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Large engineering projects. Favouring resilience in increasingly complex environments grafting an adaptive approach to waterfall technique

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Abstract

Traditional project management methodologies are too plan-driven to help organizations tackle increasing levels of complexity that characterize Large Engineering Projects (LEPs). By their nature LEPs invoke coordinated application of capital, sophisticated technology, intense planning and political influence: the combination of these peculiar features makes

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the management of these projects particularly complex to the point whereby traditional project management methodologies are put in difficulty and discussion since in the face of unforeseen circumstances and difficulties they results as excessively rigid and therefore binding consequently undermining the final success of the project.
This paper aims to understand if "adaptive" methodologies should be partially applied in the management of LEPs to overcome the typical constraints found in the rigorous application of classical/traditional methodologies considered as inadequate and too restrictive to cope with the typical complexities of LEPs. In this sense we argue that the partial and targeted application of adaptive methodologies to LEPS should favour resilience, that is the ability to identify an effective and short-term response to any negative external events of destabilizing nature and consequently contribute to the success of the project (in this case LEP) as a whole.

Key words: large engineering projects, adaptive project management, resilience

1. Scenario

Large Engineering Projects (LEPs, being part of what is referred in literature as "megaproject") are "*large-scale, complex ventures that typically cost US$/€ 100M or more and take many years to develop and build, involve multiple public and private stakeholders, are transformational, and impact millions of people*." (Flyvbjerg, 2014) such as railways, highways, airports, power plants, urban development, and other manufacturing projects having a long, wide and complex supply chain and a great variety of stakeholders. Because of their nature, LEPs invoke coordinated application of capital, sophisticated technology, intense planning and political influence, the engagement of numerous contractors, often from various countries and take years for completion (Gellert & Lynch, 2003).

It is evident that traditional approaches, characterized by linear-sequential life cycle model ("waterfall"), step-by-step progress in which any phase begins only if the previous phase is complete and no overlap between phases are permitted, result as too restrictive to help facing high and growing levels of complexity, uncertainty, ambiguity, and dynamic interfaces, typical features of LEPs (Floricel and Miller, 2001).

On the other side, currently available adaptive project management approaches, characterised by iterative and incremental life cycle models, permitting feedbacks between phases, iterations within single stages and incremental deliverables, have demonstrated, along more than two decades of application, to be critically more effective than the predictive ones in case of turbulent environment, such as software development, R&D, enterprise change management project etc. (VV.AA.4, 2017); in the last ten years these adaptive techniques have been extended to several others fields, such as R&D or organizational change projects. Today it is generally accepted that a project managed by predictive techniques can also include agile methodologies in some parts (VV.AA.1, 2017). The need for "adaptive" methodologies (Miller & Lessard, 2000), in contrast to the traditional "predictive

(waterfall)" ones, has arisen since the 90's in the software industry and its milestone is the "Agile Manifesto" published in 2001 (VV.AA., 2001).

It is however evident that agile approach cannot be the immediate solution to this research topic, as LEPs takes years, requires large teams often spread in different countries, and the "contract negotiation" stays central on the contrary to the third principle of the agile manifesto (VV.AA., 2001).

By creating a trade-off between rigidity and flexibility, the authors believe that grafting an adaptive approach to the waterfall technique should represent the proper solution to favour the global resilience of the LEP.

If we consider resilience as the process followed to anticipate, respond, adapt to, and/or rapidly recover from internal and external stresses such as crises, economic distress and unexpected events (Mallak, 1997;1998; Mallak, 1998; Vogus and Sutcliffe, 2007; Kendra and Wachtendorf, 2003; Lengnick-Hall and Beck, 2003, 2005; Lengnick-Hall et al., 2011) the working definition of a resilient project is, therefore, one that has the capability to change with minor frictions when changing contexts by demonstrating flexibility, withstand sudden shocks, and recover to a desired equilibrium while preserving the continuity of its operations.

Resilience requires both adaptability and robustness (Sutcliffe and Vogus, 2003): learning from experiences and mistakes, during turbulences and difficulties, the team working on a LEP must be able to recall solutions identified and successfully applied in the past, and, as a result, to develop new approaches to manage new risk under a common methodology by including lessons learned into risk management plans and practice.

In this sense, the research is addressed to understanding if and how adaptive project management techniques can support and favour resilience in Large Engineering Projects (LEPs), which frequently tend to fail due to their management complexity. In other words, they argue that in increasingly complex environments, like those in which LEPs come to life and develop, grafting an adaptive approach to waterfall technique should favour resilience and consequently positively influence the outcome of the project as a whole.

2. Strengths and weaknesses of traditional and adaptive Project Management approaches

Both traditional and agile approaches have strengths and weaknesses that will be briefly summarized and explained in this section.

2.1 Predictive approach: strengths and weaknesses

Traditional project management risen in the first half of the 20th century having as main target civil engineering project (Morris, 2010). Assuming that project

environment was mostly predictive and the key to success was hidden in accurate and in-depth planning in a deterministic environment, the management of uncertainty was a marginal concern, because the basic approach was planning as much as possible in order to reduce – or possibly eliminate – uncertainty; this approach is testified by the fact that "project risk management" appeared in the Project Management Body of Knowledge framework only in the 1987 edition. From the end of the 70's, the scenario has changed: project management is more and more applied to product development, R&D and, in general, kind of projects in which it is structurally impossible to set detailed requirements since the beginning, and exploring the project scope become part of the project itself (Brady and Hobday, 2010). Aside from strategic projects failed due to poor project management, several demonstrate that, even applying best practices, failing was even possible (Morris and Hough, 1987). These changes in the paradigm of project management can be addressed using the complexity theory (San Cristóbal et al., 2018.), (Baccarini, 1999), (Vidal and Marle, 2008), VV.AA., 2014). It can be argued that "*today's world of expanding globalization, rapid pace of change, intense competition, and continual innovation in a "do more with less" market environment is forcing organizations to recognize that their strategies—and the projects executed to implement them—are becoming increasingly complex*" (VV.AA., 2013).

At the beginning of 2000s, several studies pointed out the distinction between project's efficiency (time, cost, quality) and effectiveness (achieving sponsor's/stakeholders' objectives) (Miller and Lessard, 2000): how can it happen that a well-planned project, executed according to the plan, could be considered a failure at the end? This critical question arose the need for adaptive techniques, able to adapt the scope and requirements of the project according to project "externalities" while the project is running. In this new perspective traditional project management has also been referred as "plan-driven", "predictive", "deterministic" or "waterfall", and, on the other hand, adaptive techniques has been referred as "change-driven" and "agile".

2.2 Agile approach: strengths and weaknesses

Even if there is agreement that the traditional predictive approach - when requirements can be identified since the beginning of the project – stays preferable (the deterministic approach lets the goals of the project easier to be managed and reached), (VV.AA.4, 2017) when the context becomes more and more turbulent, meaning that it is not possible to determine all the requirements of the project since the beginning, even if making strong effort in planning, the traditional way is no longer effective because planning without knowing the whole project scope simply gives an illusion of having a plan, when actually the project manager and the project team are managing a project in a reactive way in a continuous change of scenario.

Especially for projects characterized by high levels of complexity, more than a recommendation, it has become a pragmatic necessity (VVAA, 2001). Agile frameworks bore at the end of the 90s, to address these turbulent contexts,

introducing, aside of linear life cycles, iterative and incremental life cycles, in order to effectively address the change of specific requirements of software development projects (Leffingwell, 2007). Iterative cycles refer to methodologies based on a cyclic process of prototyping, testing, analysing, and refining a product or process. Incremental cycles are based on the principle of releasing as often as possible working part of the project deliverable to improve the value for the customer. Agile cycles are both iterative and incremental. (VV.AA., 2001)

These attitudes can be summarized in (VV.AA., 2001):

- transparency within the team and to the Customer, making problems and collective research for solutions crystal clear. This principle entails frequent communication with customers, which leads to a constant evolution of the requirements (Murray, 2016).
- self-organization through motivated and engaged people, with a project manager working as a servant leader, and proper allocation of resources;
- deep knowledge management both in the formal (retrospective) and informal (stand-up meetings) way;
- deep attention to soft skills in managing the project.

The attitudes that are theorized by the Agile Manifesto underline a management approach that puts flexibility and adaptation to customer needs under the spotlight. Whenever a misalignment between project scopes and actual deliverable occurs, agile methodologies should be able to detect it before it turns into the so-called "*scope creep*" (Lewis, 2002). Regarding the scope, it is also fair to emphasize the importance of scope communication with stakeholders, which, this way, have their expectations always aligned with the deliverables.

As a matter of fact, agile project management methodologies have some intrinsic limits that make their application in some industrial sector, such as civil or manufacturing projects, not totally appropriate (Corbucci, 2015).

As Corbucci (2015) says, these limits are related, in particular, to the following reasons:

- the need for small teams to work closely together: this condition is rarely feasible in the most part of the industrial organizations, in particular LEPs and manufacturing fields, where a long chain of supplier is involved, spread in a wide geographical area;
- the permanent presence of a customer representative into the agile project team is also hard to achieve, because rarely the project team is located in the Customer premises;
- the iterative method with frequent delivery doesn't make sense in construction or manufacturing phase, even if it stays applicable to the concept and design phase;
- the "change-driven" approach makes the total effort of the team hard to forecast in the bid/tender phase, and this become critical in a typical contract scheme in the manufacturing or construction industry (VV.AA.2, 2017; VV.AA.3, 2017);

·the agile methodology is exposed to turn over for the outcome on the team motivation and on the knowledge management, but this phenomenon can't be avoided in large projects involving large teams and lasting for many years.

On the other hand, agile methodologies brought out critical aspects underestimated even in the traditional, predictive, project management approach, and led the perspective of project management techniques to a whole change, moving the focus on the direction expressed by the four statement of agile manifesto (VV.AA., 2001). The agile approach was developed as an attempted response to the evident criticalities of traditional "waterfall" techniques in turbulent environment, such as customer final dissatisfaction and projects' lack of flexibility and the related loss of customer value due to missing changes even in the latter stages of the project.

To face these challenges, the Agile Manifesto underlines several attitudes a project team and a project manager must apply to be effective, customer oriented, and to get the best from the team and stakeholders. In fact, since agile methodologies imply a great amount of collaboration and constant communication with customers and other stakeholders, it is easy to imagine how these two characteristics are challenging to apply in a project of large scale. Indeed, a better and more frequent communication with stakeholders enhances projects' flexibility and resilience; nevertheless, the loss of structure can prevent projects from having an up-front planning and budgeting process, which might result as a challenging feature for stakeholders to accept and sponsor.

In addition, not only agile methodologies require commitment towards the external environment, but also from the project team, which needs to be capable of practicing actual knowledge management, through the utilization of self-organization and soft skills. This requires extensive training on technical and non-technical capabilities of project teams, as well as a more attentive selection of project team members that possess the adequate resources of technical and non-technical nature. Indeed, training and selection require additional resources to be considered and deployed within the project. (VV.AA.4, 2017).

3. The search for an adequate approach for LEP management

At this point, it is that clear neither the traditional nor the agile methodology - as they are - fit for context of Large Engineering Projects. At the current state of the art, a project manager entitled to manage a LEP has no clear references to build up a consistent project organization able to govern it since the beginning from its end (many years later). With these premises, the Authors want to investigate what are the root causes of the turbulence of LEP environments, and find out recommendations enabling a Large Engineering Project Manager to "navigate" since the conceptual stage, through the planning and the development stage, to the operating, balancing project efficiency and effectiveness, being satisfactory for the wide group of stakeholders.

The Authors sharing their experience in resilience (Giustiniano and Cantoni, 2017), complexity and project management (Favari, 2012; Favari, 2013) both at academic and practical level, taking into account the epistemological problem on investigating complexity - which requires the observer not to be external to the phenomenon, but to be part of it (Morin, 2008) - and considering the multilevel approach that must be able to connect together contradictory experiences to logic systems (Morin, 2008), formulated the following considerations with a progressive approach (from general to specific):

- due basically to the complexity features faced by LEPs in terms of economic value, effort and duration, variety of stakeholders involved and their geographical distribution, the nature of their deliverables, the nature of standard international contracts for these projects (VV.AA.2, 2017) (VV.AA.3, 2017), traditional PM approaches result as too constraining. In other words, the deterministic approach is not suitable for highly complex environments (VV.AA., 2014);
- on the other hand, it is well-known that agile and adaptive PM techniques applied in software projects and in several other fields (R&D, organization change, design, etc.) favour the success of the project and resilience in the event that difficulties and unexpected events occur (Corbucci, 2015).

The Authors are however aware of the fact that even if agile and adaptive techniques can be helpful for managing complexity and uncertainty they are not immediately applicable to LEPs as they are.

From this series of considerations, the research hypothesis to be investigated - with the premise that the number and unpredictability of the risks associated with a LEP generate very high levels of complexity and the latter, if not properly managed, can lead to project failure – is the following:

Research Question: Is it possible to improve the resilience of the LEP - and consequently reduce the risk of failure - by implementing plan-driven PM methodologies made more flexible, responsive and adaptive through the grafting of adaptive techniques?

3.1 Focus group as a vehicle for field research

The Authors therefore believe that, in this preliminary phase, where it is necessary to lay the foundations of research and there are not strong consolidated scientific references available yet, the focus group represents the most adequate methodology for collecting opinions from different perspectives and points of view (Krueger and Casey, 2015).

The framework adopted by the Authors to target questions is the PMBOK. The choice has been to design one question for each of the 10 knowledge area of it. It appeared clear that only one focus group could not encompass all those topics, so that only 4 topics have been addressed, as mentioned below, in the first focus group. The remaining topics will be investigated during following events.

When it comes to LEPs, there are typically two sides involved: the contracting side (usually, a state or a country) and the contractor. For the first focus group, nine companies were selected as a representation of the contractor side. The rationale behind this choice is the willingness to adopt a bottom-up approach, in order to have a better perspective on the root causes of problems. In fact, contractors are typically the entities that initially propose "magnificent" project management practices, which, when it comes to reality, turn out be much more modest and with less structured organizations.

These companies - which are daily confronted with LEPs - and their representatives have been invited to the group interview in order to capitalise on communication between participants to generate data: five of these companies belong to the manufacturing sector, while the other four to the information sector.

The heterogeneity of the composition of the group has favoured an intense exchange of opinions and points of view. After a preliminary presentation of the project and of the terminology adopted, participants have been invited to briefly present themselves, their companies and their role. The composition of professionals participating in the focus group was also heterogeneous in terms of various roles; the focus group was, in fact, joined by a company owner, a general director, an ICT manager, a technical manager, a risk manager, an administrative director, a planning and material management director. This heterogeneity of roles and responsibilities with different organizational areas provided a broader perspective on the analysed companies and their day-to-day approach to Large Engineering Projects.

At the end of the mutual presentation, the following discussion questions have been approached:

Q1. *How does your enterprise manage risk and uncertainty?*

Q2. *When your company faces a new problem and identifies a solution, in the future is this problem automatically fixed of does it turn again? Provide an explanation*

Q3. *How does your company use data produced during the realisation of the project? Is information always complete and available for all the stakeholders?*

Q4. *How and how often are external stakeholders involved?*

The Project Management Body of Knowledge (PMBOK) is the global standard (adopted by ANSI and IEEE) for project management that collect processes, best practices, tool, techniques, terminologies, and guidelines for the management of projects in any industry. The PMBOK drafting is overseen by the Project Management Institute (PMI), the global not-for-profit association of PM professionals, established in 1969. The current PMBOK edition is the 6th, released in 2017. In the 6th edition, 49 processes are described and grouped according to 5 process groups and 10 knowledge areas in a matrix space, when process groups represent the high-level time-phases of the project, and knowledge areas groups the processes according to specific disciplines.

Each of the presented questions was theorized and formulated basing on four of the major areas of knowledge contained in the Project Management Body of

Knowledge, commonly known as PMBOK. Originally developed from the work done by the Project Management Institute, the PMBOK represents one of the most valuable sets of standard terminologies and guidelines for the discipline of project management, in order to provide with a compound of tools, techniques, procedures and approaches to better enhance the success of a project. Throughout the presentation of project management processes, the PMBOK considers ten different knowledge areas, which are considered as the milestones that processes have to align with in order to make the project successful and in line with its objectives.

The combination of the questions used in the investigation and the PMBOK's areas of knowledge results as follows:

Q1: Risk Management
Q2: Integration Management
Q3: Communication Management
Q4: Stakeholders Management

The duration of the focus group was of 3 hours during which participants have been encouraged to talk to one another asking questions, exchanging anecdotes and commenting on each other's experiences and points of view. Notes have been taken and the main results are depicted in the next paragraph.

4. Results

The focus group participants were asked to address the questions highlighted above, each of which refers to a specific area of the PMBoK. In detail: risk management, integration management, communication management and stakeholders' management.

4.1 Risk Management Area of Knowledge: how does your enterprise manage risk?

A key driver to manage uncertainty and, as a result, a good enabler of resilience, is related to RISK MANAGEMENT. In this respect, the relationship between the traditional and innovative risk management practice of a company and its ability to face uncertainty has been investigated.

Though subjective, the identification of risk presents a multiplicity of facets. As a first thing, participants converged on the fact that their companies face different types of risks, mainly: financial, technical, organizational, country-related (risk associated with the internationalization of the markets) and political. An additional risk is given by the fact that all of them need to manage several projects in parallel in a program or portfolio environment. Two companies being part of the same group in the field of machining centres reported that - since the tender phase - their focus is mainly on the technical risks, in addition to the inevitable concerns regarding the

stability and financial strength of customers and suppliers. Another company in the manufacturing of machineries for industrial processes projects reported that, during the feasibility study of a new project, a risk assessment related to the level of innovation is considered as fundamental and necessary.

A company operating in the information field, reports the need to face the digital transformation and the cultural change by showing a very careful attitude in anticipating risks, and a great attention on disaster recovery. This is possible only at the cost of doubling press machineries and spares.

This is because, when a problem arises in the information environment, the solution must be identified immediately, just as countermeasures must be activated promptly. In the new era of information, they are learning how to plan for a medium term horizon and how to manage risk both at a tactical and strategic level. In particular, they are focusing on technical and organizational risks: technical risks are related to the attempt to disclose the use of the new media they are approaching, while the organizational risk is related to the transition from the "24-hour cycle" to the adoption of a formalized project management approach. The grading of risk is based on the dimension of the new project and on the level of involvement in the company, the dimension of the market, the typology of the product and the level of innovation. The last company operating in the information field deals mainly with the public sector and reported that, in their market, the main concern is not associated to technical or financial risks, but mostly on the political stability of its customers (as the sponsors of the great majority of their projects are political figures).

Contrarily to our expectations, only a company (operating in the manufacturing of machinery for drilling in the field of oil and gas projects) has a person enrolled as "risk manager" and declares to have a clear procedure to be followed since the early stages of projects, even in the tender phase. The procedure for ranking risks is semi-quantitative: the project team defines a grading system and the executive committee or the CEO makes the approval of the risk plan. The areas of risks evaluated are: Customer, Country, Financial and Technical. Internal risks are also considered, but mainly at enterprise level.

Other companies result as less prepared to manage risk and uncertainty both from a pragmatic as well as technical perspective. A company operating in the manufacturing of measurement devices (in the field of oil and gas projects) shares risk with the suppliers since the tender phase of project. In particular, it schedules some preliminary meetings with its suppliers to reflect on the terms of payment to avoid cash flow suffering in the execution phase. The relationship between the company and its suppliers can be defined as a partnership (not a customer-supplier one).

A company operating in the manufacturing of machineries (in the field of automotive and aerospace projects) is pushed by its customers to invest on risk management, giving particular attention to the technical risks. Also in this case the "go/not-go decision" for risk management - both in the tender and in the project phase - is taken at the executive/corporate level, not at the project level. The

evaluation of the risk is made by the project team level and involves all the departments and company functions working on the project itself. The risk management process is more related to special machineries than to series ones. It emerges that the companies that are the most attentive to risk assessment and its management are those involved in the manufacturing sector. The other companies have not shared the information.

4.2 *Integration Management Area of Knowledge: when your company faces a new problem and identifies a solution, in the future is this problem automatically fixed of does it turn again? Provide an explanation*

Particular attention was also paid to learning and the area of INTEGRATION MANAGEMENT with a question addressed to understand how organizations reinforce their culture by learning from past projects lessons. Our expectation was that an organization able to learn from past situations reinforces, time by time, its ability to find the adequate answers to emerging issues so becoming more resilient. Only one company (the one producing drilling machineries) declared to perform lessons-learned session at the end of each project. The others mostly update templates and models after having faced a new issue, focus on innovation of products after a problem arises, including machine learning modules, report preventive maintenance strategies implemented because of previous problems, point out that weekly meetings are held at functional management level to discuss about nonconformities to find agreed-upon solutions.

4.3 Communication Management Area of Knowledge: how does your company use data produced during the realisation of the project? Is information always complete and available for all the stakeholders?

Another area of investigation is the COMMUNICATION MANAGEMENT. We expected that proper communication management should improve the ability of an organization to reboot the emerging problems faster, and so increase resilience. Several companies reported that they are investing for corporate communication tools, and provide examples of commercial applications they are using: some mention commercial and free ones; others mention special tools for corporate communication.
At different levels, all companies report that they invest time in periodic meetings to share information. In addition, some have shared files and repositories.

4.4 Stakeholders Management Area of Knowledge: how and how often are external stakeholders involved?

This question addresses to the Stakeholders management knowledge area. We expect that a proper stakeholder management improve resilience in an organization because information are provided since the early stages of a project, and countermeasures are faster to be adopted and with a wider range of possibilities.

All the participants report that the only external stakeholders they refer are Customers and Suppliers. Only one reported the involvement of a wider variety of stakeholders in an Arabic country they are targeting as a strategic market area.

Several reported the feasibility study of a supplier portal and cloud connections to share information.

Some companies reported intermediate meetings to track progress on complex projects, including Customers from one side and, separately, Suppliers. Tools for virtual presence and visual management have also been mentioned.

4.5 Preliminary observations

To summarize and conclude, the information gathered results as relevant as the aim - at the early stage or our research - was to identify research topics and verify their relevance for sustaining our expectations.

Risk management. According to the Authors' point of view, resilience develops through effective risk management because an organization avoiding or mitigating known risk, and planning responses to residual risk will react faster than an organization avoiding these practices. To favour resilience, risk management should be faced not only at the project level or at program/portfolio/PMO level, but at the enterprise level, embracing not only technical or financial threats, but also external risk coming from customers and suppliers, and from the business environment itself.

Poor risk management can result as providing inadequate contingencies to manage risks, so that, when an emergency should come, there can be lack of resources to face it; or - on the other hand - if too many resources are deployed, the organization could face rigidity and a slow reaction.

It also emerged that all the companies but one have very poor risk management procedures, and none of them demonstrated to have a clear and consistent process, at enterprise level, to face all the risks, even at project level, including technical, financial, external and environmental risks.

Integration management. Regarding the area of learning from past projects' lessons, none of the companies participating to the focus group described a clear procedure used to perform lessons learned/retrospective seminars or workshop at the end of the projects or at completion of a project phase. It is very interesting to

see that, in order to learn from past problems, a company employs machine-learning modules in their products: it is an effective strategy for product improving, but we currently do not see the application of this principle at an enterprise level.

Communication management. In the area of communication, several companies are investing and implementing tools for sharing information and documents. Moreover, several companies declared to invest time of their employees in holding regular meetings in order to let the communication flow within the company. Even if this finding is relevant, it clearly emerges that none of the companies has stable procedures for communication management neither regarding internal communication, nor related to external stakeholder communication and involvement.

Stakeholders' management. Regarding the focus on external stakeholders, the attention is paid only to customers and suppliers (no attention on influencing the market environment by involving a wider range of stakeholders). This can result as a lack of resilience: in facts, a wider network, if properly managed, can result as a more robust system able to resist to external stress(es).

5. Findings and recommendations

The research presented in this article summarizes the preliminary findings of the earlier phase of a study on LEPs, highly complex projects subject to a high failure rate for a variety of reasons.

To minimize the risk of failure, the Authors try to understand which elements can favour their resilience, which is the capacity of a prompt reply to unexpected events while LEPs are in course of realization.

Resilience represents two abilities of an organization: adaptability and robustness.

Adaptability principles can be taken from project management even if they require a profound reflection because in LEPs management it is not possible to apply the agile approach as it is (for the reasons explained). Instead, the robustness of an organization must be promoted through lean and easily understandable procedures and a clear stakeholders (internal and external) management approach.

Results of the focus show that for the nine companies engaged in LEPs, traditional project management techniques have been applied in a customized way, meaning that each company has some personal and specific ways to manage its projects. Several approaches to foster resilience have been exposed, addressing external risks deriving from customers and suppliers and thus facilitating the success of the project, despite the difficulties occurred, even if none of these companies has a coherent approach to address resilience.

Without any claim of exhaustiveness, the Authors assert that - besides the traditional life cycle ("waterfall") - some expedients have been applied to the LEPs to grow resilience, both in terms of adaptability and robustness. According to the preliminary results of the focus group, the areas of knowledge where to expand the

radius of action are the ones related to integration, risk, communication and stakeholders' management.

6. Further steps

During the next steps of this research projects, the Authors will extend the investigated knowledge areas of project management, in particular: resource management, business analysis, organization models, knowledge management; the Authors will deepen these hypotheses by enlarging the numbers of companies involved by creating an overview on the main areas of criticality and on the possible solutions in LEPs management.

The next steps will basically be two: the preparation of cases divided by technical area (mobility and transportation, energy, building, ITS), in order to address the specificity of each one and the creation of a complete practice guide for LEPs, that is a practical and useful guide with indications, suggestions and suggestions for immediate application.

7. Originality/Value

This work investigates a field of project management that still has no strong and comprehensive methodology: adaptive project management approaches to industry and construction projects with increased complexity environment, namely the LEPs. This paper represents the preliminary work of a wider research program called MeRIT (Megaprojects Research Interdisciplinary Team) managed by a group composed of several researchers and practitioners coming from diverse discipline (such as Management, Economics, Sociology, Law, Transportation Engineering, Energy, Architecture etc.) interested in looking for practical solutions to effective manage Megaprojects. The group has been established in 2018 and currently has 18 members.

8. Research Limitations

The still small number of investigated cases does not allow us to generalize the results but to give general indications that can be easily implemented by the organizations involved in LEPs.

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