

CAPACITY

BENCHMARKING PROJECT RESILIENCE

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Abstract: Projects still suffer from low project management success rates, mainly due to events that occur during their life-cycles, which cause deviations from their main objectives. That is why, recent studies have begun exploring the concept of resilience in project management. These studies aim to reinforce current project risk management practices and improve the capacity of a project to deal with disruptive events. Therefore, this paper reviews first the literature on the concepts of resilience, and of organizational resilience in order to propose a definition of project resilience and to set its dimensions. Second, the development of indicators to assess project resilience is achieved by conducting semi-structured interviews with 10 senior project managers from different industries, in which, 10 case studies were explored and analyzed. As a result, a definition is proposed, and 10 indicators are established to assess two dimensions of project resilience: awareness and adaptive capacity. In future research, these indicators would require a rigorous validation in different project types. This provides project team members with a robust set of indicators with which they would be able to assess their project's capacity to effectively and efficiently deal with disruptive events.

1. INTRODUCTION

Projects are becoming more and more complex. The literature reflects this complexity, and reports several examples of projects marked with difficulties and failures (Schneider, Wickert, & Marti, 2017; Brady & Davies, 2014; De Bakker, Boonstra, & Wortmann, 2010; Vidal, 2009; Bannerman, 2008). Members of project teams, and other stakeholders, still face many challenges when dealing with risks that occurred, which were unpredicted, unknown or even considered impossible to occur in specific circumstances: "These are uncertainties, ambiguities, and arrays of risk factors that are often intricately connected" (Thamhain, 2013, p. 21).

Traditional project risk management (PRM) practices have been ineffective in dealing with these risks (Albert, Balve, & Spang, 2017). In fact, these practices are criticized for being very time consuming, because they focus on 'hard theories and processes', without taking into consideration the dynamic changes in the project's environment (Crawford, Langston, & Bajracharya, 2013; Geambasu, 2011). On the other hand, PRM practices tend to identify, analyze, mitigate, and control, sources of quantifiable and predictable risks, without emphasizing the importance of dealing with risks' consequences upon occurrence (Blay, 2017).

For those reasons, among others, it has been recognized that practices that are more flexible and context-specific can empower PRM practices to deal more effectively with disruptive events (Crawford et al., 2013). The focus should be on recognizing the inherent fallibility of the project, and developing response strategies to cope efficiently with disruptive events (Geambasu, 2011). These events are circumstances leading to severe deviations from the project's objectives (e.g. delay, over budget, low quality, incomplete scope, client dissatisfaction, etc.). They are known or unknown risks that occurred and caused distress during the project life-cycle (Blay, 2017; Zhang, 2007).

Undoubtedly, it is important to spend time trying to identify all possible and imaginable risks, and to prepare mitigation plans to deal with them. However, it is of equal importance to strengthen a project's 'immune system' to deal with any event that may arise during the project life-cycle. A comparison may be drawn with medicine: vaccination is important, for it makes the human body immune to specific viruses. However, what is also important is to reinforce the human immune system itself, through specific behavior, so that it can deal with any virus, regardless of whether or not it is known.

That is why recent research has started to explore the concept of resilience as a path towards empowering PRM practices to effectively and efficiently face disruptive events during the project life-cycle (Schroeder & Hatton, 2012). Therefore, the goal of this article is to build on the suggestions of (Thomé et al., 2016), (Geambasu, 2011) and (Blay, 2017), and to propose a definition, and a set of indicators to assess project resilience through a qualitative study.

First, the literature on resilience, and on organizational resilience is reviewed in order to propose a definition of project resilience and to set its dimensions. Second, the importance of assessing project resilience is explained. Third, the methodology used to develop the indicators is described. Finally, the results are analyzed and refined in order to propose a set of indicators to assess this novel concept of project resilience and validate its definition and dimensions.

It is to mention that organizational resilience was chosen because of the close link that exists between projects and organizations. Moreover, projects exist in an organizational context in order to meet the strategic objectives of the latter (Aubry, Hobbs, & Thuillier, 2007; Thakurta, 2015). In addition, there is a line of research that defines projects as temporary organizations due to the similarity between the structure of a project and the structure of an organization (Anbari, 1985; Hanisch & Wald, 2013; Son JeongWook & Rojas Eddy M., 2011; Sydow & Braun, 2018; Thakurta, 2015). Therefore, the concept of organizational resilience, its definition, and the strategies sieved from the literature to improve it, have a guiding role in the definition of project resilience and the development of indicators to assess it.

2. LITERATURE REVIEW

2.1 Resilience

The concept of resilience has been used for decades, in many disciplines and from many perspectives. Therefore, defining it varies depending on the entity involved (an individual, a critical infrastructure, an organization, a project, etc.), and even when the focus is on a specific entity, the definitions of resilience can vary in a substantial way (Carlson et al., 2012).

Two main foundations of resilience were introduced by Holling in (1996): 'engineering resilience' and 'ecological resilience'. The term 'engineering resilience' describes a focus on resisting and absorbing a specific force. It is the capacity of a system to maintain its functions, controls, and the relationships between its entities (Bhamra, Dani, & Burnard, 2011; Ponomarov & Holcomb, 2009). Therefore, a system based on engineering resilience works within limited possible states and tends to return quickly to its equilibrium state, after a disruption. Consequently, it focuses on stability (Holling, 1973; Ponomarov & Holcomb, 2009)

On the other hand, 'ecological resilience' is defined as the capacity for change and reorganization, and is measured by: "the magnitude of disturbance that can be absorbed before the system changes its structure by changing the variables and processes that control behavior" (Holling, 1996, p. 33). Therefore, a system founded on ecological resilience endures large disturbances, tends to return gradually to its equilibrium state and, under certain conditions, can change its structure and functions completely (Holling, 1996).

These original foundations of resilience have improved over the years, and have influenced subsequent studies on resilience from many perspectives and in many fields (Bhamra et al., 2011; Geambasu, 2011; Ponomarov & Holcomb, 2009).

2.2 Organizational Resilience

Despite the various definitions of organizational resilience, it can be stated unequivocally that this concept is related to the ability of an organization to deal with disruptive events that may cause cessation of organizational operations (Lee, Vargo, & Seville, 2013; McManus, 2008; Somers, 2007; Sonnet, 2016; Stephenson, 2010).

It is mainly related to the capacity of the organization to be alert and prepared, via a set of cognitive behaviors, to successfully adapt and recover from disruptive events (Mafabi, Munene, & Ahiauzu, 2015; Stephenson, 2010). This requires a continuous rebuilding of values, processes and mechanisms to proactively and reactively deal with disruptive events (Jung, 2015; Sonnet, 2016). Therefore, the concept of organizational resilience has mainly two dimensions that can be sieved from the literature: awareness and adaptive capacity.

Awareness is related to the organization's capacity to evaluate its surroundings and to be alert to changes that may cause disruptive events (Lee et al., 2013; McManus, 2008; Sapeciay, Wilkinson, & Costello, 2017). This requires a deep knowledge of the organization's inputs and outputs in order to identify resources (e.g. tangible and intangible assets, knowledge, etc.) needed vs those available to maintain its operations (Borekci, Rofcanin, & Sahin, 2014).

Many strategies can be used to improve the awareness of an organization. To this matter, the management and the continuous development of organizational networks is needed to exchange and immobilize external resources to face future disruptive events (Jones, 2015; McManus, 2008; Petit et al., 2013). Also, the development of expertise, and the right assignment of roles and responsibilities help prevent the occurrence of disruptive events. This increases the global awareness of the organization and helps employees remain alert to possible disruptive events (Lee et al., 2013; McManus, 2008). On the other hand, the continuous monitoring of the organization's financial and economic situation, its competitors, its customers, the updates on laws and regulations, etc., and making internal changes to avoid disruptive events, increase the organization's global awareness (Gunasekaran, Rai, & Griffin, 2011; Otulana, 2011). Another strategy that can be adopted is by minimizing the communications barriers between the organization's departments which helps keep its employees alert to future disruptive events. These barriers are often related to employees' cognitive behaviors, cultural backgrounds and work experiences, and are often the cause for detrimental ways of working (Sapeciay et al., 2017; Sonnet, 2016).

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Finally, building an innovation culture and encouraging the employees to think outside of the box is essential to stay competitive and help achieving the organization's strategic objectives, and to be prepared to deal creatively with future disruptive events (Demmer, Vickery, & Calantone, 2011; Stephenson, 2010).

The second dimension of organizational resilience is adaptive capacity. It describes the capacity of an organization to transform itself in response to disruptive events (Otulana, 2011; Sonnet, 2016; Stephenson, 2010). As mentioned by Stephenson (2010): "An organization's ability to adapt is at the heart of its ability to display resilient characteristics" (Stephenson, 2010, p. 99).

To this matter, strategies can also be adopted to improve the organization's adaptive capacity. Thus, the mobilization of resources from both the inside and the outside of the organization (e.g. through networks and partnerships), help face disruptive events (Duarte Alonso & Bressan, 2015; Pettit et al., 2016; Sawalha, 2015). On the other hand, the engagement and involvement of employees in ensuring the success of organizational operations help improve its adaptive capacity. This includes understanding the link between their own daily tasks and the tasks required to adapt in the face of disruptive events. Also, the presence of employees that adopt innovative and creative solutions in response to disruptive events is a key factor in emphasizing the organization's adaptive capacity (Akgün & Keskin, 2014; Pal, Torstensson, & Mattila, 2014; Sonnet, 2016; Tillement, Cholez, & Reverdy, 2009). Consequently, adapting when faced with a disruptive event requires strong leadership and decision-making capabilities to strike a balance between daily operations and special operations. Leadership that focuses on empowering employees to use their skills and expertise to solve issues, reinforces the organization's adaptive capacity to better face disruptive events (Lee et al., 2013; Stephenson, 2010).

So, employees are encouraged to make decisions by taking advantage of their specific knowledge and expertise to manage the challenges that may occur from a specific disruptive event. This includes allowing qualified employees to take decisions in critical situations, without the necessity of senior management approval (Borekci, Rofcanin, & Gürbüz, 2015; Borekci et al., 2014; Sullivan-Taylor & Branicki, 2011). Finally, improving the organization's adaptive capacity requires quick access to information stored in secure locations, to facilitate dealing with disruptive events (Gunasekaran et al., 2011; Sapeciay et al., 2017; Stephenson, 2010). It also requires accurate analysis of the consequences of disruptive events, and the continuous adjustment of organizational priorities (Demmer et al., 2011; Price, 2012).

2.3 Project Resilience

In project management, the concept of resilience is still new and largely overlooked (Thomé et al., 2016). The need for resilience emerged as a new way of dealing with disruptive events that may occur during the project life-cycle (Geambasu, 2011). These events can potentially lead to the project failure, because they can affect: "everything from technical feasibility to cost, market timing, financial performance, and strategic objectives"(Thamhain, 2013, p. 1).

There are few definitions of project resilience, and based on our knowledge, those that do exist are presented in **Table 1**. From these definitions, key words and key activities are observed. Project resilience refers to a function (ability, capacity, capability, etc.) of the project to be proactive (notice, interpret, prepare, etc.) and reactive (restore capacity, evolve in response, overcome, cope, etc.) when facing disruptive events. In fact, the project should be aware of its surroundings and adapt when faced with disruptive events, regardless of whether or not these events are known at the beginning of the project. So, the resilience of the project is reinforced by monitoring the project system's inputs, outputs and vulnerabilities (a measure of the gap between resources needed to complete a task and resources available (Proag, 2014)), and by being able to acquire the resources needed to deal with disruptive events.

Therefore, project resilience can be defined by the capacity of the project system to be aware of its surroundings, and to adapt in order to recover from disruptive events. Accordingly, project resilience has two dimensions; awareness and adaptive capacity. Awareness is a continuous understanding of the project system's elements and vulnerabilities, and an incessant monitoring of changes in its environment. On the other hand, adaptive capacity is the capacity of the project system to transform itself in order to cope with disruptive events. From the system perspective, the project is defined by a set of elements that, in a changing environment, transform inputs into outputs. Thus, the project environment is both the main provider of inputs and the main receptor of the final outputs (the outputs that shape the final deliverables of the project), where inputs and outputs are resources (e.g. tangible and intangible assets, knowledge, etc.) (Anbari, 1985; Kopczyński & Brzozowski, 2015).

2.4 Assessment of Project Resilience

Based on prior research and our knowledge of the new concept of project resilience, it would appear that there is both a need for, and an interest in, developing indicators to assess project resilience (Geambasu, 2011; Thomé et al., 2016). In fact, assessing project resilience, by the project team members, aims to validate the state of knowledge on the ability of the project to deal with disruptive events (Blay, 2017). It refers to the progress of the knowledge's acquisition about the project, and its environment, to deal with events that can potentially lead to its failure. Therefore, these indicators, when developed, can be used as a diagnostic tool to assess the impact of the efforts required to support the resilience of current and future projects. These indicators can potentially help determine the project's strengths and weaknesses regarding its capacity to deal with disruptive events, as well as to suggest action plans to improve its resilience.

Definitions of project resilience	Reference
Resilience describes: 1) the project system's ability to restore capacity and continuously adapt to changes, and 2) to fulfill its objectives in order to continue to function at its fullest possible extent, in spite of threatening critical events	(Geambasu, 2011)
The capacity for projects to evolve in response to the consequences of unexpected risks that are unknowable at the project planning stage	(Schroeder & Hatton, 2012)
The capacity to maintain core purpose and integrity in the face of external or internal shock and change	(Hillson, 2014)
The art of noticing, interpreting, preparing, containing and recovering	(Turner & Kutsch, 2015)
Project capacity to overcome the unexpected	(Giezen, Salet, & Bertolini, 2015)
The ability of project systems to cope with uncertainty	(Zhu, 2016)
The capability of a project to respond to, prepare for and reduce the impact of disruption caused by the drifting environment and project complexity	(Blay, 2017)

Table 1: Definitions of project resilience found in the literature.

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3 Methodology

The inductive approach was employed to achieve the objectives of this study and to propose a set of indicators to assess project resilience. This approach is appropriate, because it allows the generation of a set of indicators to assess project resilience by exploring the reality. This approach is mainly used: "When the conceptual basis for a construct may not result in easily identifiable dimensions for which items can then be generated" (Hinkin, 1998, p. 6), which is well suited to the context of this study. Therefore, semi-structured interviews were conducted with 10 senior project managers from different industries. The goal was to understand how project managers become aware of, deal with, and manage disruptive events that occur during the project life-cycle. Two series of questions were asked during these interviews. The first series of questions was related to the current methods used by the respondent, in their most common projects, to identify project weaknesses (where the project is most vulnerable), and to deal with disruptive events in general. The second series of questions was related to the identification and the management of a specific major disruptive event (a case study). Each interview lasted between 30 min and 45 min. **Table 2** provides the characteristics of respondents who participated in the interviews (while ensuring the confidentiality of their names and the companies that they work for), and the case studies that were discussed with the interviewees. The interviews' transcripts were analyzed by QDAMiner Lite to propose a set of indicators that can potentially be used to assess this concept.

It is to mention that the word 'resilience' was deliberately not used during the interviews, because it is still a new concept in project management, and project managers are not used to it. So, phrases such as: "unforeseen and unknown risks", "project management processes and practices," and "are aware, deal with, and manage" were used instead. It was during the analysis phase that these phrases

were transposed to 'resilience', in order to fulfill the objective of this study.

On the other hand, the literature reviewed, in the previous sections, on organizational resilience inspired the development of the interview questions and helped in the development of indicators to assess project resilience.

4 Results & Discussion

Based on the findings from the qualitative study, project resilience is indeed the capacity of the project system to be aware of its surroundings and to adapt in order to recover from disruptive events. The evidence emphasized the importance of recognizing the project system's vulnerabilities, of analyzing potential threats, and on being prepared to deal with them on occurrence. On the other hand, the analysis of the case studies provided evidence of positive adjustments when facing disruptive events. These positive adjustments are transformations that occurred in order to cope with the disruptive events and recover successfully.

Therefore, 10 indicators and 48 items are proposed to measure the two dimensions of project resilience: awareness and adaptive capacity. **Table 3** presents the indicators, and the items to measure them, along with their link to awareness and adaptive capacity. As suggested by Hinkin (1998), Likert-type scales are the most useful in behavioral research. Therefore, it is suggested that a 5-point Likert scale would be appropriate to evaluate the indicators, by rating the correspondent items from 'strongly disagree' to 'strongly agree', with a neutral midpoint.

4.1 Awareness

The awareness dimension of project resilience is measured by 6 indicators and 26 items. These indicators are presented and explained in the following sections.

4.1.1 Clarity of Roles & Responsibilities

Increasing awareness, and accomplishing successfully project objectives, require a clear understanding of the functions assumed, the accountability and collaboration needed, and the right skills, expertise, physical and mental states demanded by team members, during the project life-cycle.

Interviewee #	Years of experience in PM	Industry	Range of projects' budgets (\$ CAD)	Key deliverables	Range of projects' schedules	Brief description of the case study discussed
1	5	IT ^[1] consulting	500K to 2M	Software applications and enterprise shared services modules in a SOA ^[2] environment	3 to 12 months	A migration project from Windows XP to Windows 7 in a Canadian Bank in which, based on an executive decision during the execution phase of the project, 80% of the team was changed. This decision led to serious compatibility issues between the team members and tensions with senior management.
2	18	Financial services	10K to 500K	System upgrades to various organizations' payroll platform	2 to 18 months	During the go-live date of the implementation of a payroll application, the client decided to make important changes to a specific interface. This issue caused all processing in the application to fail and, consequently, the main provider did not receive accurate information related to his employees' payroll on time.
3	7	Software development and implementation	10K to 70K	Software payroll platforms	4 to 6 months	During the implementation of a technological system, and before the go-live date, the main resource (the resource that owns the most critical information on the application and the data) from the client's side left the project. This change was followed by a new requirement that has never been implemented before.
4	8	Construction	25K to 3M	Electrical construction related	1 to 4 years	During the commissioning, delivery and integration of 8 critical electrical generators for a hospital, a team member forgot to trigger the ventilation system. This led to the explosion of some pieces within the electrical generators which caused delays, and additional, unforeseen cost.
5	6	Wood industry and production	100K to 1M	Plant/factory development, installation of assembly lines in factories	4 to 5 months	During the assembly of a production line, the senior management decision to purchase a cheaper machine led to many issues in the piping system. This issue led to delays and additional costs.
6	8	IT and payroll services	50K to 400K	Payroll system including benefits, and time & attendance	4 to 18 months	After signing the contract with the client and gathering the initial requirements to start the implementation of a software application, it was noticed, during the project life-cycle, that the application did not meet, at all, the client's needs.
7	5	Construction / transportation	300M to 400M	Constructed establishments	Around 5 years	For a big construction project, the design was completed, and a specific engineering firm was hired to execute specific task. However, an opposition from a specific municipality prevented the company from getting the license to move forward with the project, because of the presence of a dog park.
8	7	Construction	25K to 4M	Buildings renovations and small constructed establishments	6 to 24 months	A general strike in the construction industry stopped 30 construction projects at the same time due to the lack of resources. This led to delays and an unhappy customer.
9	7	Decontamination and construction	20M to 80M	Installation and extension of gas networks	2 years	A change in a law within the committee on standards, equity, health and safety at work led to a major change on a construction project. This change cost millions of dollars and delays.
10	5	IT	10K to 250K	Hardware installation and support. SAAS ^[3] , cloud-based, implementation projects.	3 to 12 months	While working with a client that purchased a software application with many interrelated components, he decided, during the testing phase, to withdraw a specific component which led the whole application to crash.

^[1]Information Technology
^[2]Service Oriented Architecture
^[3]Software as a Service

Table 2: Information on the interviewee and the case studies discussed

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As mentioned by a senior project manager, whose project suffered from severe consequences due to the negligence of an experienced team member: "Having the experience and skills to complete a specific task is important but not enough: physical and mental states are of equal importance". It must also be mentioned that this indicator is in line with the indicators used to assess organizational resilience. The latter refers to the work of Lee et al. (2013), McManus (2008), and Stephenson (2010).

4.1.2 Availability of Project & Risk Management Methods

The availability of project management and risk management tools and applications to keep stakeholders updated on project performance, and informed about project weaknesses, during the project life-cycle, increases awareness. As noted by the majority of the respondents, having clear processes, together with risk and project management templates, including field-specific methods, helped the project team to capture project weakness, and remain alert to possible disruptive events.

4.1.3 Alertness to Scope & Performance Deviations

Remaining alert to disruptive events demands continuous monitoring, throughout the project life-cycle, of project Key Performance Indicators (KPIs), and of changes to the project's scope. This indicator is compatible with the studies of Geambasu (2011) and Zhu (2016), in which it was noted that deviations in KPIs can lead project managers and project team members to the potential occurrence of disruptive events. These KPIs are related to the budget, the schedule and the quality of work (if quality insurance is continuously performed). Thus, the positive adjustment of these KPIs increases the project's ability to remain alerted to possible disruptive events.

4.1.4 Sensitivity to Environmental Changes

External events can have a huge impact on the project's objectives. These external events can be, among others: a change in laws and regulations, a general strike, critical weather conditions, etc. These events can happen anytime during the project life-cycle. Therefore, the continuous monitoring and assessment of events or conditions in the project's environment will help in the identification and assessment of possible threats. Therefore, and as suggested by one respondent, participating more actively and frequently in the meetings of associations, and staying aware of changes on laws and regulations can help the project avoid the negative effects of external disruptive events. On the other hand, learning from history, in a specific field, can also improve the general awareness of the project. For example, a senior project manager in the construction industry suffered from a lack of resources on his projects, because of a general strike in the province of Quebec. He mentioned: "It is important to verify the frequency of having strikes in Quebec. Strikes in this province are not rare. This lack of verification caused serious delays on the projects, and unsatisfied customers".

4.1.5 Efficiency of External Resources

A project's global awareness may be increased by the continuous development and updates of partnerships and networks, so as to better identify and assess possible threats through external resources. Many respondents emphasized the importance of developing and maintaining partnerships with external parties, to help in the identification and assessment of project weaknesses. A specific example that occurred in the construction industry, where consultants were encouraged at the beginning of the project, to participate in risk analysis sessions and project planning, especially that those consultants are typically the ones who execute the work. The importance of networks is also discussed in studies on organizational resilience, such as the work of Jones (2015), Pettit et al. (2016), and Sapeciay et al. (2017).

4.1.6 Leadership & Involvement of Stakeholders

Awareness requires that leaders embrace transparency when dealing with all stakeholders, by continuously setting expectations, providing updates on changes, and having the optimal visibility of issues that may lead to disruptive events. As mentioned by one of the respondents: "A lack of an open and transparent communication between senior managers and the team members caused a major change in the project's main resources (80% of the team members were changed without any notice), which creates tension between team members and delays on the project". It is to mention that the role of leadership is also discussed in studies on organizational resilience, as part of developing strategies and supporting employees to deal with disruptive events (e.g. Sullivan-Taylor & Branicki (2011)).

4.2 Adaptive Capacity

The adaptive capacity dimension of project resilience is measured by 4 indicators and 22 items. These indicators are presented and explained in the following sections.

4.2.1 Accessibility & Mobilization of Resources

A project's adaptive capacity to recover, and to continue fulfilling its objectives, is increased by having access to accurate information, and by being able to mobilize external (e.g. through partnerships) and internal (e.g. from different organizational departments) resources to face disruptive events. As mentioned by one of the respondents in the IT industry: "mobilizing a qualified internal resource, which was not part of the project, helped hand-holding the client on site until he recovered from the loss of its key resource". Another respondent from the construction industry received help from external resources, through partnership, to redesign a whole solution that allowed the project to recover from a major disruptive event. The importance of accessing qualified internal and external resources, and being able to mobilize them, is also discussed in studies on organizational resilience (e.g. Lee et al. (2013), S. T. McManus (2008), Stephenson (2010)).

4.2.2 Responsiveness of Team Members

To increase the adaptive capacity of the project system, team members are encouraged and rewarded for adopting innovative and creative solutions, through their managerial and technical skills, and expertise when faced with disruptive events. Many examples given by the respondents show how team members' responsiveness enabled quick recovery from disruptive events. For example, as mentioned by one respondent in the IT industry: "another resource, that was not even supposed to work on the project, showed diligence, filled in the job required by both ill resources, and continued the project by himself for two weeks". This indicator is also discussed in studies on organizational resilience, where the organization's adaptive capacity is increased by its employees' cognitive behaviors and their innovative attitude to face disruptive events (Akgün & Keskin, 2014; Pal et al., 2014; Sonnet, 2016; Tillement et al., 2009).

4.2.3 Effectiveness of Communications and Relationships

Continuous follow-ups, with honest and transparent communications, in which stakeholders take ownership of the issues and suggest possible solutions, enable an efficient management of disruptive events. As mentioned by one of the respondents: "It is very important to report the disruptive event with great honesty and transparency and take ownership to deal with it. Therefore, when the external consultant and the client took ownership and had the commitment to deliver according to the new plan, the disruptive event was successfully managed". As also mentioned by another respondent: "during a disruptive event, projects may fail because of a lack of effective communication". The adoption of effective, transparent and honest communication is also discussed in studies on organizational resilience. In fact, as mentioned by Stephenson (2010): "during crisis, organizations often fail (or the crisis is escalated) because of their lack of effective communication."

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4.2.4 Adapted & Responsible Decision-Making

To better adapt when facing disruptive events, the devolution of decision-making is encouraged by leadership. In fact, leadership must act strategically to face disruptive events, by taking into account the project importance, by always ensuring stakeholders' satisfaction, and by respecting signed contracts and agreements. Additionally, the delegation of authority to qualified team members, to make decisions related to their tasks, can help in dealing with disruptive events. However, this expansion of decision-making needs to be well controlled to avoid, as much as possible, the 'silo mentality' effect (Geambasu, 2011; Zhu, 2016). This effect occurs when project team members adopt an individualistic approach when making decisions (S. T. McManus, 2008). In fact, if there is a lack of understanding of a disruptive event, and without coordinating with other team members and senior management, individual decisions can lead to additional risks that may cause the project to deviate from its main objectives (Schroeder & Hatton, 2012).

Table 3: The indicators and their items to assess the awareness and the adaptive capacity dimensions of project resilience

Indicator	Items
<i>Awareness</i>	
Clarity of Roles & Responsibilities	<ol style="list-style-type: none"> 1. I have a clear understanding of my tasks during the project life-cycle. 2. I continuously use my expertise to identify project risks. 3. I continuously use my expertise to assess (probability vs impact) projects' risks. 4. I work in collaboration with other team members to remain alert to disruptive events. 5. I use field-specific practices (e. g. safety measures, protocols and certifications, etc.) to ensure tasks are completed based on field-specific regulatory compliance.
Availability of Project & Risk Management Methods	<ol style="list-style-type: none"> 1. Based on the project type, project management methods (e.g. project plan template, Agile, etc.) are employed to capture all project's requirements and potentially avoid possible disruptive events. 2. Based on the project type, risk management methods (e.g. risk register template, Monte Carlo analysis, etc.) are used to avoid possible disruptive events. 3. Lessons learned from previous similar projects are analyzed to identify project weaknesses. 4. Field-specific methods (e.g. field-specific checklists, equipment installation guides and procedures, etc.) are used to remain alert to project weaknesses.
Alertness to Scope & Performance Deviations	<ol style="list-style-type: none"> 1. Scope changes are continuously monitored through the project life-cycle. 2. Project requirements are properly gathered from the beginning of the project. 3. KPIs for the budget are continuously monitored to detect any budget performance deviation through the project life-cycle. 4. KPIs for the schedule are continuously monitored to detect any schedule performance deviation through the project life-cycle. 5. Quality control is continuously achieved to detect any discrepancies that may lead to disruptive events through the project life-cycle.
Sensitivity to Environmental Changes	<ol style="list-style-type: none"> 1. External changes (e.g. changes in laws, regulations and field-specific trends, etc.) are proactively monitored (e.g. by participation with industry-specific groups or associations, etc.) to have early warnings of possible disruptive events. 2. Internal organizational changes (e.g. new project management processes, updates to existing methods, etc.), that may impact the project, are clearly communicated to avoid possible disruptive events. 3. When needed, access to resources within the organization is available to help identify project weaknesses. 4. When needed, access to resources within the organization is available to help assess project weaknesses.
Efficiency of External Resources	<ol style="list-style-type: none"> 1. Partnerships with external parties that have the field-specific knowledge are continuously developed. 2. Current partnerships with external parties are continuously reinforced. 3. Access to external resources through partnerships is possible to help identify project weaknesses. 4. Access to external resources through partnerships is possible to help assess project weaknesses.
Leadership & Involvement of Stakeholders	<ol style="list-style-type: none"> 1. Senior managers are transparent regarding any organizational changes that may cause disruptive events during the project life-cycle. 2. All detected issues through the project life-cycle are communicated to senior managers, to keep them alert to possible disruptive events. 3. Expectations are continuously set to reinforce trust and avoid surprises. 4. Follow-ups (regular meetings, status calls, etc.) take place regularly to remain alert to possible disruptive events.
<i>Adaptive Capacity</i>	
Accessibility & Mobilization of Resources	<ol style="list-style-type: none"> 1. When needed, resources can be mobilized from different departments to face disruptive events. 2. When needed, resources can be mobilized through partnerships to face disruptive events. 3. Information systems are available to provide quick access to information to solve an issue. 4. Information systems are available to log disruptive events. 5. Departments can provide feedback on possible solutions to face disruptive events through information systems. 6. External partners can provide feedback on possible solutions to face disruptive events through information systems. 7. When the budget contingency is completely consumed, leadership can release additional funds to face disruptive events.
Responsiveness of Team Members	<ol style="list-style-type: none"> 1. I tend to adopt creative solutions to face disruptive events. 2. I am encouraged to think outside of the box to find solutions to face disruptive events. 3. I have the expertise to deal with disruptive events. 4. When faced with disruptive events, it is a priority to find the best ways to avoid them.
Effectiveness of Communications & Relationships	<ol style="list-style-type: none"> 1. Clear explanations of issues and possible solutions are provided to all stakeholders through transparent communications. 2. Stakeholders, including the client, are encouraged to take ownership of the issue and any possible solutions. 3. Stakeholders are involved through continuous follow-ups (e.g. regular meetings, status calls, etc.) to ensure proper management of disruptive events. 4. Stakeholders are open to reassess project objectives (e.g. new ways of doing things, new roadmap, new strategies, etc.), if needed, to face disruptive events. 5. A clear escalation plan is available to face disruptive events.
Adapted & Responsible Decision Making	<ol style="list-style-type: none"> 1. Senior managers plot a course of actions to face disruptive events. 2. Senior managers ensure actions are implemented in the right way and at the right time to effectively face disruptive events. 3. Senior managers adapt their strategies to face disruptive events based on the project's importance to the organization. 4. Stakeholders' satisfaction is taken into consideration when finding solutions to face disruptive events. 5. Clauses in the contract can be bypassed, to a certain extent, to find solutions to face disruptive events. 6. Qualified team members are encouraged to make critical decisions without the need for senior managers' approval.

5 Conclusion

Project resilience is still a novel and an interesting concept to be explored in scientific studies. It empowers current project management methods, to better deal with events that may cause severe deviations from a project's objectives. Following an inductive approach, in which 10 senior project managers were interviewed, and 10 case studies were carefully examined, 10 indicators were mined from this empirical study to assess the two dimensions of project resilience: awareness and adaptive capacity. The clarity of roles and responsibilities, the availability of project and risk management methods, the alertness to scope and performance deviations, the sensitivity to environmental changes, the efficiency of external resources, and the leadership and involvement of stakeholders measure the continuous understanding of the project system's elements and vulnerabilities, and the incessant monitoring of changes in its environment (awareness). On the other hand, the accessibility and mobilization of resources, the responsiveness of team members, the effectiveness of communication and relationships, and adapted and responsible decision-making, measure the capacity of the project system to efficiently acquire resources in order to transform itself (adaptive capacity). It is suggested that future research should seek to validate these indicators (e.g. exploratory and confirmatory factor analysis) in different project types (e.g. IT, Construction, Pharmaceutical, etc.), in order to give project team members more robust indicators to help them assess the project's capacity to deal effectively and efficiently with disruptive events.

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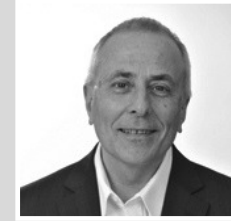
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