seen by many consultants and researchers as the nuclei of 21st century organizations [2].

Organizations must consider whether their workforce and leaders are sufficiently prepared to face these changes and if their models of human resources management are still adequate or, on the contrary, obsolete. The obsolete idea of transactional relationships, and employee retention for only extrinsic rewards, especially in a virtual world where the competition to capture talent is global, will undoubtedly lead many companies to limit their growth, development or even affect their viability for the inability to access or retain qualified resources. In the globalized world the differential factor is people, and therefore the behaviour of people at work tip the balance between operational success or failure [3].

In this paper, we propose the main job demands that virtual teams operating globally face in their day to day activities.

2. Definition of GVTs

The first definitions found in the literature on GVTs describe them as temporary, culturally diverse, geographically dispersed and electronically communicated work groups. [4], [5].

Global. This implies both cultural diversity and geographic dispersion. Members can be separated not only physically, but also temporally due to their placement in different time zones and with different working hours and schedules, but they can and should think and act considering the diversities found in this global environment. This temporal separation makes the possibility of communicating, not just face to face, but synchronously more difficult. When the geographic dispersion increases, the coordination of resources suffers since the opportunities to have synchronous meetings are narrowed to small windows of time during the day or displaced to non-standard working hours. [6] The more geographically and temporally dispersed, the more necessary technology will be to collaborate.

By culture we understand not only the characteristics of nations, including different native languages [7], but the ''the collective programming of the human mind that distinguishes the members of one human group from another'' [8]. Within the global teams, multi-functional and inter-organizational collaborations are often present [9]. We must assume that we will find diversity by education or by training (engineers of various specialties, lawyers, accountants, physicists, biologists, psychologists, etc.) but also characteristics and business values that define each entity (business unit, suppliers, clients, services providers, consultants, etc.) that contributes to the project staffing the team with its members.

Virtual. This designates distributed works that are mainly based on electronic information and communication tools. [1] There is no clear definition of the balance between face-to-face and virtual interaction between team members, but in general it is believed that face-to-face interaction tends to be non-existent to very uncommon in remote teams. As a consequence of virtuality, members separated across time and space are heavily reliant on

technology that allows them to communicate and engage in collaborative activities of their work. [5]

However, we must note that nowadays we interact more and more with our closest environment through digital information systems. The use of electronic communication media, ERPs, computerized collaborative tools, databases in the cloud, and digitized management processes are replacing face-to-face interaction even in those environments where there are no spatial or temporal barriers.

Temporality and Dynamism. Another relevant characteristic of the GVT is the concept of temporality. In the definition used by some authors [5], [10] , it is commonly accepted that team members have never worked together before and will not do it again in the future, or at least have that perception. Therefore, the team members do not share a common history or future, and this will have implications on the generation of trust and reciprocity. The dynamic structure is also linked to temporality, and assumes the team itself morphs in size and composition, where a handful of members are the core of the team with other members joining and leaving ad-hoc after their contribution is completed [11]. This allows members to often participate simultaneously in several part-time projects where the content of work is also changing and moving towards a more intellectual rather physical type of task [12].

3. Job Demands and its costs.

Job strain is the result of a disturbance of the equilibrium between the demands employees are exposed to, and the resources they have at their disposal.[13] Among the several models in the Occupational Health literature, our preferred one thanks to its flexibility, is the Job Demands-Resources (JD-R) theory [14], [15], which proposes that every occupation has its own specific risk factors associated with job strain and stress, and that these could be categorized in two groups: job demands and job resources. Job demands trigger a health impairment process and are generally the most important predictors of such outcomes as exhaustion and psychosomatic health complaints, [14], [13] because they require sustained effort and may exhaust employees' resources and lead to energy depletion [15]. Examples of different demands for different professions are a high work pressure (e.g. stockbrokers), an unfavourable physical environment (e.g. miners), emotionally demanding interactions with clients (e.g. nurses), etc.[13] On the other hand, the job resources activate a motivational process, being the main predictors of work enjoyment, motivation, engagement [16], [17] and organizational commitment [18]. They also contribute to reduce the job demands and their associated physiological and psychological costs [15] so that employees who have many job resources available can cope better with their daily job demands.[16]

The JD-R model has been used to predict job burnout [19], and work engagement [17], as well as consequences of these experiences like employee wellbeing [20], sickness absenteeism [21] or job performance [19]

3.1. Particularizing in GVTs

In this paper, we want to particularize for the members of GVTs what Job demands they need to cope with in their daily work environment. For this exercise we define JD as those physical, psychological, social, or organizational aspects of the job that require sustained physical and/or psychological effort and are therefore associated with certain physiological and/or psychological costs [15]. Based on the available literature on the hindrances and difficulties affecting members or leaders of GVTs, whether related to the virtuality itself or the global aspects of its work environment, we have selected those which reveal to be most significant and fall under the definition of Job demand.

Intercultural Communication. Communication in GVTs uses extensively asynchronous computer-mediated information and knowledge diffusion and very little or almost no synchronous face-to-face communication. Comparing GVTs with collocated teams, the members of the first will suffer during communication: information loss, lack of feelings of social presence and conversational involvement, lack of information about social standing and social context, and as a result, they will need more physical and cognitive effort. [22]

Differences in culture, mother tongue and their proficiency level of the working language generate lack of accuracy and difficulties in both written and spoken language, requiring team members to invest more time and effort in encoding and decoding messages [23]. Even when mastering the vocabulary and grammar of the foreign language, sometimes the literal meaning will not allow to capture aspects about the social context and subtleties or possible reinterpretations.[24]

Also, the communication style can be a source of misunderstandings. Low-context (LC) communication is used predominantly in individualistic cultures, whereas high-context (HC) communication is used predominantly in collectivistic cultures. [25], [26] LC involves the use of explicit and direct messages in which meanings are contained mainly in the transmitted messages. In contrast, HC involves the use of implicit and indirect messages in which meanings are embedded in the person or in the sociocultural context. [25] When low and high-context members cohabit in a team and there is lack of awareness of the opposite culture, frustration and misunderstandings appear. HCC seek out background information when dealing with people or communicate in ways that "camouflage and conceal speakers' true intentions" to maintain harmony in their in-groups [26] but for the LCC this can be seen as "beating around the bush" or "non-committal" [27] ending up in frustration. On the other hand, HHC members may feel challenged, perhaps even attacked or confronted, due to the direct nature of the questions [27].

Another remark about cultural communication, or more precisely the lack of it, is a higher presence of the "mum" effect. Mum, with the intended meaning of keeping silent, is defined as the reluctance or failure to deliver negative information or undesirable

messages. [28]. Culture is perceived as one of the potential factors for mum effect [29] and has been reviewed using Hofstede's work [8] concluding that Power distance, individualism and long-term orientation contribute to the mum effect. [27].

Team politics. There is a relationship between perceived organizational politics and job distress and job burnout [30]. Organizational politics refers to the complex mixture of power, influence and interest seeking behaviours that dominate individual's activity in the workplace [30] with the potential for dysfunctional outcomes at both the individual and the team level. [31] In other words, one's behaviour is strategically designed to maximize short-term or long-term self-interest, which may or may not be at the expense of other members' interest, [32] motivating increased competition against other team members and decreased cooperation with others [33]. Although it may not be always a negative for members practicing it, there are harmful outcomes, like loss of strategic power and position credibility, negative feeling towards others, internal feeling of guilt and hampered job performance of various kinds, and it is identified as one source of conflict in the work environment. [30] In the case of the GVTs, where different business units, functions, cultural differences and affinities (both national and organizational), cohabit within the team, we may expect organizational politics to be more present than in a collocated team.

Affective conflict. This is characterized by person-related disagreements that include "tension, animosity, and annoyance among the team members" [34] and arises because of personality clashes and continued cognitive disagreements that may trigger animosity among the members [35], [36] In GVTs, technology and the lack of opportunity for face-to-face cues while interacting [37] together with the intercultural communication misunderstandings are major sources of conflict, both cognitive and affective. Also the lack of non-verbal clues make difficult the identification of these misunderstandings and cognitive conflicts, prolonging them over time and transforming them into affective ones.

Information and Communication Technology (ICT) Demands. Technology is at the core of GVTs because without internet, email, video and audio conferences, virtual drives, mobile devices, etc. teams can't even exist. [38] For this reason we must consider the specific demands cause by ICTs.

Day et al. [39] theorized eight areas of ICT-related demands which are associated with increased strain, stress, and burnout. (1) Immediate response expectations. (2) 24/7Availability: as demands to respond immediately may extend beyond regular work hours. (3) Ineffective communication as ICTs mediated communication has the greatest margin of error resulting from limited verbal and nonverbal cues that assist the receiver in inferring tone and intonation of the message; (4) Lack of control over ICT, meaning lack of input or decision authority into the implementation of new ICT at work; (5) Hassles using ICT: everyday hassles in using technology (e.g., losing data; computer crashing; internet down or slow); (6) Employee monitoring when companies track ICT usage (keystrokes, recorded phone calls, email and internet use, etc.) to monitor performance; (7) ICT Learning Expectations as the software and hardware are continuously upgraded forcing employees to continuously implement and learn new ICTs; and (8) Workload, since work efficiency may be increase due to the ICT tools it also increases the amount of work to be completed.

4. Conclusion and future research

The theoretical contribution of this paper is to compile the most relevant aspects in the literature of Virtual Teams that potentially contribute to job strain and stress and by extension to low job performance, burnout and its consequences.

To fully understand the costs associated with these demands a similar exercise mapping the Job resources specific to GVT will be needed. Finally, an empirical study to validate the model and demonstrate the significance of the different constructs included will confirm the theoretical propositions.

As for the practical contribution, practitioners and team leaders may increase their knowledge about the challenges GVTs face and the interactions between team members, so they can anticipate undesired outcomes by intervening earlier and contributing to their team wellbeing.

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Competencies for Managing the Digital Transformation for the Setup of a Master Programme

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Abstract:

While the subject of Digital Transformation gets defined more and more profound, companies need people who can manage the process itself. The virtual, cross-border Master School for "Managing the Digital Transformation" is a joint undertaking of the EuroPIM consortium and its partners aimed to prepare individuals with according qualifications. For the Dortmund University of Applied Sciences and Arts (FH Dortmund) it is part of a broader concept on education and applied sciences which is based on an industry-university cluster and several educational initiatives [1]. As Digital Transformation is a rather new cross-disciplinary subject, the competence-based approach is used to define educational goals and scope of the master programme.

Keywords: digital transformation; competence; master education.

1. Introduction

In order to be successful and competitive in the market, nowadays it is vital for companies to anticipate the needs of the rapidly changing marketplace and successfully implement new technology [2]. During the last two years, 90% of the worldwide data was created [3], therefore, for a company "digital incompetence" may result in a loss of its market position [4]. While improving organizational performance, business processes need to be changed along with the IT [5]. These and other statements of scholars point out to digital transformation as a key trend of the future.

Realization of digital transformation requires preparation of new leaders who are qualified not just to build knowledge in technological aspects, but deal with the whole area of impact of digitization [6]. In this paper, the authors study competences that can be provided on the level of a master degree. As a case study, the competence-based development of a master programme on digital transformation at FH Dortmund is presented.

2. Digital transformation

Leading digital change requires managers to envision how to transform their company for a digital world [8]. Therefore, these three pillars can serve as strategical goals of digital transformation when readjusted to a company's level. On a company level, according to Westermann et al. digital transformation has nine key elements (see Figure 1). Westermann et al. represent digital transformation as a set of such measures as optimizing operations, transforming

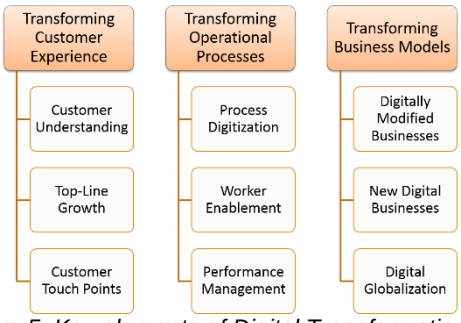

Figure 5. Key elements of Digital Transformation [8]

products, services, processes, methods, etc. and empowering employees (see Figure 1). In general, the literature presents very distinctive approaches to define and structure the notion of Digital Transformation. In the given article, the authors offer a perspective that allows focusing on key competence fields for the master programme on digital transformation based on literature review and the existing FH Dortmund competence network.

2. Digital Transformation Competences

According to Rankin, competences can articulate both the expected outcomes from an individual's efforts and the manner in which these activities are carried out; everyone can learn to speak a particular language; and competences provide common, universally understood means of describing expected performance in many different contexts [9]. Competences represent abstractions of work-relevant human behavior and introduce a concept for

Figure 2. Approach for defining Digital Transformation [3]

making human skills, knowledge and abilities manageable and addressable in a wide range of application areas [10]. In human resource management, competency models have already become a mainstream practice [11]. A competence model represents a framework used for organizing a collection of observable skills, behaviors, and attitudes that describe what people need to know and be able to do in order to execute their responsibilities effectively [12].

The competence-based approach to higher education ensures that employees both understand the concepts being taught and can apply them in the work environment as competencies represent clear learning outcomes [13]. In the sphere of higher education in Europe, competences serve to have clarity on the objectives of education. [14]. In The European Qualification Framework (EQF) [15], competences are used as a tool to bridge diverse education and training systems in Europe.

The Master level education is defined by the EQF level 7, which requires the competence, ability and attitude to "manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams" [15].

Specific digital transformation competences are studied, for example, by Forrerster. They identified five important aspects of digital competence represent fields that are to be covered by the digital leader or digital teams ([16], cited according to [6]) (see *Figure 3*).

Overall, competences are not widely used in a manner that allows providing a holistic systematic view on a study programme. For this reason, the authors are offering to use a competence breakdown structure method to represent the master programme on digital transformation at FH Dortmund. This method disintegrates the notion of competence into smaller elements and based on a common project management approach to structure a complex system into manageable elements [17].

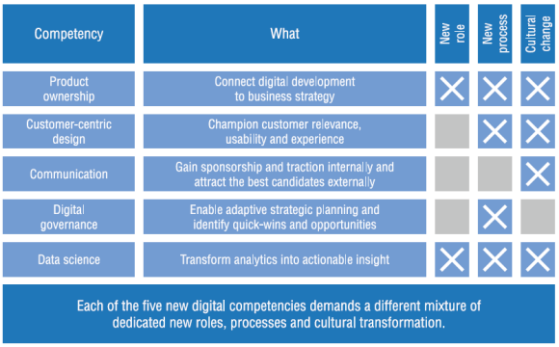

Figure 3. Five fields of digital transformation competence [17]

4. Competence breakdown structure for FH Dortmund Master Programme on Digital Transformation

In this chapter, the author presents considerations which the programme is built on. The programme will consider as the key elements of digital transformation relationships between technology, value, and information supply chains (see Figure 4). Education programmes in digital transformation have to be executed on the master level due to the following reasons:

- A master programme relates to the EQF level 7, which relates to managerial/leading positions.
- An individual have to understand information technology sphere, in order to lead digital projects, which is often obtained between bachelor and master studies.
- Digital Transformation requires a big deal of innovation and R&D skills which are related to a master level.
- Interdisciplinary character of the subject.

Currently the Master programme for Digital Transformation is being developed based on the following principles [1]:

- The competences delivered by the modules are combining project and change management with methods from IT and business.
- Need for a consistent and holistic approach.
- Consequent orientation towards innovation ("develop innovators").

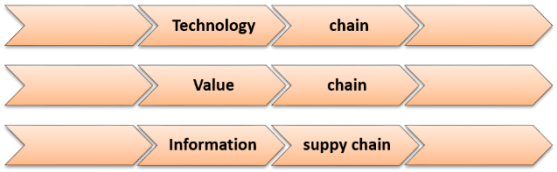

Figure 4. Digital Transformation elements: chain view

The scope of the Master programme for Digital Transformation lies within the following three dimensions:

- Software engineering with the associated methods, processes, architectures and tools

- A human-related innovation and development process with the goal of making people aware of digital solutions (including Usability)
- Digital systems in technology and business as the basis of digitalization

Let us define competence fields covered by the master programme (see *Figure 5*) according to the research on key managerial skills on the international level [18] and scope of the digital transformation.

For example, the field of technical skills contains the following topics:

- Software Engineering;
- User Centered Design;
- Innovation Processes;
- Digital Systems;
- R&D processes and tools.
- Soft skills.

Our purpose is to define development goals according to the competence fields so that a student clearly understands what he or she is supposed to be able to do after finishing the master programme. Due to the limited scope of the paper, let us represent one part of the developed competency breakdown structure, which is related to change management. (see *Figure 6*).

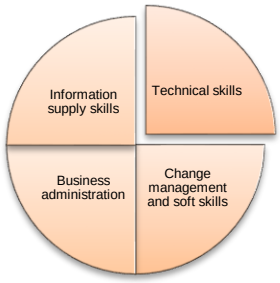

Figure 5. Master of Digital Transformation: four competence fields.

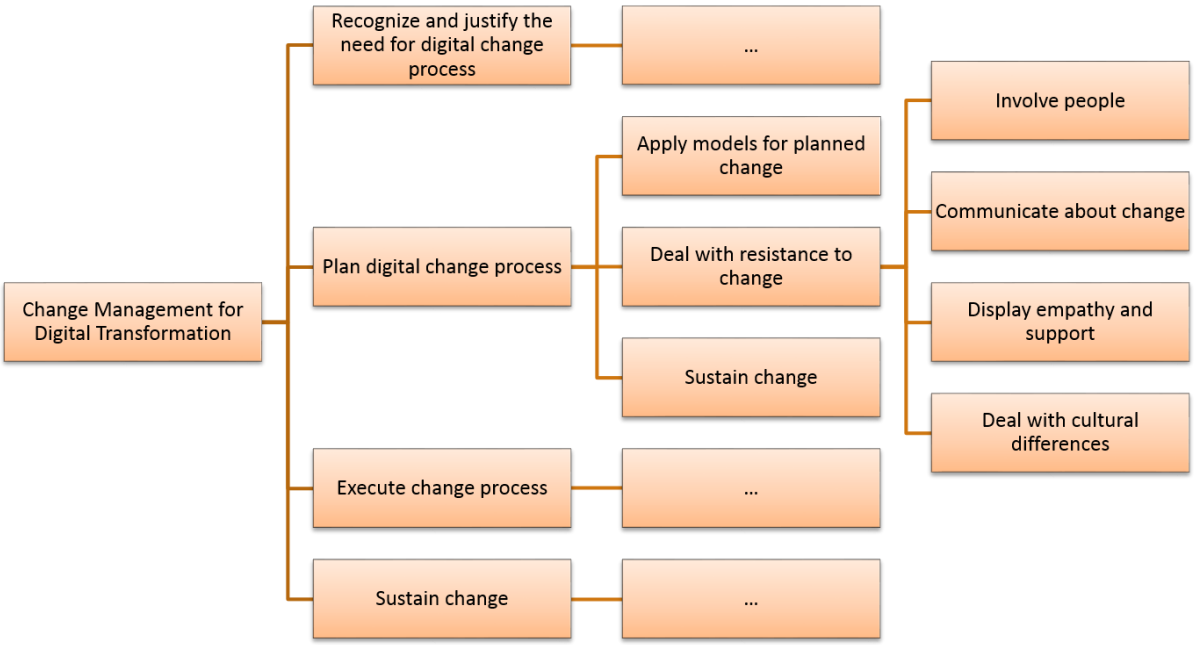

Figure 6. Master of Digital Transformation: competence breakdown structure (fragment)

The application of change management, which is aimed to plan and sustain the new digital manner of working within the company, is an inevitable measure because only those involving the employees from the very start will be able to manage the transformation successfully [3]. For this reason, the change management competence field has been chosen as an example, highlighting the importance of this field in digital transformation.

Such a competence breakdown structure includes competencies that are based on current trends in the digital transformation, and the interdisciplinary and international experience of FH Dortmund and its partners.

5. Conclusions and discussions

Digital Transformation is a current trend that requires preparation of new leaders of a new generation that is capable of dealing with digital complexity, managing changes, and applying managerial and soft skills. In order to address these challenges, education on a master level fits best, providing the necessary level of qualification. Studying the respective EQF requirements and elements of the notion of the Digital Transformation, the authors have introduced the main competence fields for the Master programme for “Managing the Digital Transformation” and the competence breakdown structure as a method to represent educational goals for students. Further research and analysis of relevant competences and their decomposition are needed in order to specify each field of the digital transformation perspective.

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The Sustainable Value of firms and their projects

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Abstract:

A successful integration of socio-environmental activities must begin in the strategy. At the portfolio, program and project level, this top-down approach involves value management.This document studies the value proposition of companies and their projects considering social, environmental and economic dimension. The evaluation is performed at project and firm-level. The results are compared between levels and they reveal in what extent the sustainability integrated in the host company is reflected in projects.

Keywords: **Sustainability; business model; project-level; firm-level.**

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1. Introduction

Companies are being pressured to respect the environment and internalize the costs associated with pollution, inequalities and other ecological or social problems. In response, they try to integrate sustainability practices in their companies, projects or processes. A failure in these tactics can be reflected in the cost of production, a decrease in profits or a poor penetration in the target market. In addition, the client can interpret these initiatives as green image washing and not be willing to pay more for the same service.

Eccles sans Serafeim [1] affirm that a successful integration of socio-environmental activities must begin in the strategy and requires innovation in the product, the processes and the business model. At the portfolio, program and project level, this top-down approach involves value management.

This document studies the value delivered by companies and their projects in order to find similarities and links between them.

2. Theoretical Background

2.1 The sustainable value delivered by firms

Sustainable value proposition is a promise on the economic, environmental and social benefits that a firm's offering delivers to customers and society at large, considering both short-term profits and long-term sustainability [2]. According to Boons and Lüdeke-Freund [3], there are three requirements that should be fulfilled:

- "The value proposition provides measurable ecological and/or social value in concert with economic value.
- The value proposition reflects a business-society dialog concerning the balance of economic, ecological and social needs as such values are temporally and spatially determined.
- For existing products, a particular balance is embedded in existing practices of actors in the production and consumption system; for new products or services, such a balance is actively being struck among participants in the evolving alternative network of producers, consumers and other associated actors"

Conditions like the measurability, business-society dialog, and the balance among actors have also being discussed by other authors. For instance, Joyce and Paquin [4] propose the design of environmental indicators based on Life Cycle Assessment and the stakeholder management approach to explore social value.

Bocken et al. [5]identified companies that delivered sustainable value, products and services that engage with stakeholders.. The balance is reflected also with the suppliers, selected based on durability, reparability and upgradability of materials. The engagement with the stakeholders make them prioritize the delivery of social and environmental benefits rather than the economic profit.

2.2 The sustainable value delivered by projects

Portfolio management seeks the maximization of resources to fulfill the strategic goals. The evaluation of projects assess value in terms of financial and commercial metrics. Martinsuo and Killen [6] recognize that project portfolios have strategic value beyond economic profit but is not accounted due to a lack of enough approaches that

consider indicators like reduction of emissions, the use of water, the involvement of the society, etc. Abidin [7] suggested that being sustainable in terms of Value Management involves a dedication towards three matters:

- Economic sustainability: Enhancing the project's profitability through the efficient use and management of resources.
- Environmental sustainability: Reducing pollution and the environmental footprint through a rational use of natural resources and effective waste management.
- Social sustainability: Enhancing the quality of life and social prosperity in addition to responding to the needs of society (including those of end-users, clients, the wider community, and other project stakeholders).

2.3 The relationship of value at project-level and firm-level

Projects are vehicles to create or deliver value. In a project based organization (PBO), the value is delivered directly to the client. In a project oriented organization (POO), the project output is meant to improve the internal processes [8].

In Corporate Social Responsibility initiatives, firms frequently develop projects which sustainable value is not really aligned with their business case, thus it is interpreted as green washing. This situation creates two uncaptured effects: one is a value surplus, exists but is not required from the company perspective and a value missed, is required but it doesn´t exist from the society perspective [9].

PBO and POO, should find ways to integrate sustainability goals no matter if they are considering projects as an autonomous or subordinate organization. Although researchers Kivila, Martinsuo and Vuorine [10] pointed out that indicators centered frameworks are not enough to cover project value and benefits over the project life cycle, they do agree that sustainability value needs to be built proactively.

The work of Mutka and Aaltonen [11] as well as Reginato [12] evaluates the value delivered by projects and compares it with the value delivered to the firm to the external stakeholders. This paper enhances their frameworks with the inclusion of the three requirements of sustainability value suggested by Boons and Lüdeke-Freund [3]: Measurability, Social Dialogue and Balance.

The aim of this paper is to answer the following Research Questions:

RQ1. What factors add environmental and social value to projects?

RQ2. Is there any relationship of the sustainable value between both: the project-level and firm-level?

3. Methodology

The Methodology is Content Analysis [13], [14]. The analytical construct is derived from the theoretical background [15]. The sample is obtained from the companies and projects disclosed in CSR Reporting. Mixed Methods techniques collect and analyze the data [16]. First steps consist in having a theoretical framework, define the research questions followed by the conceptualization and operationalization of variables.

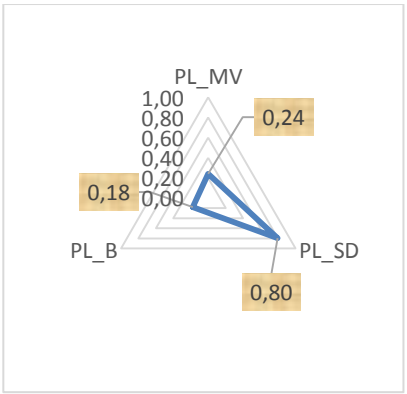
For this study, we have defined three variables: measurability, social dialogue and balance. Based on Boons and Lüdeke-Freund [3], we state that these variables define the sustainable value. Then, we examine the variables at project-level and firm-level to compare if the value delivered is aligned with each other

4. Results

Boons [3] pointed out that the value delivered should provide environmental and social metrics in concert with the economic one. If the projects or the company fulfilled this condition, a value of 1 was assigned to the variable Measurability Value (MV), otherwise the data was collected as a 0. The Social Dialogue (Variable SD) reflects a business-society communication, about the three dimension, people, planet and profit, spatially al temporary delimited. Finally, the Balance (variable B) reflects the responsible involvement of the stakeholder in the production and consumption.

The three variables are Boolean, collected as 1 when the presence is detected, and 0 when it is absent in the GRI report. To distinguish the data between project and firm, the prefix PL and FL is adopted.

The three properties of value delivered (measurability, social dialogue and balance) are represented in figure 1. The left radial diagram belongs to projects and the right diagram belongs to firms.



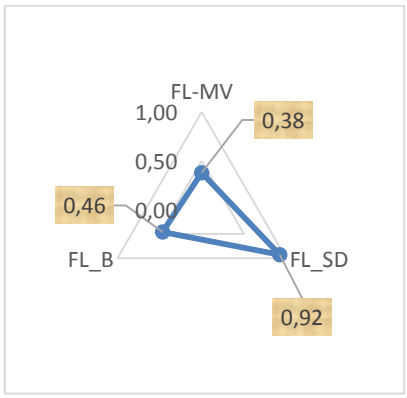


Figure 6. Measurability, Social Dialogue and Balance at project and firm-level

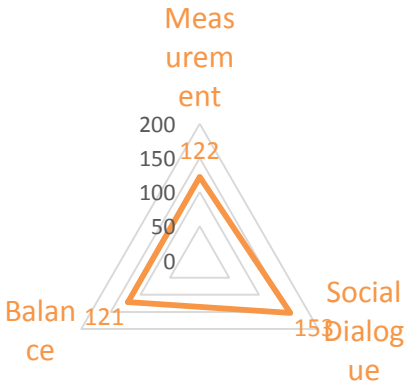


Figure 7. Similarities between value at project-level and firm-level

The second Research Question, "Is there any relationship of the sustainable value between both: the project-level and firm-level?" is analyzed by the following descriptive figures. The figure 2 explains how many cases are similar between projects and their parent organizations. For instance, the same behavior of measurement between projects and their parent organization was detected in 122 cases. Similarly, the Social Dialogue and Balance presented in 153 and 121 observations.

We have decided to run a t-test to find an answer for the Research Question 2: Is there any relationship of the sustainable value between both: the project-level and firm-level?

The Sig. (2-Tailed) value is less than 0,5. Because of this, we can conclude that there is a statistically significant difference between the mean of measurability, social dialogue and balance. In all the three cases, the project level mean is fewer that the firm level so we can conclude that the sustainable value delivered by firms is considerable more significant than the projects

Table1: Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Project-Level Measurable Value - Firm-Level Measurable Value	-.134	.568	.042	-.217	-.052	-3.229	185	.001
Pair 2	Project-Level Social Dialogue - Firm-Level Social Dialogue	-.129	.395	.029	-.186	-.072	-4.452	185	.000
Pair 3	Project-Level Balance - Firm-Level Balance	-.285	.519	.038	-.360	-.210	-7.483	185	.000

5. Discussion and conclusions

This paper evaluates the sustainable value delivered by the firms and their projects. It assesses measurability, social dialogue and balance [3] at project and firm level.

Quantitative content analysis approach [13]-[15] guides the methodological path to ensure the reliability of the data gathered. Corporate Social Reporting is the source of the sample.

The results show that firms and their projects show high levels of Social Dialogue in the firms and their projects. It can be explained in the context of Corporate Reporting because the organizations voluntary communicates their activities.

The measurable ecological and social value, in concert with the economic one is still missed in the reports. Although indicators are developed in the environmental domain there is still a lack in social indicators.

Regarding to the balance, the projects disclosed in the reports did not showed the presence of different actors or stakeholders in the production or consumption of the project deliveries. Nevertheless, firms showed a medium level in this area. This observation reinforces the assumptions about the marketing or green washing orientation of the projects developed by companies.

The following conclusion can be indicated:

- The sustainable value delivered by firms is mainly based on the dialogue between the company and the society, followed by the balance among producers and consumers. The weakest property is the measurability of the value, due to the lack of social indicators.
- The sustainable value delivered by projects is also based on the dialogue, followed by measurability and finally by the balance. It is important to point out that measurability and balance has lower values compared with their parent organization.
- The sustainable value delivered by firms is more significant than the sustainable value delivered by projects and there is no evidence that a top-down relationship exists.

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European energy strategy implementation through Projects of Common Interest: A challenge for Project Management

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Abstract:

In the process of European unification, there is a need to draw up a common energy strategy that affects the electricity system in terms of both infrastructure and generation. The action lines of this strategy are a reduction in emissions, an increase in renewable energies, energy efficiency and the avoidance of electricity islands. To this end, 173 projects have been identified as projects of common interest. These projects are of special treatment.

This working paper presents the complexity of the implementation of these projects, which are managed by two member states coordinated by European guidelines. Although these projects are clearly identified as strategic projects the quantitative treatment of their socio-economic management according to the benefit in the strategic objective is complex. The main players are electrical regulators, industry sectors, citizens and the electricity market. At this point the Trans-European Energy Networks regulation plays an important role in regulators' efforts to fund projects through electricity grid tariffs.

Keywords: European energy strategy; project of common interest; alignment.

1. Introduction

The European Union (EU) recommended in 2002 that all member states should reach a minimum of 10% electricity interconnection ratio by 2020. The aim of promoting interconnection is to eliminate isolated systems and to promote a single electricity market.
In 2015, the European Commission (EC) publishes a new strategic framework for achieving the EU's energy policy and climate change objectives, in particular for 2030 targets: 40% reduction in emissions compared to 1990, 27% share of renewables in final energy consumption, 27% energy savings compared to consumption forecasts and 15% interconnection capacity between member countries.
The objective of the European energy strategy is to make progress towards energy security, sustainability and competitiveness.
The projects attempting this strategy face vital obstacles: national regulations, technological challenges, budgetary constraints, consumers' unwillingness to pay more in their electricity bill, lack of funding and social acceptance of electricity interconnection infrastructures.

This case study presents the characteristic uncertainty of any change, say quantitatively determine the degree of alignment of a project in a corporate strategy. In other words, the investment of a short-term project how contributes to a long-term strategic objective.
The complexity of this case is intensified since the execution of these projects will directly affect the future electricity market and consequently the return on investment. Future scenarios are highly uncertain. The management of these projects is so complex that even the European Union has classified them under a special name, Projects of common interest (PCI).

This working paper is organized as follows: after this general introduction, section 2 is devoted to understanding the European Energy Strategy nature. Section 3 explores the project portfolio phase. Section 4 presents how Projects of Common Interest are managed. Section 5 is a discussion of the main findings. The final section deals with conclusions and further research.

2. European Energy Strategy

The amount of fossil energy imported into the EU is clearly reflected in the price European households and industry payment for its consumption. The EU is thus exposed to global trends in the energy economy.
Figure 1 shows the estimated amount of energy imported into the EU. Note that the amount of imported oil has decreased due to the increased supply of shale gas and LNG.

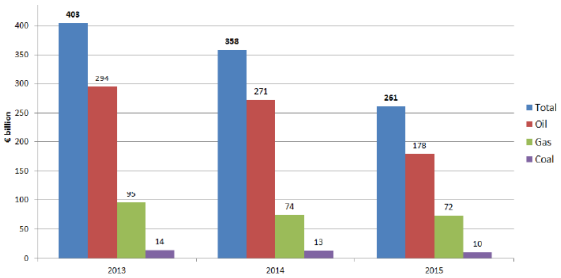

Figure 1 Estimated import bill (source EC).

The road to mitigate the amount of imported energy is to increase energy efficiency and promote cost-effective energy alternatives.
However, the energy strategy challenge should not only be focused on price, also on energy security and climate change.

3. European energy strategy implementation

To ensure the result of this strategy the European Parliament adopted in 2013 the Regulation No. 347/2013 on guidelines for trans-European energy infrastructure [1]. The projects included in the latest ten year network development plans prepared by the European Network of Transmission System Operators for electricity (ENTSO-E) can be included as PCI.
So, the first step of the projects, the discovery phase, is determined by the needs detected in the EU Commission to complete a single European grid. This is a top down approach. One of the key performance indicators (KPI) all along the life cycle of this strategy is the degree of connection of each member state with its neighbour country. In table 1 it can be observed the levels of electricity interconnection in 2014.

Luxemburg 245%	France 10%	Spain 3%
Finland 30%	Germany 10%	Poland 2%
Hungary 29%	Italy 7%	Ciprus 0%
Holland 17%	Portugal 7%	Baltic 0%

Table 1 Levels of electricity interconnection in 2014.

And, in table 2 we can observe the interconnection targets for the year 2020.

Luxemburg 185%	France 12%	Spain 6%
Finland 19%	Germany 13%	Poland 8%
Hungary 98%	Italy 10%	Ciprus 0%
Holland 17%	Portugal 21%	Baltic 8%

Table 2 Electricity interconnection targets for the year 2020.

The three Baltic States, Estonia, Latvia and Lithuania are not synchronized with the European network and are therefore considered as a single identity.

The PCIs are designed and implemented by both Transmission System Operators (TSO) and private promoters. So, the project planning finally is a bottom up approach that is subjected to selection criteria.

Projects are selected as PCIs on the basis of five criteria. They must fulfill [1]:

- have a significant impact on at least two EU countries.
- enhance market integration and contribute to the integration of EU countries' networks
- increase competition on energy markets by offering alternatives to consumers.
- enhance security of supply.
- contribute to the EU's energy and climate goals. They should facilitate the integration of an increasing share of energy from variable renewable energy sources.

The analysis to determine these parameters, and in consequence select the right project is the objective **cost-benefit analysis**. Those projects that commercially are not viable and have positive impact are suspect for grants.

The responsible of the project portfolio is the Commission and main stakeholders (local project promoters, regulatory authorities, permit granting authorities and other representatives of member states). The PCI list is updated every two years. Consumer and environmental protection organizations are invited to participate in the PCI selection process and to bring their insight on the infrastructure bottlenecks.

Currently there are four higher level groups along Europe, who provide strategic steering and policy guidance according to four specific European regions facing particular challenges.
The central and South-Western Europe energy connectivity is integrating the Iberian peninsula with the European mainland internal energy market.
North Seas energy cooperation promotes the integration of offshore wind and enhances interconnection.
Central South Eastern energy connectivity is historically vulnerable to supply disruptions. Here, the main is a gas corridor.
The Baltic Energy Market Interconnection Plan is a key political priority which aims the synchronization of the three Baltic states with the European network.
Each of these regional group contribute in the development process as they foster high level political commitment, help reach agreement in regional plans and optimize EU financial support.

4. Projects of Common Interest

The advantage of PCI qualification is how much the project contributes in the European energy strategic objective. So, the EU provides financial, regulatory and bureaucratic support.
The main stumbling block for energy infrastructure projects is the process of concession and public acceptance.
The Regulation introduces a period of 3 to 4 years for authorization and concentrated permits to a single competent authority.
In addition, the regulation has introduced new rules on consultation to involve citizens in the planning process and guidelines for environmental impact assessment procedures have been developed.

On 23 of November 2017, the European Union announce the third union list of the projects of common interest by country. In all 28 European country members are involved and 13 non members. The number of projects adds up to110.
Here, we can see some of them [2],
<u>Baltic synchronization:</u>
Lithuania has recently connected with Europe via Sweden, Finland and Poland. However, the electricity network is still operated by Russia and Belarus. This Project will allow synchronization with the Continental European Network (CEN). This site is vulnerable to potential supply shortages.

The North-South German Interconnector:
This project avoids spill-over generated by the neighbouring countries. The capacity of this underground cable is of 4,000MW and 500 km long.
Bay of Biscay:
This project consists of the creation of an electrical interconnection for the Bay of Biscay between the Red Eléctrica de España (REE) and Réseau Transport D' Électricité (RTE). This interconnection, 370 km long, would connect the 400 kV Gatika substation and the Cubnezais substation in Bordeaux. The transmission capacity is 2,000 MW.
Celtic interconnector:
This is the first electricity interconnection between Ireland and France. The planning is a 700 MW high voltage underwater cable and 600 km long.
Cobra cable:
This cable will facilitate the integration of renewable, wind energy, into the grid between Denmark and Netherlands. The capacity is 700 MW and 350 km long.

Current projects are in different stages of development; some are under construction but many are still in the early phases of preparation.

Figure 2 and 3 show graphically a clear difference in the European electricity state before and after the implementation of the European energy strategy.

Figure 2. European interconnection in year 2010 [3].

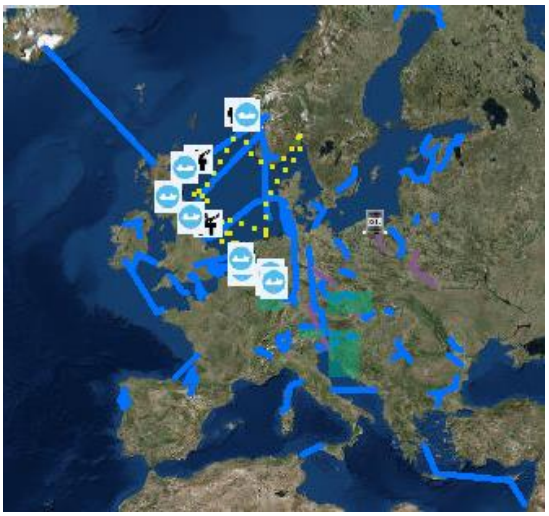

Figure 3. European interconnection in year 2020 [3].

4.1 Electricity cost, project cost and financial support

The price of electricity is very sensitive. Low electricity prices can be economically speaking beneficial since it raises our purchasing power, the standard of living, reduces the cost of our industrial production and makes us globally speaking more competitive. On the other hand, high prices reflect the fact that coal is being reduced as a raw material for electricity production, energy efficiency is being promoted or we are using clean production technology [4].

In a competitive market, price changes in wholesale markets are passed on to retail markets, but in Europe several factors restrict this step. In addition, lower market prices are the result of network taxes, fees and/or regulated tariffs. Whilst wholesale prices in 2016 have been the lowest in the last 12 years, domestic prices have increased by 2-3% per year. In the other hand, the EU industry prices vary significantly across member states and sectors. The EU industrial electricity prices are lower than in Japan, similar to Brazil or China and higher than USA or Russia.

As we have seen, electricity is distributed through markets and energy suppliers need to cover production costs and finance infrastructure investments to ensure future energy distribution.

The energy network infrastructure in Europe is becoming obsolete and there are doubts as to whether it will be able to meet energy demand by ensuring a reliable supply. The investment and adaptation of existing networks and the development of new structures are estimated up to 2030 about 180 €billion.

In order to encourage private investors and accelerate PCI projects, the European Union creates Connecting Europe Facility (CEF) which has access to a total of 5.35 € billion. This funding is in accordance for projects that bring significant socio-economic benefits but the costs of which could not be borne by the market alone.

4.2. Project Management

Trans-European Energy Networks (TEN-E) regional groups are the responsible of monitoring the project progress. It is based on annual reports prepared by the Agency for Cooperation of Energy Regulators (ACER) and the competent national authority. In case the project is not viable over time, it will be removed from the list.

Project planning requires the follow-up of a Gantt chart. The preliminary stage of the project could follow the following steps:

a) 1st Regional group meeting for all stakeholders: Kick-off for selection.
b) Cost benefit analysis.
c) 2nd Regional group meeting for all stakeholders.
d) 3rd Regional group meeting for promoters: submit the project proposal.

For managing the project it is necessary to identify a series of indicators particular for each project. Some indicators are directly related to the strategic objective, others will be related to regional strategic indicators and the last are inherent for each project. In the first level we can enumerate indicators such as K_{11} reduction of greenhouse emissions or K_{12} ratio between interconnection capacity and its electricity demand, in the second level K_{21} voltage quality performance or K_{22} methods to calculate charges and tariffs, and lastly K_{31} involvement of users in management of their energy usage or K_{32} stability of the electricity system.

5. Discussion

The European energy strategy can be translated on the basis of four high-level strategic indicators a) emission reductions b) share of renewable c) energy efficiency and d) interconnection. These four indicators converge to create a single electricity system that is more sustainable and less dependent on energy imports.

In the project selection phase, different projects are presented. The projects are indirectly associated with a region and in each region there is a task that is determined on the basis of the roadmap of the high-level groups. For example, in the South Western region interconnection is given priority and not so much renewable share (although there may be a high contribution in this regard). On the other hand, the Baltic region will give priority to network synchronisation over the share of renewable energy. This means that not all regions push in the same direction of the different aims of the strategy, it should be determinate each region how much contributes in the overall strategy and in which aspect.

The casuistry of projects is multiple. This means that positive projects in terms of technical, economical and publicly accepted could be successfully planned and executed. These projects will undoubtedly have contributed to the corporate strategic objective. A more precise data and necessary to manage the programme is the degree of contribution.

On the other hand, we can also find projects that are not economically viable, but nevertheless make a great contribution to the strategic objective. These projects are clearly susceptible of funding. If the European funding provision covers the cost of the project, its implementation will not be problematic. However, projects that are still being financed but which are not yet viable are liable to be delayed. In order to facilitate its implementation a global mechanism should be established. The challenge is to measure what the project contributes to the strategic objective. In this attempt a rigorous cost-benefit analysis is necessary. The difficulty of this matrix is to measure the benefits that are not tangible. While the quantification of these intangible parameters may be relative, the uniform use of their mass distribution along all projects and all regions can generate a well adjusted weighting.

The last chance for launching these projects is adjusting the funding through electricity tariffs. This analysis should have a triple perspective: local level, regional level and European level.

Nevertheless for this adverse case, the EU has developed the TEN-E regulation. The regulation obliges national competent authorities to provide for proportionate regulatory incentives for such projects. This means that the tariffs set for the use of the infrastructure take into account, for example, a sufficient duration to recover the investments.

On the basis of the February 2015 communication [5] the integration of energy markets in the EU has led to a one-third fall in wholesale electricity prices.

6. Conclusion and further research

In the long term, greater flexibility of supply should reduce the wholesaler's price. In a scenario of wholesalers and retailers competition, consumers and domestic receipts can benefit.

According to Booz & Company once the market coupling is fully implemented the benefits will be of the order of 2.5 € billion to 4 € billion per year. Booz adds that a fully integrated market would facilitate the short and long term of trading of energy. Regardless a full integration will require large investments in transmission capacity.

Many Projects of Common Interest are still not on track, others are having delays and some are being rescheduled, often due to the uncertainty associated with commercial viability and future demand.

This working paper gives a significant further research which lies in how to manage electricity infrastructure investment that is not cost effective but in long term is suspect of adding value.

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Understanding consumer´s behavior as a first approach to implement Sustainable Project Management

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Abstract:

Sustainability, People and Project Management are studied as isolated topics in countless studies. The term Sustainability is an urgent topic in all business. The consumer's behavior is under investigation in Project Management and people through their behavior could be the bridge to introduce sustainability to Project Management. This research aims to be a first approach to determine if there is a relation between consumer behavior and Sustainable Project Management. This paper presents a first analysis of people's knowledge about sustainability. For the analysis, one of the sustainable measures -indicated by United Nations in their 2030 agenda- has been selected: Sustainable and modern energy for all.

Keywords: Project Sustainability Management; Renewable Energy; Consumer Behavior.

1. Introduction

One of the main aspects of sustainability is to achieve social, environmental and economic goals within the same context both in short and long term duration. This is known as Triple Bottom Line [1] The United Nations has summarized 17 goals to transform our World in order to accomplish the 2030 agenda for Sustainable Development.

In this paper, the focus is set on one of these goals: "Ensure access to affordable, reliable, sustainable and modern energy for all". The paper presents an analysis to investigate if the consumer´s behavior influences the implementation of Sustainable Project Management.

2. Background Concepts

The pressure on organizations to incorporate the principles of sustainable development into policies and activities is high: sustainability is recognized as one of the most important challenges of our time. Sustainability has become a very important issue particularly in terms of environmental care but nowadays there is a lack of integration of the term sustainability when a project is being executed.

Since there are not specific guides about sustainable project management, how could be sustainability taken into account in project management processes? If organizations "put their money where their mouth is" on sustainability, is it inevitable that sustainability criteria and indicators will find their way into project management methodologies? [2]

The Project Management Body of Knowledge (PMBOK) identifies five processes that need to be carried out to swift information flow among stakeholders [3] and to meet the overall project requirements, but there is a clear missing linkage between the project management and design for sustainability [4]. The sustainability concept does not clearly appear in the PMBOK guide. However, it does in the published ISO 21505 standard on governance of projects, programmes and portfolio management [5] which states that "The governance of projects, programmes and portfolios should reflect the organization´s commitment to ethical values and sustainability" Nowadays, the standard certification of management systems (ISO9001, ISO14001, OHSAS18001, SA8000 among others) are references to start the integration of sustainability variables into project management routines [6]

3. Methodology

The principal question addressed in this paper is: Has the consumer´s behavior, as key stakeholder, influenced in the implementation of a project sustainability management?

The methodology adopted comprises of the following steps:

(1) Analysis of the price for the electricity from different utility companies
(2) Analysis of the answers to a survey about sustainability and power generation.

Both steps were analyzed through online surveys. The survey had a total of five questions and the interviewees were requested to attach their electricity bill.

3.1. Analysis of the price for electricity of different utilities

87 people answered the survey but only a total of six bills provided were effective since some of them were from the same utility. Therefore, in order to analyze the price of energy different utility companies, it was necessary to search for more information on the Internet (see Figure 1)

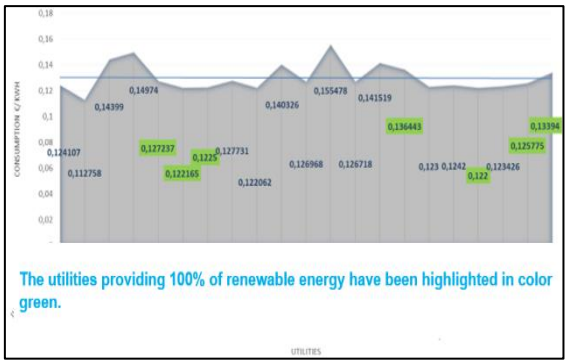
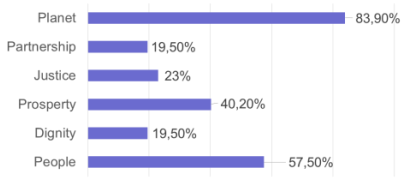


Figure 1. List of Utilities and their price for Energy (€/KWh)

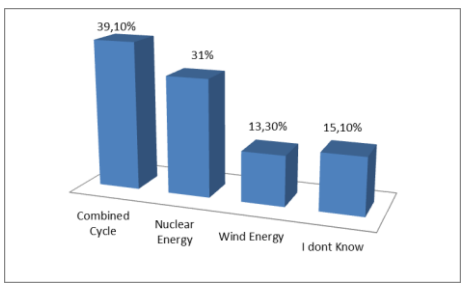
3.2. Survey: Questions and Answers

The survey has five questions with closed answers:

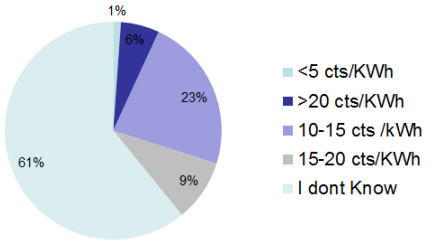
Question 1.In your own opinion, which of the following dimensions are relevant to Sustainability?



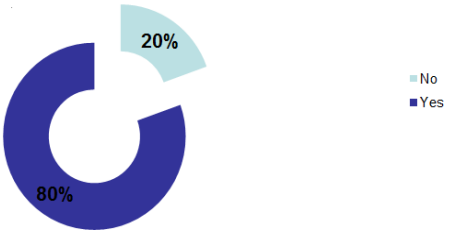
Questions 2.Which of the following sources of electricity are used by the majority utilities in Spain?



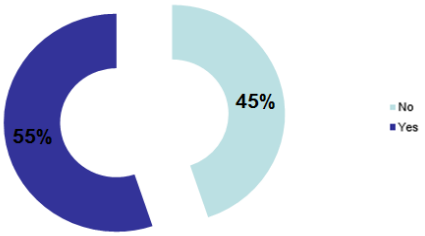
Question 3.How much does your energy at home cost? (€/ kWh)



Question 4.Are you worried about saving energy from appliances?



Question 5. Would you be willing to pay more if your electricity came from renewable sources?



4. Discussion

Consumers' education and information are the main keys to succeed in the implementation of a new measure.

The aim of the survey is to analyses the interviewees' knowledge on the topic "sustainability"

In Spain, from a population of professionals between 35 and 60 years old, Sustainability is highly correlated to Planet and People and therefore partially recognized. However, Dignity or Partnership does not seem to be linked with Sustainability. Most the interviewees are aware of the existence of renewable energy as part of the Power grid and half of them would invest in it. 61 % of interviewees do not know how much they pay for the energy at home. 6 % of interviewees (5 people) selected the price of the energy as the highest cost (more than 25cts/kWh) and 3 of them also confirmed that they would pay even more to have renewable energy.

55% of interviewees would accept to pay more for the renewable energy. But, is renewable energy actually more expensive? Has the implementation of a sustainable measure impact on cost? According to the figure 1 it would not be the case.

5. Conclusion

Despite the fact that the outcomes of this paper are limited to a particular context, it could be concluded that even though most of the interviewees are worried about the savings energy appliances and they are likely to pay more to have renewable energy, a great percentage has no idea about the cost of the electricity. How it is possible, then, to be willing to pay more if the price is unknown?

Nowadays, it is not possible for all people to have a contract with an utility Company providing 100% of renewable energy but if all consumers looked for companies with a higher percentage of renewable energy in their electricity bill, consumers would be supporting a sustainable measure: clean energy. (It is assumed that with more utility Companies providing renewable energy, more clean energy will be needed.) So, it could be confirmed that consumers' behavior is vital to accomplish a sustainable measure. Could this philosophy work with Sustainable Project Management?

If the sustainability concept was integrated in our routines, any project, process or product would be managed through a sustainable perspective. In other words, to have sustainable principles should not be an option and should not be used exclusively in organizations. Any person should prioritize and raise sustainability in their daily routines.

Since Sustainable Project Management does not have clear guides, all stakeholders in the Project should support and encourage sustainable measures. This research presents a first outcome that should be further explored in an extended population, to find out if consumers, as key stakeholders under their daily sustainable routines, are essential to the success of Sustainable Project Management**.** The goal is to confirm if being sustainable in daily routines could help soften the path for the implementation of sustainable Project Management.

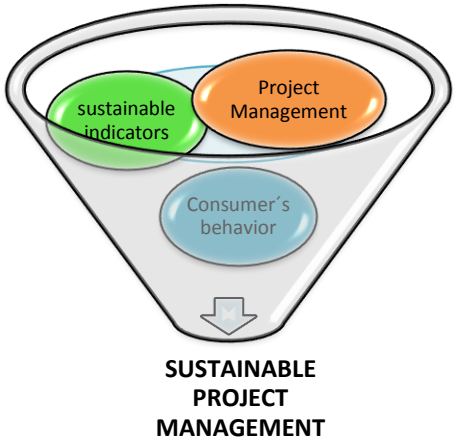


Figure 2. Sustainability in Project Management.

Acknowledgment

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Maturity models' selection criteria for assessment in a specific organisation: a case study

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Abstract:

The aim of this research is to make a small selection of existing maturity models that may be used to assess a specific organisation regarding PM maturity. The research was carried out analysing the most relevant and known maturity models, developed either by standards developing organisations or specific researchers on the matter. The models' implementation, mostly as online free self-assessment tool and availability of information, have been looked into. As a result, selection criteria were established and a narrower selection of models sorted out. This research is intended to be the foundation of further studies, such as the assessment of a specific organisation through the application of a selected maturity model's self-assessment. The objective of these studies are to define an optimisation strategy for their processes, through detecting improvement opportunities or areas, as well as developing key performance indicators and improvement plans that would help the organisation achieve the next level.

Keywords: Project management; maturity models; case study.

1. Introduction

The aim of this research is to get near the full picture regarding maturity models to select a few maturity level assessment methodologies that may be applied in Nortegas. As the main objective is to determine Nortegas' likely project management –PM- maturity level and define an optimisation strategy, the applicability of the methodologies and the possibility of performing a free self-assessment is taken as an advantage, for it is the path in which both limitations and improvement opportunities are expected to be detected.

The conceptual knowledge that is already handled in the organisation will be determined in a forthcoming document, which findings will be crossed with these selected methodologies to determine the one that is suitable.

This document is organised as follows: *Section 2* provides a state of the art analysis on selected existing maturity models, describing each model, highlighting advantages and disadvantages of them; *Section 3* shows a selection of maturity models for further studies, according to certain specific criteria; and *Section 4* presents the conclusion of this document.

2. State of the art

Within an organisation, the ongoing work in a project is generally a repetitive process that follows the organisation's procedures [1]. These procedures might have been developed based on cases of success and then improved when failure is detected, taking failure as a lesson learned. Consequently, knowing how the organisation is dealing with projects and whether the process may be replicated becomes of the utmost importance. Thus, several maturity models have arisen in order to assess an organisation's maturity in project management.

A maturity model is defined as a conceptual model that consists of different yet subsequent maturity levels for processes in one or more areas, and represents a wanted evolutionary path for these processes [2]. Maturity models are widely used in organisations worldwide, for they attempt to systematise processes and areas within an organisation [3]. Maturity models consist of, mainly, a set of maturity levels and provide precise criteria to achieve the each level of maturity. Scaling up along those levels means the organisation has improved. Because of this, the concept of maturity is linked to the success/failure rate an organisation holds [4].

2.1. Maturity Models

2.1.1. Kerzner's Project Management Maturity Model [5]

Kerzner makes it clear that the use of a standard methodology does not ensure organisational success but it does increase the possibilities of achieving it [4], [5]. His methodology consists of five levels –Figure 8, which represent different degrees of maturity. In Kerzner's book, each level is explained in detail: features, how to achieve it and issues that prevents the organisation from reaching such level are thoroughly explained. Each level is presented with a set of questions intended to determine whether the organisation has completed such level.

The cleverness in this model relies on the idea that a company may determine its degree of belonging in each level. Since levels may overlap, an organisation may find itself in more than one level

and get intelligence on how to achieve fully the next level.

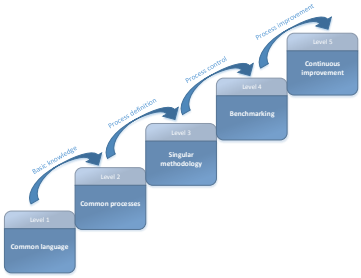

Figure 8 – The five levels of Kerzner's PMMM. Based on Kerzner, 2001 [5]

As drawbacks, this model relies solely on the employees and managers' points of view. It does not provide a way to assess projects' performance, and therefore no correlation with the current organisation's maturity level may be determined.

2.1.2. Capability Maturity Model Integration [6]

The Capability Maturity Model Integration -CMMI®- was developed in 1986 with improving software development processes as main goal, but also to help organisations align their processes with their business objectives [4]. Given its success, several maturity models arose, mainly to be applied in other fields [2].

CMMI® is defined by CSSA as a process-improvement model, which provides a set of best practices to improve productivity and performance [7]. It has two representations: CMMI® staged and continuous. CMMI® staged uses defined maturity levels: Initial: **Individual learning**; Managed: **Project learning**; Defined: **Organisational learning**; Quantitatively managed: **Quantitative learning and decision making**; Optimising: **Agile, adaptive learning** [7].

One of the advantages of CMMI® is that it is known to have been used in other fields, for it provides applicable guidelines for improvement [4]. However, needing to know beforehand which representation is to be used may be a drawback, for it requires certain knowledge and understanding of the two. Additionally, a free self-assessment questionnaire was found, but not accompanied with guidance to understand the results.

2.1.3. Ibbs & Kwak Maturity Model [8]

The model was developed by the authors and applied to 38 companies in order to assess their project management maturity level to therefore determine the financial and organisational impacts of project management.

This model covers eight PM knowledge areas and six PM phases –the PMBoK® is used as reference-. The authors also included one extra phase called "project-driven organisation environment". This model is able to identify both strengths and weaknesses of the PM practices the organisation uses, while identifying both problematic knowledge areas and phases, allowing the organisation to see precisely which areas may be improved.

An overall 1 to 5 score is calculated, and averaged scores specifically both for knowledge areas and PM phases are calculated as well.

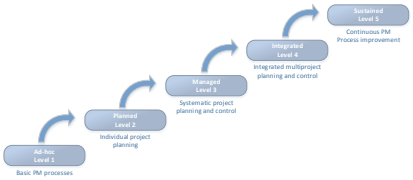

Figure 9 – The 5 levels of Ibbs & Kwak Maturity Model. Based on Ibbs & Kwak maturity model [9]

What is more, not only does this model integrate knowledge areas and phases to assess maturity, but it also contrasts the collected information against project **performance data**. The authors related maturity levels with two indexes: Cost Index and Schedule Index, which indicate project performance comparing actual cost and schedule against the originally defined. Moreover, a procedure to estimate PM return of investment was developed by the authors, using the former indexes and the determined and desired maturity level [9].

2.1.4. OPM3® Maturity Model [10]

OPM3® is a continuous process that involves three steps: **Knowledge**: prepare for assessment, understanding the model thoroughly; **Assessment**: perform a maturity level self-assessment; **Improvement**: outcomes of the assessment are prioritised and some are selected to then make improvements. After assessing itself, the organisation will be able to determine which best practices and capabilities have and which others does not in order to, therefore, take action [11].

OPM3® provides a wide directory of best practices and capability statements -along with an improvement planning directory- to standardise or continuously improve processes. Best practices are led up by one or more capabilities, being capabilities OPM3®'s core, essential to understand the model, along with best practices and its dependencies. The assessment provides the organisation with a list of the capabilities it is lacking of.

Nowadays, an OPM3® expert-PMI certified is required to assess an organisation. After searching PMI website and store, and other OPM3®-related websites, both capability statements and the assessment could not be found for purchase. Additionally, there is no mention on PMI's website about OPM3® certification, which may lead to the idea that further changes are in order. These are believed to be a clear disadvantage. Besides, OPM3® requires acquiring deep knowledge about the model before implementing. Despite that, the model provides the organisation with plenty of information to take action specifically in areas where there is room for improvement.

2.1.5. P3M3® Maturity model [12]

The P3M3® is an organisational maturity model that assesses how projects, programmes and portfolios are managed. According to Axelos [13], P3M3® is able to be tailored to suit the organisations' needs.

P3M3® consists of three sub-models: PfM3; PgM3 and PjM3: Portfolio, Programme and Project management respectively; and is also described by a five-level framework: 1: **Awareness of process**; 2: **Repeatable process**; 3: **Defined process**; 4: **Managed process**; 5: **Optimised process**. The model focuses on seven areas/perspectives, which are present in the three sub-models and, therefore, assessed in all maturity levels -shown in Figure 10.

During the assessment, specific attributes for each area are defined and assessed. Consequently, these attributes would be the foundations of the improvement actions taken. The organisation may choose which sub-model/s to assess as well as make a combinations, for it would rather put more effort in one of the models and yet assess the other two to obtain information that may be of use.

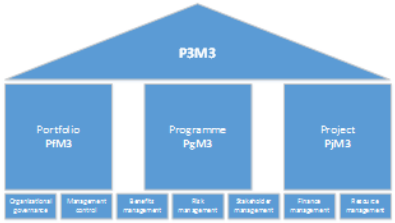

Figure 10 – Structure of P3M3®. Based on P3M3® [13]

The model provides a free self-assessment toolkit that helps the organisation identify capability weaknesses, but Axelos recommends the full assessment. Nevertheless, the fact of having a free self-assessment toolkit is certainly beneficial, for it gives the organisation a clear idea on what it is like and how it is applied, thus providing substantial information to decide whether to run the full assessment and continue with this model.

2.1.6. The P2CMM maturity model based on PRINCE2® [14]

The authors developed a maturity model based on PRINCE2®, which is a structured method for managing projects effectively regardless of type or scale [15]. This methodology is based on an approach that considers the 7 PRINCE2® processes plus an 8th one: Planning [14]. Precisely, they have structured their model in three layers: **Target layer**: the purpose of the study; **Process layer**, and **Sub-process layer**, all assessed using a questionnaire. The answers provided are scored and a synthetic attribute assessment is conducted [16]. The outcome would be which level the organisation is in: 1: **Cognitive**; 2: **Repeatable**; 3: **Management**; 4: **Integration**; 5: **Continuous**.

This model, according to the authors, is to be further developed in future research. Additionally, this model would be applicable if the organisation is familiar with PRINCE2®.

2.1.7. IPMA OCB® and IPMA Delta® [17]

IPMA Delta® stands out for it focuses on *competence* to achieve PM maturity [18]. It is the approach by which IPMA® assesses an organisation's maturity/competence level. IPMA OCB® is its foundation, defining five groups of organisational competence, their scope and responsibilities. IPMA Delta® defines five levels of competence –see Figure 10.

Criteria for assessment / Competence class	Existence of standards	Application of standards	Management of standards	Stakeholder engagement	Results in line with targets	Project achievements are likely on
Initial	Per project	Limited	Not yet	Project owner -PO-	Some good results but often challenged targets for time, budget and scope	Personal level
Defined	Partially	Per project	Limited	PO and essential internal stakeholders -SH-	Below benchmark	Project level
Standardised	Mostly	Partially	Per project	PO and all relevant internal SH	At benchmark	Project based on procedures
Managed	Fully	Mostly	Partially	PO, all internal and all essential external SH	Automatically above benchmark portfolio, overrun at benchmark	Projects in alliance with programmes and/or portfolios
Optimising	Tailoring to the project	Fully	Continuously improving	All relevant stakeholders	Most projects meet objectives, only very small portfolio overrun standards end	PP&P in alliance with the organisation's strategy, generally achieving their objectives

Figure 11 - Competence levels. Based on IPMA OCB® [17]

IPMA Delta® uses IPMA ICB® -competence baseline, IPMA PEB® -Project Excellence Baseline and IPMA OCB® to assess organisational maturity. After being performed, the assessment gives information on its current level combined with the missing gap, or "Delta", to reach a target level [18].

One of the striking advantages of this model is that the relationship among its three modules provides a holistic view on project management [18]. On the other hand, an IPMA Delta® assessor is mandatory to perform the assessment.

3. Selection criteria

To make a selection of models that may be applied in further studies, a series of considerations have been taken into account:

- *Availability of free self-assessment tools*: for the purpose of this and further studies, it is essential to count on a self-assessment tool to estimate the organisation's likely maturity level.
- *Guidance to understand the results*: Particularities of each methodology might be unwillingly overlooked. The availability of this guidance is as important as the self-assessment's.
- *Ease of understanding*: The model is to be fully understood, since improvement opportunities and optimisation strategies are to be implemented lining them up with the model, as well as the organisation's PM model if applicable.
- *Guidance for improvements implementation*: The model is clear regarding which aspects are to be improved and how. Provides clear steps and recommendations on how to proceed.

Even though all models have considerable advantages regarding organisational project management and improvement, the availability of free self-assessment tools is limited. Most of the models do not provide them and let alone a guidance to understand their results; the way provided to assess an organisation is through certified consultants.

Due to the purpose of the study, the ones with free self-assessment tools and guidance to understand the results are selected for these are the ones that may be applied in an organisation with no participation of consulting partners. Although Ibbs and Kwak's provides the organisation with useful information, sadly, this model could not be taken into consideration for the self-assessment tool is not available. However, certain approaches of this model may be considered. Therefore, the selected models are the ones that cover the 4 criteria: Kerzner's PMMM and P3M3® Maturity model.

Criteria for selection	KPMMM	CMMI	Ibbs & Kwak MM	OPM3®	P3M3®	P2CMM	IPMA Delta®
Availability of free self-assessment tools	✓	✓	✗	✗	✓	✗	✗
Guidance to understand results	✓	✗	✗	✗	✓	✗	✗
Ease of understanding	✓	✗	✓	✗	✓	✗	✓
Guidance for improvements' implementation	✓	✓	✓	✓	✓	✗	✓

Figure 12 – Suitability of models according to selection criteria

4. Conclusions

A selection of seven existing maturity models has been explained, their foundations analysed in depth, and their pros and cons –regarding the scope and future studies- were also addressed.

Selection criteria that would cover the purpose of the study have been established. As a consequence of the analysis of each model along with the selection criteria, two methodologies have been selected. These two will be crossed with the information from Nortegas in order to select the one that is more suitable to the organisation.
Certain useful ideas from other methodologies will be taken into account in order to complement the methodology and assessment selected.

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Analysis of the Relevance of Contextual Factors While Selecting the PM Approach

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Abstract:

Due to increased complexity in the business arena, the complexity in managing projects increases and the delivery of a successful project becomes a challenge. Success itself becomes elusive, due to the increased need for interdisciplinary, cross-country collaboration on projects. Therefore, selecting the appropriate project management (PM) approach to ensure the project success is influenced by various factors. Researches in the past leaned towards a universal project management approach that is very classic in all senses. However, recent studies show the need for adapting the project management approach in order to maximize the project success rate. In our paper, we have looked at the context of a project and analyzed the relevance of contextual factors in respect to decision making regarding the choice of suitable PM approach. Based on a literature review and comparative analysis of case studies we found that depending on the project context, the PM approach has varied time to time. The most successful results can be derived from the PM approach when it is chosen on situation specific manner and altered by considering the influencing contextual factors.

Keywords: Project Management Approach, Contextual Factors, Project Context.

1. Introduction

Projects are a powerful mean for achieving economic value, foster competitive advantage and produce business benefits for the organizations but differ in size, uniqueness and complexity, thus the criteria for measuring success vary from project to project [1] making it unlikely that a universal set of project success criteria will be agreed [2]. On the other hand, project management is fundamental for attaining the final results of a project, manage its contributors and outcomes, as well as drive and assess the alternatives in order to fulfill the different stakeholders' needs.

Lehtonen and Martinsuo [3] summed up that organisations tend to swing between standardized and customized systems, and between formal and chaotic methodologies. And why such kind confusion exists while choosing the suitable PM approach is still a matter of research. In our paper, we have tried to focus on the decision making of suitable PM approach from the basis of contextual factor analysis. Our paper is based on literature review and a comparative case study analysis to see how PM approach has differed due to the project context. For our case study analysis, we have used secondary sources and focused on cases of the type mega projects. With that, we focus on the specific characteristics of this type of project, compare the contexts and look for their critical success factors.

2. Literature Review

2.1 Project success factors, project success criteria and project success

To decide on the appropriate PM approach for a project, it is important to first understand when this project is considered successful. We start our analysis with a literature review on project success.

Whether a project can be defined as a success or a failure is highly subjective [4]. Shenhar et al. [5] described project success concept with four dimensions: project efficiency, impact on the customer, direct business and organizational success, and preparing for the future. Müller and Judgev [6] have mentioned project success/failure as "predominately in the eyes of beholder" meaning project success or failure may vary from stakeholder to stakeholder depending on their expectations.

To reduce the subjectivity relating to project success, a common understanding is required where not only should success criteria be defined from the beginning of the project [7], but also the related success factors also need to be recognized and integrated in a suitable way across the project life cycle [8]. Morris and Hough [9] define success criteria as the dependent variables used to judge/measure the success or failure of a project. Project success criteria have evolved from the iron triangle (time, scope, and cost measures), which refers to project efficiency [10] to measures that have a long term effect related to effectiveness and organizational impact [11].

Project success factors are the fundamental elements of a project which, when influenced, increase the likelihood of success; which are the independent variables that make success more probable [6]. Previously Belassi and Tukel [12] classified the success factors into four groups: related to project, related to project manager and team members, related to organization, and related to external environment. In the following table we have listed the relevant success factors and

success criteria for the mega projects, which will create the basis for understanding our case study analysis on the later part:

Critical success factors [13]	Critical success criteria [14]
Support from senior management	Meeting operational and technical performances
Clear realistic objectives	Meeting user requirements
Strong/detailed plan kept up to date	Balancing budget, schedule and quality
Good communication /feedback	Solving serious problem
User/client involvement	Customer/End-user satisfaction
Effective change management	Addressing the recognized need
Competent project manager & project team	Team satisfaction

Table 1: List of relevant critical success factors and success criteria [13, 14].

So now on the later part we are investigating the contextual factors for deciding the success factors and success criteria.

2.2 Contextual factors relevant to PM Approach

The project management approach is considered the structural variable that must be adapted based on certain internal and contextual contingencies in order to optimize the effectiveness of project management [15]. To pursue this, conceptualization of the project context and various contextual factors are necessary. Project context is any information that can be used to characterize the situation of a project which includes physical and mental aspects. The physical aspects of project context include previous projects as well as the project environment where the project actually resides, whereas the mental aspects include social, emotional, or informational states. And the contextual factors are referred to the building blocks of a situation which have an influencing impact on the final outcome. The importance of analyzing these factors has been acknowledged by different researchers [15][16].

Lippe, Brocke, & Stanoevska-Slabeva [16] have done an empirical research on the constituent factors of a project and grouped those factors into four high-level categories - related to stakeholders (the project stakeholders involved in a certain situation), related to results (the results to be produced), and related to activities (the underlying project activities to be managed) and others. They also point out that for most factors attention should be also given to concrete dimensions. But not all these factors are relevant for all projects. The relevance depends on the project typology in order to determine which factors are more influencing, require close attention and demand appropriate interpretation and sense making.

On the other hand, the Pentagon model by Schiefloe [17], which was designed as a framework for investigating the performance of complex organizations, moves from the analysis of project constituent factors to using a system-oriented approach based on causal analysis to understand a project situation from the view of the different actors involved [13].

Contextual factors by Lippe(2013)		The Pentagon model (Schiefloe (2011),	
Related to stakeholders (the project stakeholders involved in a certain situation)	Involved roles, affiliation, geographic location, level of cooperation efforts, amount, applied success criteria, sector of activity, ambiguity of framing device, experience of working together, level of trust	Structure	Defined roles, responsibilities, and authority in the formal organization, defined procedures, regulations, and working requirements.
Related to results (the results to be produced)	type, tangibility, novelty, clarity, complexity, uncertainty, number of solution options	Technologies	Project control systems, communication and collaboration technologies, office lay-out, etc.
Related to activities (the underlying project activities to be managed)	complexity, pace, type, steps in research process, degree of expertise, predictability of working steps, task dependency, formality.	Culture	Language/concepts, values, attitudes, norms, knowledge, and established expectations concerning "ways of working."
Others	occurrence, politics, criticality, law and regulations, technical environment	Interaction	Communication, cooperation, and coordination
		Social relations and networks	Trust, friendship, access to knowledge and experiences, informal power, alliances, competition, and conflicts.

Table 2: List of Contextual factors [16] and elements of Pentagon model [17].

2.3 Decision making for the suitable the PM approach

Practically, the suitability of existing project management methods (including a set of specific approaches for the project type) changes along the project life cycle and managers need support in finding the right project management method for each situation they are confronted with [18]. Merriam-Webster [19], defines a method as "a systematic procedure, technique, or mode of inquiry employed by or proper to a particular discipline." A methodology comprises many methods where each method is applied in a particular situation. [15]. While the term project methodology implies a homogeneous entity, it is instead a heterogeneous collection of practices that vary from organization to organization [20]. However, when these methodologies do not produce the expected outcomes, they are replaced by other methodologies and often with those that have other limitations [21]. The two main topics in research on project methodologies are linked with whether project methodologies should be standardized [22] or customized to the project environment [23]. And, PM contingency research aims at identifying influencing factors for various project types and circumstances [16] and the interplay between the project needs and the best suited management approach applicable in this context [5]. Shenhar et al. [5] also argued that success factors are dependent on contextual influence and different factors affect different types of projects differently and this impact should be adapted or altered a more project-specific approach to recognize the grounds of project success or failure.

3. Interactions between contextual and causal factors to support the decision about the suitable project management approach

Based on the analysis of the models and literature above, we have analyzed the interaction between

the factors relevant for taking the decision for suitable PM approach**.** Every project has its own context and contextual factors which can be analyzed and categorized in different ways depending on their impact and after that they can be put again five concrete categories to identify the relevant success factors and thus also set applicable project success criteria. These success factors and criteria should be reviewed and analyzed depending on the variations of the contextual factors. There should be an alignment in the PM approach depending on those variations.

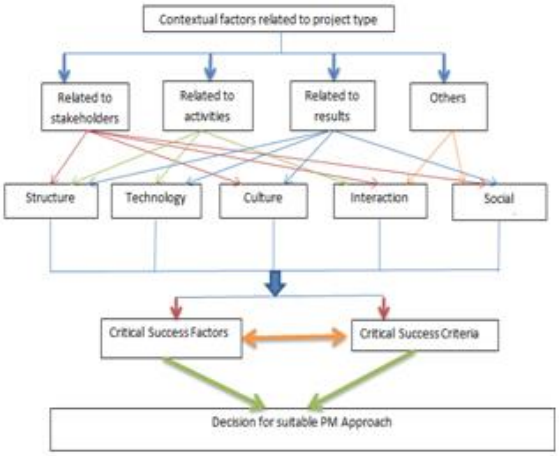

Figure 1: Framework for conceptualizing contextual factors for selecting PM approach based on [6], [13] & [15].

4. Case study Analysis

Due to limitation of accessing the data, we have adopted two case studies from a secondary source [13] and tried to analyze our findings depending on the framework.

Case A is an oil and gas project in Norway comprising subsea wells with a multiphase pipeline to on-shore process facilities. The project was successfully completed on time and within budget. In order to understand the performance of the project organization, it is necessary to know what conditions the organization had to work under. The three significant conditions are: [13]

- Relations with partners (Related to structure, interaction): This project had six owner companies and one of them acting as an operator on behalf of all [13].
- External stakeholders (Related to social relation and networks): Referred to the local political requirements and expectations. This was crucial for obtaining acceptance in the local community and commitment from the local key players [13].
- Contract strategy (Related to structure): The contract strategy was important to maximize the benefits from a competitive market [13].

And, Case B is a building construction project in California, USA. The facility is a large healthcare institution and is considered to be an extremely complex project, in part due to the governmental regulations to sustain earthquakes. In fact, the first team that tackled this project failed in their assignment, unable to design a project, meeting the owner's requirements within the available budget. Their strategy was to apply the principles of lean construction [13]. The most important frame conditions challenging the project organization were:

- Related to Activity and results: The earlier project team had failed and mentioned that conventional PM approaches in the then-current market conditions would not be able to meet the requirements of this project [13]
- Complicated and slow government permitting had created due to incomplete drawings submission early for approval [13].
- A significant gap existed between the estimated costs of the facility required and the financial resources available for the project [13]

Here, we have made a comparative analysis of both cases to check the success factors and the applied PM approach. In both cases there are similarities have been seen in respect of collaborative and participative working culture. But where case A has chosen a hybrid PM approach, case B used an unconventional Lean Construction Principles and Manage by Means (MBM) approach.

5. Findings based on the Case Study Analysis

Case study A		Case study B	
Success Factors	**PM Approach**	**Success Factors**	**PM Approach**
Aligned governance	A **common governance structure** with all involved partners	Manage by means (MBM) approach	Project leaders **align and nurture the capabilities** of the project delivery team with the demands imposed on the project
Project tools	**Well-proven project management tools** with specifications, deliveries, and schedules	Lean construction principles	**Lean construction is an adaption** and augmentation of lean manufacturing principles to construction projects
Contract strategy	**Sufficient flexibility** for merging contracts to improve performance and project control	The Five Big Ideas	The five ideas are: **collaborate – really collaborate,** increase relatedness, projects are networks of commitment, optimize the whole, and tightly couple learning with action.
Existing relations	**Project culture was characterized by openness**, allowing room for discussion and new ideas	Integrated form of agreement	This contract form fosters an environment of collaboration and innovation on the project
External Stakeholder management	The project management strategy for obtaining local support and assistance had **openness** as its basic foundation	Facilitate team learning	Implementation of the **Plan-Do-Check-Act cycle,** was promoted throughout the organization
Recruitment strategy	Participants were selected based on their **known competence** and their **former relations and personal networks**. Gradually, they built up the organization emphasizing **team building and learning**	Office infrastructure	Different project participants shared **physical workspaces** and had **easy access to information sharing and discussions.**

Table 3: Comparative analysis of case studies based on data from [13].

From the case studies and the analysis of the contextual factors related to them, we see how the different context, even within the same typology of projects affects the choice of the project management approach. We connect those results to the list of success factors identified earlier in this paper in order to make recommendations for the project management approach. The following list

gives brief explanations of the success factors and chosen project management approach identified for this case which are related to mega projects:

6. Conclusion

Cooper [24] observed that several organizations are mismanaging projects because of using tools and techniques that are inappropriate for the project type. Fortune and White [25] found that 27% of respondents experienced limitations with in-house PM approach and 57% of respondents experienced limitations with other alternative PM approaches.

But how to choose the most appropriate PM approach still needs to be defined. In our paper we analyzed the relevance and impact of contextual factors in choosing the PM approach based on literature review. Several researchers show that it is not the use of a specific PM approach that leads to project success; it is the ability to tailor it to the context of a project [21, 26].

Our work is limited by the lack of primary data for the case studies and further empirical information. In order to improve the findings of this paper, it would also be worth applying the list of factors identified on projects other than the type mega projects. In addition, the subjectivity of the definition of success needs to be taken into consideration upon deciding whether the selected project management approach was really the right approach leading to satisfying results in the view points of the many stakeholders involved in the project. Therefore, we see that further research about the role of context, definition of success and their influence on the selection of a project management approach is necessary.

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Implementing the Objectives in Earned Value Management with a New Forecasting Formula and Dynamic Risk Analysis

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Abstract:

This paper introduces an analytical model that implements the project objectives in Earned Value Management. It also incorporates the novel contribution of a formula for forecasting objectives at the end of the project. This formula adopts the same style as the EVM forecasting formulas. Moreover, the model can be used for risk analysis by means of Monte Carlo simulations building a dynamic probability field of project success. The application of the model to a real engineering project gives that the measurement of technical objectives provides more realistic earned value from a functional point of view. This allows the project managers to better define the acceptance limits for the performance indexes at the initial phases of a project.

Keywords: Project Objectives, EVM, EVO, Risk Analysis, Monte Carlo Simulation, Engineering Projects.

5. Introduction

This work presents a novel model that integrates the project objectives in the EVM, and it consists of two components. First of all, a new formula that implements the fulfillment of the project objectives in the Earned Value (EV) of the EVM methodology. Thereby obtaining a new EVM parameter that we refer to as Earned Value and Objectives (EVO). Secondly, a new formula for forecasting project status at completion, including "earned" objectives. Thus, we refer to this as Earned Value and Objectives At Completion (EVOAC). The model has been applied to a real engineering product development project where the drivers are the technical objectives for the operating of a combustion engine. See all details in Muñoz et al.

As a future development, the model can be used for Monte Carlo simulations projecting at the end of the project the estimated earned value and objectives.

6. Formulating a new EVM parameter: the EVO

Once the objectives are defined, a weight for each one is assigned in this model depending on their impact on the project success criteria.

In the next step, some control points are selected where tasks fulfilment is evaluated and, in this case, the fulfilment of objectives. The completed tasks or earned tasks will provide us with the EV. And in order to define the earned objectives we develop a weighted average of the fulfilment of objectives, which we have referred to as the Objectives Average (OA), as defined in (1).

$$\mathbf{OA} = \frac{\sum_i^n \mathbf{X_i} \times \mathbf{W_i}}{\sum_i^n \mathbf{W_i}} \quad (1)$$

Where,

OA = Objectives weighted Average, X_i= objective achievement, W_i= objective weight, i=each project objective, n=number of project objectives

In the current model, in order to represent the influence of the first phases of the project, a weight is assigned to each phase, which we have called Phase Weight (PW) and it is defined as the project progress inverse. This PW can be defined in EVM terms using the Budget At Completion (BAC) and the Planned Value (PV), according to (2).

$$\mathbf{PW} = \frac{1}{\mathbf{Project\ Scheduled\ Progress}} = \frac{\mathbf{BAC}}{\mathbf{PV}} \quad (2)$$

Where,

PW = Phase Weight, BAC = Budget At Completion, PV = Planned Value

Following this, and in order to integrate both the objectives weighted average and each phase weight, OA is powered to PW. In this way, the objectives average is reduced by the first project phase's weight. Therefore, the objectives weighted average powered to the phase weight will provide the project earned objectives factor or Earned Objectives (EO), according to (3).

$$\mathbf{EO} = \mathbf{OA^{PW}} = \left(\frac{\sum_i^n \mathbf{X_i} \times \mathbf{W_i}}{\sum_i^n \mathbf{W_i}}\right)^{\frac{\mathbf{BAC}}{\mathbf{PV}}} \quad (3)$$

Finally, EV is multiplied by EO to obtain EVO according to (4)

$$\mathbf{EVO} = \mathbf{EV} \times \mathbf{EO} = \mathbf{EV} \times \left(\frac{\sum_i^n \mathbf{X_i} \times \mathbf{W_i}}{\sum_i^n \mathbf{W_i}}\right)^{\frac{\mathbf{BAC}}{\mathbf{PV}}} \quad (4)$$

Where,

EVO = Earned Value and Objectives, EV = Earned Value, EO = Earned Objectives, X_i= objective achievement, W_i= objective weight, i = each project objective, n = number of project objectives, BAC = Budget At Completion, PV = Planned Value

From this EVO formula it is possible to calculate the EVM variances, including objectives.

$$\mathbf{CV_{evo}} = \mathbf{EVO} - \mathbf{AC} \quad (5)$$

$$\mathbf{SV_{evo}} = \mathbf{EVO} - \mathbf{PV} \quad (6)$$

In addition to the EVM performance indexes, including objectives.

$$\mathbf{CPI_{evo}} = \mathbf{EVO}/\mathbf{AC} \quad (7)$$

$$\mathbf{SPI_{evo}} = \mathbf{EVO}/\mathbf{PV} \quad (8)$$

To illustrate these formulas we proceeded to apply them to a sample project. In figure 1 we can see typical S curves for EVM parameters PC, AC and EV. Superpose to them it is represented an example of calculated EVO.

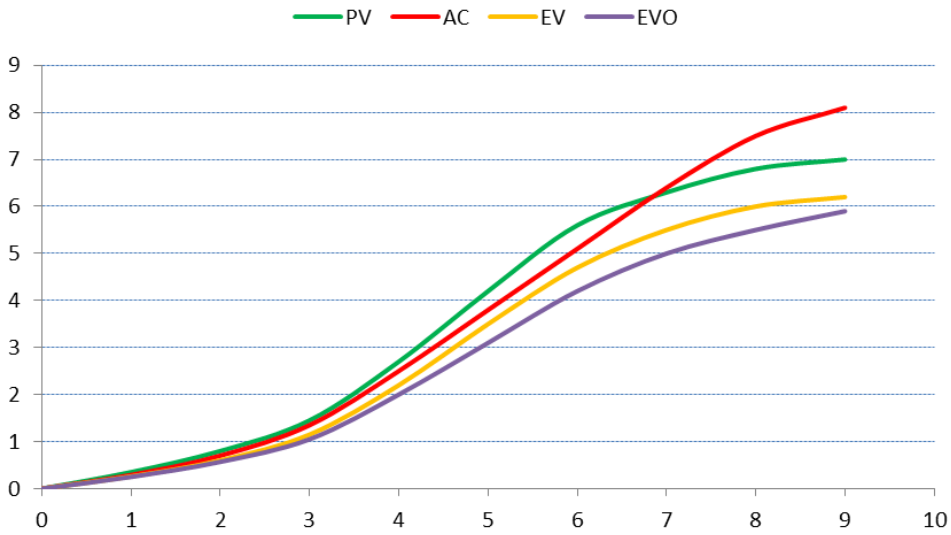

Figure 1. Sample Project EVO graph with PV, AC and EV.

7. Formulating a new EVM estimation at completion, the EVOAC

In addition, this work presents a forecasting formula to predict the Earned Value and Objectives (EVO) at project completion. This formula adopts the same style as the EVM forecasting formulas for Cost Estimate At Completion (CEAC or EAC) and Time Estimate At Completion (TEAC) (Anbari, 2003; PMbok, 2013).

EAC considering that past performance is a good indicator for future performance is expressed in (9).

$$\mathbf{EAC} = \mathbf{AC} + (\mathbf{BAC} - \mathbf{EV})/\mathbf{CPI} \quad (9)$$

The forecasting formula for Earned Value and Objectives At project Completion is defined in (10).

$$\mathbf{EVOAC} = \mathbf{EVO} + (\mathbf{BAC} - \mathbf{PV}) \times \mathbf{SPI_{EVO}} \quad \mathbf{(10)}$$

Where,

EVOAC = Earned Value and Objectives At Completion, EVO = Earned Value and Objectives, BAC = Budget At Completion, PV = Planned Value, SPI_{EVO}= Schedule Performance Index with EVO. Calculated by equation

$$\mathbf{SPI_{EVO}} = \frac{\mathbf{EVO}}{\mathbf{PV}} \quad (11)$$

2 displays sample project EVO values with typical S Curve shape and the projection of these EVO values at project completion that generate EVOAC values.

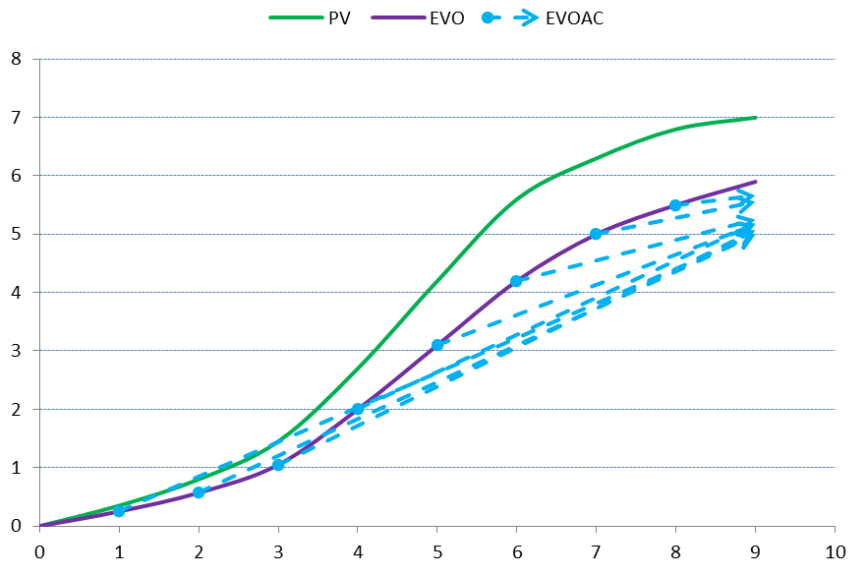

Figure 2. EVO projection at project completion: EVOAC

8. Conclusions

The formulas proposed here for EVO and EVOAC have the same mathematics as the EVM standard formulas and we have demonstrated that they can be readily applied to both an example with typical EVM S-curve values and a case study of engine development with more real and irregular project values.

In this work technical objectives from engineering projects have been considered but the model is valid for any kind of objective or project, such as, for example quality issues in information technology projects, and client satisfaction levels in service projects, among others.

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