

# Project portfolios in dynamic environments: Organizing for uncertainty

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Received 31 July 2011; received in revised form 28 October 2011; accepted 22 November 2011

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## Abstract

This research investigated the following research question: *How is uncertainty affecting project portfolios managed in dynamic environments?* While different approaches have been developed in the context of the management of single projects these ideas have not been carried over to the management of project portfolios.

The dynamic capabilities framework is used as the framework to study the management of project portfolios in dynamic environments. The research is based on four portfolios in two firms using retrospective analysis. Sufficient material was collected and analyzed to contribute in the following areas: (1) To provide a better understanding of the management of project portfolios facing uncertainty, (2) to analyze the relationships between the sources of uncertainty in dynamic environments and the organizing mechanisms put in place by organizations to minimize their impact and to capitalize on opportunities, and (3) to identify possible improvements to project portfolio models and standards.

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*Keywords:* Project portfolio management; Strategic management theory; Resource-based view; Dynamic capabilities; Uncertainty

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## 1. Introduction

The project portfolio management (PPM) literature has been focusing primarily on project selection, prioritization and balancing with the primary aim of doing the right projects. Once the list of projects is decided, the assumption is that projects will be managed using the now commonly accepted good practices documented in the project management literature. An underlying assumption is that there will not be significant changes to the portfolio until the next periodic review, be that quarterly, bi-annually or annually, and that individual projects will deal with the risks and uncertainties in the course of their execution. This research studied how uncertainties are managed at the portfolio level reusing concepts borrowed from the dynamic capability literature. Following the presentation of the theoretical framework, the research methodology is described. The final section of the article presents and discusses the results.

This research attempts to answer the following research question: *How is uncertainty affecting project portfolios managed in dynamic environments?* with four main objectives:

- To identify the organizing mechanisms used to manage uncertainty affecting project portfolios in dynamic environments,
- To evaluate the use of the dynamic capability framework for the study of project portfolios,
- To study project portfolio management at the operational level using concepts borrowed from sensemaking (traditionally used to study the interpretative mechanism at the individual level) and from dynamic capabilities (traditionally used to study strategic processes at the corporate level),
- To identify useful practices in the field of project portfolio management.

## 2. Project portfolio management

The most significant literature on PPM was developed in the study of new product development portfolios (Cooper et al., 2001; Krishnan and Ulrich, 2001; McGrath, 2004). This

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empirically-based literature focuses on the project selection process and choices among many potential projects. The concepts of selection criteria, balancing and strategic alignment are central to this literature. The *Standard for Project Portfolio Management—Second Edition* (Project Management Institute, 2008b), is based on the same concepts and has much the same focus. The standard defines a project portfolio as: “a collection of projects or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives” (Project Management Institute, 2008b, p.138). This standard proposes a process that stresses the importance of the alignment of the project portfolio to the firm’s strategy, as well as the identification and prioritization of the projects being fundamental to ensure that firms execute the most beneficial projects. This concept is analogous to financial portfolios but the primary focus of PPM is on how to select and prioritize projects to ensure that risks, complexity, potential returns, and resource allocations are balanced and aligned to the corporate strategy in order to provide optimal benefits to the enterprise.

Up until now, the PPM literature has made little mention of potential disturbances to the portfolio typically found in dynamic environments although the Project Management Institute (PMI) standard describes two types of changes. The first one refers to periodical reviews of the portfolio performance “to ensure that the portfolio contains only components that support achievement of the strategic goals. To achieve this, components must be added, reprioritized, or excluded based on their performance and ongoing alignment with the defined strategy in order to ensure effective management of the portfolio” (Project Management Institute, 2008b, p.77). The second type relates to significant changes in the business environment resulting in a new strategic direction: “as environments inside and outside the organization change, criteria for determining the composition and direction of the portfolio may also change... When the need for new criteria becomes evident, the portfolio management team needs to examine the current criteria in the strategic plan and move ahead with appropriate changes, usually focusing first on categorization. If strategic change is not occurring, the efforts should focus on portfolio balancing” (Project Management Institute, 2008b, p.84).

In addition, adjustments to the ongoing portfolio might be made without going through a complete review cycle, an activity briefly mentioned in the PMI standard in the section on Communicate Portfolio Adjustment (Project Management Institute, 2008b, p.71). The Association for Project Management (APM) mentions this type of change in terms of “adjustments of the portfolio with regard to the constraints, risks, and returns anticipated, and in the light of developing circumstances around the portfolio” (Association for Project Management, 2006, p. 8).

The present research focuses on the management of the project portfolio in dynamic environment after the project portfolio has been established. In this research, it is assumed that portfolio managers might not only monitor changes but might also implement processes to manage and control change. It is therefore suggested that the existing processes be supplemented with additional empirical information.

### 3. Risk management and uncertainty management

#### 3.1. Risks

Both PMI and APM define a risk as an uncertain *event* which might have positive effects (opportunities) or negative effects (threats). A typical classification of risks is based on the level of knowledge about the risk occurrence (known or unknown) and the level of knowledge about the impact (known or unknown). This leads to four possibilities (Cleden, 2009, p.13): (1) Known–Knowns (Knowledge), (2) Unknown–Knowns (Untapped Knowledge), (3) Known–Unknowns (Risks), and (4) Unknown–Unknowns: (Unfathomable uncertainty).

#### 3.2. Risk management

Different processes have been developed to deal with risks, mainly in the category of the *known–unknowns*. Risk management includes the different techniques to either reduce the probability of occurrence of an event or reduce its impact on the project (or inversely for positive risks). The risk management processes include activities to identify, assess, plan a response, and implement a response. It uses mainly proactive management actions although it might involve reactive action in the case of uncontrollable unknowns or in the case when risks become reality (Association for Project Management, 2006; Pavlak, 2004; Power, 2007; Project Management Institute, 2008b).

Once risks have been identified through brainstorming techniques or expert judgment they are typically assessed using a probability and impact assessment to determine the overall potential impact on the project (Association for Project Management, 2006; Project Management Institute, 2008a). The risk management response planning techniques include: (1) Risk avoidance, (2) Risk mitigation, (3) Risk transfer, and (4) Risk acceptance. The techniques proposed to analyze and develop risk responses at project portfolio level are similar to the techniques identified in the PMBOK Guide® for single projects i.e. avoidance, mitigation, transfer and acceptance.

#### 3.3. Uncertainty management versus risk management

The term *risk* refers to *events* rather than being associated to more general sources of uncertainty. In projects undertaken in rapidly changing environments where uncertainty may be unavoidable managers need to go beyond traditional risk management, adopting roles and techniques oriented less toward planning and more toward flexibility and learning (De Meyer et al., 2002; Platje and Seidel, 1993).

Some authors have advocated the use of the broader concept of *uncertainty management* instead of *risk management*, which is too focused on threats and events (Cleden, 2009; Perminova et al., 2007, 2008; Ward and Chapman, 2003). “Uncertainty management is not just about managing perceived threats, opportunities and their implications. [...] It implies exploring and understanding the origins of project uncertainty before seeking to manage it, with no preconceptions about what is desirable or undesirable”. (Ward and Chapman, 2003, p. 98–99).

An *uncertainty management* perspective in the context of PPM draws attention to the need to understand and manage variability in organizational activities that have impacts on a number of projects. This perspective highlights the need to put in place different approaches and techniques to address some aspects of project related uncertainty outside individual project contexts.

Ward and Chapman (2003) and Leifer et al. (2000) propose a typology of uncertainty affecting projects based on their sources, e.g. technical, market, organization or financial. Instead of focusing on their sources, De Meyer et al. (2002) and Loch et al. (2006) propose a typology based on the characteristics of uncertainty:

**Variation:** comes from many small influences and yields a range of values on a particular activity. Project managers can still plan a complete project based on the sequence of tasks but the duration estimates might vary.

**Foreseen uncertainty:** are identifiable and understood influences. This is analogous to risks which can be identified and might lead to contingent actions.

**Unforeseen uncertainty:** this is analogous to the unknown–unknowns. However, “it can also arise from the unanticipated interaction of many events each of which might, in principle, be foreseeable” (De Meyer et al., 2002, p.62).

**Chaos:** “Whereas projects subject to unforeseen uncertainty start out with reasonably stable assumptions and goals, projects subject to chaos do not. Even the basic structure of the project plan is uncertain, as is the case when technology is in upheaval or when research, not development, is the main goal. Often the project ends up with final results that are completely different from the project’s original intent” (De Meyer et al., 2002, p.62). Collyer and Warren (2009) surveyed the literature to identify approaches that might be used to deal with dynamic environments. The classification includes the following items: (1) making dynamic static; (2) emergent planning approaches; (3) scope control; (4) management coordination and control; (5) Controlled Experimentation; (6) lifecycle strategies. These techniques provide a good starting point for the investigation of similar techniques used for managing project portfolios. However, it is not clear whether all these approaches are applicable to portfolios or whether new approaches are developed to support PPM. The topic of organizations having to cope with changing and uncertain environments has been studied from many points of view in the Organization Theory and in the Strategy literature. The term *environmental uncertainty* has been used in organization theory, both as a descriptor of the state of organizational environments (Dahlgren and Söderlund, 2010; Scott, 1998) and as a descriptor of the state of a person who perceives himself/herself to be lacking critical information about the environment (Duncan, 1972; Milliken, 1987).

## 4. Conceptual framework

### 4.1. Dynamic capabilities

Following the criticisms and the limitations of the Resource-Based View in environments of rapid technological change

(Barney, 2001; Kraaijenbrink et al., 2010; Priem and Butler, 2001), Teece et al. (1997) published their seminal article in which they defined *Dynamic capabilities* as “the firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments” (Teece et al., 1997, p.516). This expression emphasizes two main aspects: the capacity to renew competence in the face of changing business environments, and the key role of strategic management in adapting, integrating, and *reconfiguring* internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment. Teece et al. argue that the competitive advantage of firms is based on *organizational processes* shaped by *asset position* and the *paths* available to it where the term *organizational process* refers to: coordination/integration, learning, reconfiguration, and transformation processes. The *asset position* refers to the resources typically covered by the RBV: technological assets, innovation capabilities, financial assets, reputational assets, structural assets, institutional assets, and market assets. *Path dependencies* add the idea that the possible paths a firm can take are dependent on its history. It is the history which is sometimes hard if not impossible to imitate by competitors. For example, technological opportunities depend on knowledge and competence already built by the firms.

The recent publications on *Dynamic capabilities* theory argue that it is no longer sufficient to develop unique resources or capabilities (as initially proposed in the RBV) to gain a strategic advantage but that these resources and capabilities must be constantly re-allocated and re-optimized to adapt to changing environments. The definition proposed by Teece (2009) makes a clear distinction between the different processes:

Dynamic capabilities refer to the particular (nonimitability) capacity business enterprises possess to shape, reshape, configure, and reconfigure assets so as to respond to changing technologies and markets and escape the zero-profit condition. Dynamic capabilities relate to the enterprise’s ability to sense, seize, and adapt in order to generate and exploit internal and external enterprise-specific competences, and to address the enterprise’s changing environment (p. 87–88).

This is precisely what the management of project portfolios in dynamic environments is about. The study of the *micro-foundations* in this particular context should therefore have the potential to contribute to a better understanding of PPM in dynamic environments and of Dynamic capabilities in a multi-project context.

This research uses Teece’s framework (2007, 2009) to structure the micro-foundations of the Dynamic capabilities used when managing project portfolios under high levels of uncertainty. Teece (2007, 2009) proposes a Dynamic capabilities framework that identifies classes of relevant variables and their interrelationships. It is made of three main capabilities: “(1) to *sense* and shape opportunities and threats; (2) to *seize* opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and when necessary,

reconfiguring the business enterprise’s intangible and tangible assets” (Teece, 2009, p.4).

4.2. Conceptual framework based on Dynamic capabilities

A conceptual framework, based on the dynamic capability framework discussed above, was adapted for this research, see Fig. 1. It provides the basis for data collection via the methodology described in the next section. It is composed of three main levels: organizational context, Dynamic capabilities, and the micro-foundations.

The organizational context was studied to provide background data to understand why the project portfolio is put in place and under which organizational processes and constraints it must operate. It includes the following elements:

Environment: this includes the type of industry, the market, the competition, the legal aspects, the political aspects and how dynamic the environment is. This was also used to assess and select the case studies to be investigated.

Strategy: it was assumed that a strategy for the project portfolio was established; the process used to develop the strategy has not been investigated in this study. However, the vision, the mission, and the strategy were identified.

Organizational structure: This organizational structure was assessed to understand how the project organizations are structured. This included the functional organization, the utilization of external resources, and the alliances with external firms.

Constraints: includes mainly but is not limited to the financial budget for the project portfolio.

Corporate governance: includes the decision bodies at corporate level, the directives, rules, and guidelines to control the organization and the portfolio.

Project portfolio characteristics: the structure of the project portfolios, the history of the portfolio, the characteristics of the projects, the dependencies between the projects and the resources dependencies were assessed.

The conceptual framework includes two levels of processes. The first one, more operational, corresponds to the reconfiguration of the projects in the portfolio and the resources based on sensed changes in the environments. The second level leads to transformations and process improvements but also of changes of other organizational aspects which might impact PPM.

The operational processes dealing with uncertainty include: *sensing* which refers to structures, tools, and processes to sense, filter, and interpret changes and uncertainties; *seizing* i.e. the structures, the tools, and procedures for identifying that changes are required once a change or uncertainly has been sensed; and *reconfiguring* defined as the actions taken to ensure alignment of projects and resources with the changes identified by the *sensing* mechanisms and decided upon in *seizing*.

The second-order of Dynamic capabilities also involves three groups of processes, in this case *second-order sensing*, *second-order seizing*, and *transforming*. *Second-order sensing*

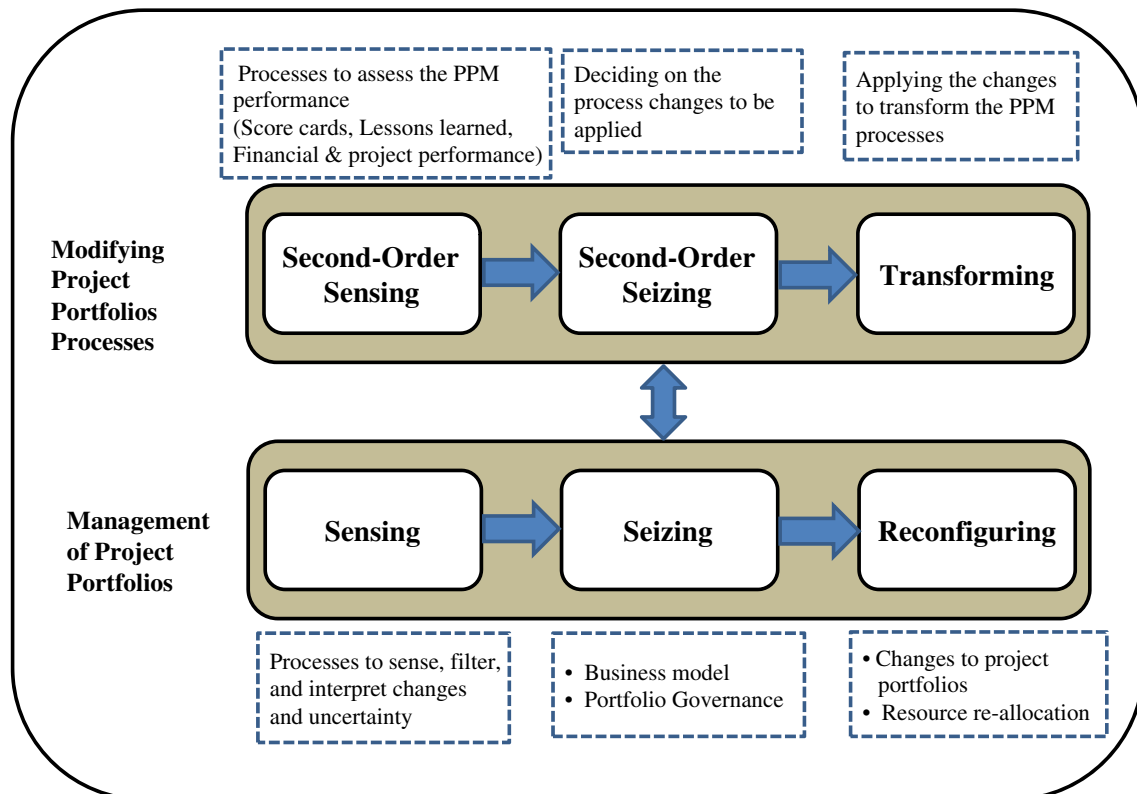


Fig. 1. Graphical representation of conceptual framework.



includes the processes to assess PPM performance. This requires the *sensing* of the performance of the first-order dynamic capability as well as the identification of new practices which might be identified outside of the organization. Once the potential need for changes is identified by the *sensing* processes, *second-order seizing* decides the changes which must be put in place in addition to how and when they should be deployed. This might include: corrective actions, new routines, structures, or tools to improve the performance of PPM and be better aligned with the changing external conditions. *Transforming* mechanisms improve the *sensing–seizing–reconfiguring* mechanisms used in the first-order dynamic capability or the modification of the supporting environment (processes, routines, knowledge management, and structure).

There have been only a handful of studies of PPM based on Dynamic capabilities. In the context of PPM as a dynamic capability, Killen, Hunt, and Kleinschmidt (Killen, 2008; Killen and Hunt, 2010a, b; Killen et al., 2007, 2008a, b) focus primarily on the corporate learning and improvement process involved in PPM. This corresponds to the knowledge management component of the transforming processes. In addition both the concept of organizational learning and transforming are also used by Bresnen (2009) to study project organizations in the construction industry and by Newey and Zahra (2009) in the project portfolio management in the pharmaceutical industry.

## 5. Methodology

### 5.1. Research strategy

This research used an in-depth study of a limited number of cases. According to Yin (2003), case studies are the preferred strategy when: *how* or *why* questions are being posed; when the investigator has little control over events; when the focus is a contemporary phenomenon within some real-life context, and when very little is known about a topic.

The research strategy was based on qualitative methods, pre-structured in its conceptual framework but evolving based on early findings, focusing on identifying the *organizing mechanisms* put in place to respond to uncertainty.

A conceptual framework and interview guide based on a preliminary research question “*How are unexpected events affecting project portfolios identified, interpreted and managed?*” were tested prior to the actual case study investigation. The initial conceptual framework focused on the project portfolio regulating process, under constraint, when unexpected events occur. Initial interviews were carried out during summer 2008: one with the person responsible for the project portfolio process deployment at a division of a Canadian utility company, *Util2008*, and one with the portfolio manager of the IT division of a Canadian financial institution, *Fin2008*. This allowed to refine the research question, the questionnaires and the conceptual framework.

### 5.2. Organizing mechanisms as the unit of analysis

Dawidson (2006) studied how the project portfolio management activities are organized in seven Swedish companies. She

showed that aspects of importance for organizing portfolio management can be grouped in three different areas: (1) how the portfolio management activities are organized (i.e. the *organizational processes*), (2) how the *tools and methods* are used, and (3) how the relevant organizational participants get involved (i.e. *organizational structures*).

These three elements (organizational processes, tools, and structure) are referred to as *organizing mechanisms* throughout this research and is the unit of analysis being investigated. As a consequence, during analysis of documents and of the interviews, attempts were made to identify the *sensing–seizing–reconfiguring/transforming* mechanisms and to classify them according to the three categories proposed by Dawidson. A fourth organizing mechanism called: *basis for decisions* was also added. This included any constraint (such as approved budgets, guidelines, or corporate directives) which would determine how the courses of action were decided upon.

### 5.3. Cases investigated

Four portfolios in two firms, *Company Soft* and *Company Fin* were selected. The portfolios had been in existence for more than two years i.e. long enough to have encountered different types of changes and have faced different types of uncertainty. The portfolios were complex and included a large number of dependencies between projects. Having two portfolios per firm offers opportunities to validate if observations could be replicated within a given firm. This is particularly relevant because PPM and project management practices are often established and deployed at corporate level. This provides many similarities between the cases (i.e. the different portfolios) but due to the particularities of the individual portfolios, differences might still be observed.

The project and portfolio management practices were well established in the organization. There was access to documents and to people involved and the history of the portfolio was well documented.

Project steering, portfolio planning and project documents were collected and analyzed with respect to: descriptions of the project portfolios over time, major events which resulted in changes to project portfolios, and the project portfolio change management process. Interviews were performed with a number of actors which have been involved in the portfolio management process in the period under study. An interview guide was used as opposed to more structured questionnaires. This left some room for probing and further investigating new areas identified during the interviews. The interviews were always performed by the same researcher, during working hours at the interviewees' workplace. A total of 48 interviews with 43 people were performed. In *Portfolio Soft1*, the portfolio manager was interviewed three times, in *Portfolio Soft2* the product manager was interviewed twice, in *Portfolios Fin1* and *Fin2*, the portfolio manager was interviewed twice. Each interview took between 45 and 90 min. For *Company Soft*, interviews were carried out in English, for *Company Fin*, all interviews were done in French.

The interviews were taped, transcribed, and transferred to Atlas.Ti® where they were coded and analyzed to identify patterns. A number of families of codes related to the conceptual framework were first created: organizational context, *sensing*, *seizing*, *transforming*, and *others*. The interviews of *Company Soft* were coded first. Based on this initial analysis, the conceptual framework was updated and additional codes were created. The coding for *Company Soft* was then reviewed in an additional iteration and updated accordingly. The coding for *Company Fin* followed using a similar approach. Based on free coding within these families, a total of 87 codes were created. The codes with few citations and the citations tagged with codes in the category *other* were reviewed in detail and merged when appropriate. This reduced the number of codes to 78.

### 5.3.1. Within-case analysis

The data collected was analyzed using the conceptual framework as a basis. The sources of uncertainty were first assessed and a connection to the different *sensing* mechanisms was sought. A complete flow from the source of uncertainty all the way through changes to project portfolios was investigated searching for some connections with *seizing* and *reconfiguring* mechanisms. Each case was initially analyzed as if they were unique cases.

### 5.3.2. Company Soft

The first company referred to as *Company Soft* is a large multinational with over 60,000 employees out of which approx. 15,000 work in the R&D divisions where the investigation was carried out. The enterprise has a long history of managing software and hardware projects with well-documented practices and guidelines. They have experience in managing projects for more than 30 years. In the last 8 to 10 years, the company started to manage their projects as programs and portfolios.

Soft is structured into a number of design units (DU) responsible for the financial success and the development of a portfolio of products. These design units are further structured into product design units (PDU). A number of design centers around the world are involved in the development of the components within the PDU. This includes centers in Europe, Asia, and North and South America. Portfolios are managed at the PDU level. The DU is composed of over 5000 employees who manage five portfolios that correspond to the five PDUs. Two portfolios, called *Soft1* and *Soft2*, were studied.

The *Portfolio Soft1* is composed of approximately 15 large projects/programs in one PDU and a total of approximately 50 subprojects/projects between four months and 18 months in duration. The planning horizon is between 18 months and two years. The portfolio was created approximately five years ago when the market for their product did not yet exist. It involves over 1000 people located in seven sites on three continents.

The portfolio *Soft2* is managed in another PDU and is composed of projects developing components and platforms used by the other PDUs and DUs, including the PDU managing *Soft1*. The main difference with the previous portfolio is that the products are not delivered directly to external customers but internally to other units. They have conflicting requirements

coming from the different units which must be reconciled. Their products also include the integration of a large number of third-party products.

### 5.3.3. Company Fin

The second company, referred to as *Fin*, is a large Canadian financial services company. The projects are managed by project managers in the different business units and the relevant departments (e.g., IT). They have experience in managing projects for more than 15 years.

The portfolio *Fin1* includes four programs covering a total of approximately 150 projects over a period of five years. The portfolio was put in place to comply with the Basel II Accord, which is an international agreement specifying the capital requirements for the underlying risks that financial institutions face. The portfolio was established in 2004 and is planned to continue for at least another year. The same portfolio manager is in place since 2005. The resources are mainly in Canada and are composed of a large proportion of consultants (approximately 50%). The history of this portfolio is well documented and includes a large number of changes.

A second portfolio in this enterprise; called *Fin2*, develops new procedures and tools to support upgrades to their accounting system. The portfolio was established in 2007 and is planned to be completed in 2011. It is composed of approximately 25 projects running in parallel. It includes short projects (less than 3 months) and longer projects (more than 1 year) with a high level of dependencies between projects.

## 6. Results

### 6.1. Sources of uncertainty requiring sensing

Using the categorization proposed by Leifer et al. (2000), the project uncertainties could be classified into four broad categories according to their sources: technical uncertainty, market uncertainties, organizational uncertainties, and financial uncertainties. They include: matching the product with customer requirements, competitor's offering evolution, new customers, new market, and new applications. In the case of *Company Fin*, uncertainties in the content and interpretation of norms have been included the category of market uncertainties. Market uncertainties are the most significant in all four portfolios. Financial uncertainty is observed primarily in *Portfolio Soft2* and uncertainty regarding resources is mainly a concern at *Company Fin*. A fifth category called *Norms and Regulations* was added to refer to the uncertainty affecting primarily *Company Fin*. Table 1 maps the different types of uncertainties mentioned during the interviews according to these five categories.

The connection between the sources of uncertainties, their potential impacts on the portfolios and the need for sensing mechanism is shown in Fig. 2. Based on the classification of uncertainties proposed by De Meyer et al. (2002), the mechanisms described in this research mainly address *foreseen uncertainty* i.e. when the uncertainty is identifiable and the projects have stable goals. This type of uncertainty can lead

Table 1  
Mapping of the sources of uncertainty.

	<i>Soft1</i>	<i>Soft2</i>	<i>Fin1</i>	<i>Fin2</i>
Technical	3rd party product Technology	3rd party product Technology		
Market	Match product with customers needs Competitor’s offering New customers New market New applications	Match product with customer needs Competitor’s offering	Match product with customer needs	Match product with customer needs
Organizational			Availability of resources	Availability of resources
Financial		Funding structure		
Norms and regulations			Content of Basel agreement Interpretation of Basel agreement	Content of new accounting regulations interpretation of new accounting regulations

to contingent actions, which in the cases observed resulted in processes and structures to mitigate the impacts of the uncertainties on the performance of the organization. In the four portfolios observed technical and market uncertainties were considered foreseen uncertainties for which specific *sensing* mechanisms were put in place. Although it can be argued that these types of uncertainties could also be unforeseen uncertainties, this type of uncertainties did not occur during the period observed for these portfolios.

Although organizational uncertainties and financial uncertainties can lead to frequent changes in the project portfolios, in the cases studied here they are *unforeseen uncertainties* analogous to the unknown–unknowns. They are not considered sources of uncertainties for which *sensing* mechanism would be appropriate.

Finally the inability to accurately plan projects constitutes a *variation* i.e. comes from many small influences and yields a range of values on a particular activity. Variations have to be monitored and managed on a continuous basis. Although it might be argued that project portfolio performance is under the control of the organizations managing them, they still carry a significant amount of inherent variation, which must be managed.

In the context of PPM, first-order *reconfiguring* corresponds to the following group of activities:

- Changes in the project portfolio structure. This included any changes in the project configuration: new projects, new sub-portfolios, termination of projects, etc.

- Changes in the allocation of financial and human resource to the project portfolios
- Any operational changes related to a better alignment of the portfolio to the changes in the environment.

Second-order *transforming* refers to the following types of activities

- Modifying the *sensing–seizing–reconfiguring* mechanisms used in the first-order level of PPM described above (for example changing the governance structure, modifying the rules to structure the project portfolio used for *reconfiguring*, adding a new *sensing* mechanism).
- Introduction of new structures, processes, or tools to support the PPM activities, which might not directly result in changes in the first-order *sensing–seizing–reconfiguring* mechanisms (for example. modifications to the software development process, new architecture to support a more flexible product structure).

## 6.2. Organizing mechanisms specific to Company Soft

### 6.2.1. First order sensing–seizing–reconfiguring

The sources of uncertainty and sensing mechanisms observed at *Company Soft* have been documented in (Reference removed). In both portfolios at *Company Soft*, the main sources of uncertainty were related to the project scope. Multiple *sensing* mechanisms are put in place to interpret the sources of uncertainty related to new customers, new technologies,

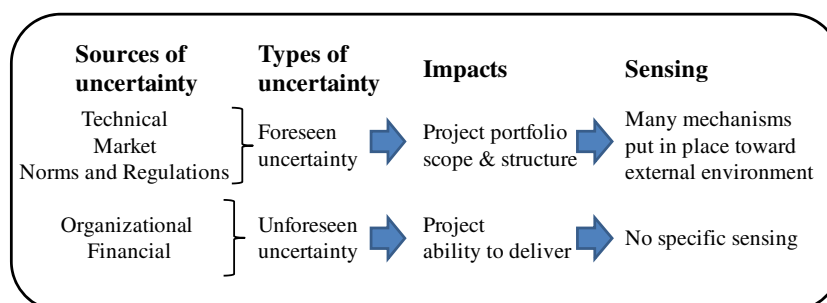


Fig. 2. Mapping sources of uncertainties to *sensing*.

new products, new applications, etc. This includes a mixture of structures, processes, and roles such as a dedicated role for specifying content, a system management group to follow-up on technology evolution, early demonstrations to customers, special process for customer trials, and innovations through employee contributions.

Because *Company Soft* has learned that it is pointless to try to plan projects in details over a long period of time due to the expected number of change requests, the projects are no longer planned as waterfalls. The recent trend has been to evolve toward development processes analogous to Agile with short projects and short iterations. Although the project delivery sequence is determined in advance, like train schedules, the exact content of the different deliveries remains tentative and is planned progressively. The portfolio scope is therefore constantly being managed and as such offers a very different picture from the PPM described in the portfolio literature where the content of individual projects is well known and the portfolio goal is to select among projects.

On the contrary, special mechanisms are put in place for managing project scope at portfolio level. In *Portfolio Soft1* a special body was introduced, the requirement request board, to control the flow of requests for product features. This board can rapidly assess the amount of work and determine the best project to develop each feature based on the status of the ongoing projects in the portfolio. Projects are scoped-in rather than scope-out to reduce the amount of rework or rejected requirements once the projects are started.

*We were scoping out all the time, so we wasted a lot of effort doing feasibility on things maybe we shouldn't be doing or we had to cut out later on. At one point, we estimated that, probably 50% of all of the systems work that we did was a waste, because we never got to the market. Instead of doing that we decided to do it the other way, we should only scope-in the things that really, really matter based on the customer requirements. And then we study it and we want to make sure that whatever we study there is almost a 100% success rate that it gets into the next release of the product (Strategic Planning Manager — Portfolio Soft1).*

Although the company is a very mature project organization and the project portfolio is clearly in place and managed, interviewees had difficulties pointing to a single person as the portfolio manager. The portfolio management function is not centralized into a single person with the title of portfolio manager. The responsibility is split among dozens of people each looking after specific aspects (product managers, product development unit manager, node managers, portfolio planners, financial controllers). For example, one person in *Portfolio Soft1* is taking care of the project portfolio with respect to balancing of the resources and budget. This excludes the responsibility for content and business profitability, which is included in the product management role.

The governance structure put in place at *Company Soft* is complex and the portfolio governance responsibility is spread among a multitude of intertwined bodies and groups each

responsible for a subset of the governance process. There are also different levels of planning boards to ensure that the organization has enough capacity and competence to execute all the projects being requested. The boards serve as decision bodies for the *resource balancing* function.

Resource balancing is crucial at *Company Soft*. For many interviewees, portfolio management and resource balancing was more or less synonymous. There were also a number of references to *capability management* and *pipeline management*, which is the ability of the organization to assess on which project every person is working at any given time but more importantly what is the capability of the organization to undertake additional projects in the future. *Company Soft* put in place a regular resource planning process based on sophisticated tools to monitor the allocation of the resources to the projects. The *Company Soft* has developed an internal web-based tool to support this process. This means that data is continuously being kept up-to-date by project managers and line managers. This allows all the governing functions to base their decisions on more reliable resource data while continuing to provide the necessary data for the quarterly financial forecast. Another benefit was the ability to share the data about the resource demand and supply across the organization. The focus on resource planning might be due to the fact that they are structured as a matrix organization.

*Company Soft* also had a large amount of ongoing organizational transformations. Continuous changes in the ways of working, the structure, and the tools were part of the corporate culture. For example, there was tremendous effort put into the improvement of the software development process used by the developers. Process improvement teams were constantly in place to challenge the ways of working. Employees were asked, on one hand, to follow the process to keep the efficiency high but on the other hand were also encouraged to challenge the processes and suggest improvements. The approach taken by *Company Soft* was to use the ongoing projects as vehicles to deploy new processes and tools. This included activities such as: new accounting systems, new requirement tracking tools, new resource planning tools, new project management processes, new software releases.

Frequent re-organizations, transfers to different design centers, closing down units to create new ones, merging departments were part of the corporate culture. Changes of the organizational structure were even considered the best way for the line organization to support the project portfolios and surprisingly were not considered as significant hindrances by project managers.

*You want to have your organization structured in a way that is the most useful to your current project road map. You don't want to be in a situation where to start up a new project you require five resources from one organization and ten resources from another organization. So you want to have your organization structured and balanced with your product portfolio. We take a look at the organization structure that we have and say does this organization structure that we have today get us to where we want to*



be? And then sometimes we make organizational changes. We are just about to conclude one [...] Projects have different lifecycles so there is always going to be some projects that are in the middle of organization changes (System Group Manager — *Portfolio Soft2*).

In addition to the flexibility in process, *Company Soft* implemented *flexibility in the product* where alternative demands can be met with the same product. A first approach to provide the required flexibility was to offer a very large number of parameters to configure the product in a multitude of ways even without knowing in advance what the customer might require. A second approach was the decomposition of the product into a number of independent nodes linked through standardized interfaces. The first approach has the drawback of increasing the product complexity while the second increased the management overhead in terms of testing and integration.

#### 6.2.2. Second-order sensing–seizing–transforming

When the first-order *sensing–seizing–reallocating* mechanisms were analyzed in depth, it became clear that these mechanisms are not static. There are many instances when interviewees mentioned that new processes have just been implemented or are in the midst of getting evaluated or getting deployed. In a turbulent environment, such as *Portfolio Soft1*, employees are asked, on one hand, to follow the process to keep the efficiency high but on the other hand are also encouraged to challenge the processes and suggest improvements. Good practices and the knowledge gained from process improvement pilot are also shared across the different divisions of *Company Soft*. Through the contacts with consultants, tool vendors and communities of practices, practitioners are also well aware of innovations in the software development processes such as *Agile*. The continuous change of the ways of working could be considered a part of the corporate culture. Although there is a strong tradition in developing software and hardware products, it is customary to include some form of changes in ways of working in almost every project. This is in addition to other forms of changes such as the structural organization itself to support the requirements of the project portfolios.

At *Company Soft*, a number of people are dedicated to process monitoring and improvement. This includes different roles: Discipline owners, Operation development, and Process improvement teams. The project management office holds, among other things, the responsibility to ensure that the organization runs as smoothly and as efficiently as possible. This includes primarily how efficiently projects are managed but also covers many other supporting aspects such as: the resource planning and allocation, the governance, portfolio management, value management, etc. Some of the *transforming* activities discussed in the previous section were triggered by direct observations made by members of the project management office. For example, the introduction of monthly resource planning cycles was justified by the inability of the project management office manager to respond quickly to demands from product management regarding the available resource capacity to handle additional projects.

Transforming the sensing mechanisms: a new process was developed to support customer trials which are considered strategic activities to gain key customers in *Portfolio Soft1*. These trials include the demonstration that test cases can be executed successfully and that the pass rate is very high. This includes a number of deviations to existing processes, feedback loops to the scope management, and new escalation processes. This new process cannot be generalized to the *normal* software development processes but is particularly well adapted to the very turbulent environment in which these trials projects are exposed to.

In addition, because *Portfolio Soft1* is very new, ideas for applications are still being investigated. Because *Portfolio Soft1* wants to tap on the creativity of their employees they put in place a contest in which employees could contribute. This is likely to be a temporary process which is still in the midst of being evaluated and improved.

Transforming the seizing mechanisms: the business model is an important component of the *seizing* mechanism which is used as the decision criteria to select, prioritize, and group components into projects. When the interviewees are carried out at *Portfolio Soft2*, the whole PDU has just been restructured to supply components rather than platforms. The consequences of this change include reducing the size of the projects and a new grouping of projects. Most importantly the level of integration and verification is strongly challenged. If the PDU delivers components instead of complete platforms, the level of testing can then potentially be greatly reduced. It has repercussions not only on the portfolio structure but also on the project funding financial structure and the supply of the products to the different units. However, this new business model is considered more flexible and better adapted to the requirements of the internal customers.

In addition a new process and structure is introduced to provide some form of continuity in the analysis of new requirements feeding the different projects. It is believed that the issuance of change requests directly to projects results in multiple change requests bouncing between projects without a complete system view of the optimal location for a request. By providing a central point for the investigation of all feature requests and a process to analyze and decide upon these requests, it becomes easier to track and optimize the flow of new requests across the portfolio.

*Company Soft* has in place internal steering boards to oversee the improvements teams. These boards include representatives of the different departments to ensure cohesions in the improvement projects. In addition, a number of improvement projects are driven at corporate or DU levels. This ensures a more holistic view. For example, there are a number of initiatives to ensure that the revenues (and profits) in the service organization were not negatively affected by the product development process of the PDUs.

Transforming the reconfiguring mechanisms: Three years ago, *Portfolio Soft1* used what they called a scope-out strategy, a methodology inherited from their project management tradition. They consciously started projects with a scope much larger than the capacity of the organization to deliver; going

through the early phases of the projects (i.e. the pre-study and feasibility phases) allowed them to gradually decrease the scope of the project until the scope matched the organizational capacity to deliver. This occasionally caused some problems when the scope included too many compulsory or high priority features. During that period they frequently used scenario analysis techniques to plan and identify options when changes were requested to their already overloaded projects. In addition, change control boards for each project were used to monitor and control the baselined content. However this created a lot of wasted effort because many of the features for which pre-studies were carried out never reached the execution phase. *Portfolio Soft1* faces a very turbulent environment in which the product specification is very fuzzy and the customer demands continuously changing. In such a context, they try to minimize rework by postponing decisions until more information is available. When projects are initiated, the objective is that only about 50% of the content is planned when the feasibility Phase begins. Subsequent work packages are left available for subsequent addition of content; the project portfolio plan becomes a way to communicate the planned deliveries to customers without necessarily committing to its content. When the execution starts, the objective was to have reached 90% of the scope capacity if the project, leaving 10% for additional features during the project execution for later additions.

The resource planning process used to be executed every quarter. However because the resource planning process took approximately one month to execute the data quality was not considered sufficient for operational resource allocation decisions by the steering groups. The project office manager was continuously being asked if capacity was available to start new projects. In order to respond, up-to-date and reliable data about the resource requirements and allocation had to be available. In addition, similar data was necessary for the re-allocation of resources when issues occurred in projects and the resource plans had to be modified. Historically, the resource plan which was produced quarterly to the finance department through an internally developed web-based tool was used for this purpose. However, these resource plans were getting rapidly obsolete (once some reallocation had taken place) and nobody really relied on them. This was not deemed appropriate to respond to the reallocation requests. A more frequent resource planning process is put in place with the appropriate tools and processes. In the last two years, the PMO director and the senior management have started to implement a monthly resource planning process. As a consequence both project managers and line managers must maintain the information up-to-date continuously.

### 6.3. Organizing mechanisms specific to *Company Fin*

#### 6.3.1. First order sensing–seizing–reconfiguring

In both portfolios at *Company Fin*, the main sources of uncertainty were also related to the project scope. This is mainly due to the norms being changed by the regulating bodies but an even greater source of uncertainty is the interpretation of the norms by the firm itself. To ensure that changes to the

norms are captured as early as possible, both *Portfolio Fin1* and *Fin2* assigned a person to be responsible of regularly monitoring the updates of the norms by regulatory bodies. This is a good example of a dedicated person assigned to a *sensing* function, which might lead to *reconfiguring* of resources within the portfolios.

A second source of uncertainty is the performance of the projects in the portfolio. In the case of *Company Fin*, the level of dependencies is considered extremely high. This makes the evaluation of the impacts of project deviations more problematic. The production of dependency matrices is a special technique, which is used primarily by *Portfolio Fin1* to formalize and document dependencies between the different projects. This helps the portfolio manager and the steering groups to assess impacts of change requests (due to new functionality or deviations in project performance) when they are issued. This tool can be considered both a *sensing* mechanism (because it helps identify impacts on projects) and to some extent a *seizing* mechanism (because it helps to take action on the resource allocation based on these impacts).

*Company Fin* introduced the concept of a change control board at the project portfolio level. At the project portfolio level the change requests are used to monitor the overall budget situation and to ensure that the sum of the money spent on all projects (including actual and planned costs) within a given year would remain within the limits of the portfolio budget. There could be a number of ways that budget overruns could be handled at the portfolio level: moving content to subsequent years, reducing content of some projects, reducing number of people involved in activities (e.g. review meetings with stakeholders).

At *Company Fin* project managers and portfolio managers claimed that they had no buffer whatsoever to cater for uncertainty. They had to issue change requests or additional funding requests whenever they expected their project cost to be exceeded. Similarly they would report to their steering group any delay that they would consider significant. A small amount of money is put aside as margins at the portfolio level and is kept in case some projects would exceed their budget. This serves as a form of contingency fund for all projects.

*At Company Fin, we do not use contingencies. We have a project that is very difficult to estimate precisely. If it would be possible to get a buffer, at least 15% it would be good [...]. But our plans must be balanced to the cent with budgets. But afterwards, we either issue change requests (if the scope changes) or request additional funds if need additional money because the budget was incorrectly assessed (Project Manager — Portfolio Fin2).*

#### 6.3.2. Second-order sensing–seizing–transforming

At *Company Fin*, Project proposals are analyzed and prioritized by the steering groups, once a year, for the following year. These yearly cycles were not deemed appropriate, by the manager of *Portfolio Fin1* for the planning of the entire portfolio. She requested a four-year budget for more or less the equivalent of the duration of all projects part of the portfolio. This long-

term budget allowed the portfolio management team to better plan the sequence of projects and the allocation of resources. It also provided senior management with the estimated cost and duration of the entire portfolio, not just for the following year. According to the portfolio manager, this is the first time in the history of *Company Fin* that such longer-term budgets were allocated. This was after long debates and battles by the portfolio manager. Despite this four-year budget, yearly forecasts still have to be submitted and monitored.

Change requests at project level are used at *Company Fin*. The concept of change requests at portfolio level was also introduced to monitor and control changes at a higher level. Project managers are not allowed to include contingency reserves in their plan and are forced to report any expected deviations once the project is under execution. This allows the portfolio manager to be informed on any deviations from the plans, even when they are very small.

At *Portfolio Fin1*, the number of dependencies between projects is extremely high. The management comes up with mechanisms to help them assess if the changes in one project would have consequences on other projects. The evaluation and documentation of the dependencies by each project and its integration into a dependency matrix was introduced to support the interpretation and assessment of uncertainty and changes on other projects. Table 2 compares the specific organizing mechanisms at *Company Soft* and *Fin*.

6.4. Common organizing mechanisms

Table 3 summarizes the organizing mechanisms observed in all four portfolios. For example, multi-project plans are used to represent the project portfolio at a high level. In a multi-project plan, each project is represented on a single line with significant milestones. Additional information is included about the projects such as the budget, the amount of money spent, the level of risk,

the customer, etc. The multi-project plan is never baselined. Latest versions are used as references and are continuously being updated with additions, modifications to projects, granting of tollgates, newly planned targets dates, etc.

The specification of the scope of the different projects is a complex task and in all four portfolios, it was neither the sponsors nor the project managers who were specifying the project content. This task is delegated to specific roles: product managers in the case of *Company Soft* and business analysts in the case of *Company Fin*. This role is rarely mentioned in the PPM literature.

In all portfolios, the overall yearly budget for a given project portfolio was considered fixed and non re-negotiable. Contrary to the common ability to negotiate between cost, time, and scope at project level, the annual project portfolio budget always seems to be untouchable. Portfolio budgets are approved at a very high level in the organizations after long negotiations and are normally allocated on a yearly basis. Exceptionally the *Portfolio Fin1* budget is approved for a four year period but even in this case increase to this overall budget is considered non negotiable. Yearly budgets are still being planned and approved within the four-year budget envelope.

*At Company Fin we normally allocate budgets annually. Since 2005, I sold the idea to get a multi-year budget and we are the only one at Company Fin to have this. It allowed us to transfer budgets across projects within a year but also from one year to the other For example, if it was not possible to define the requirements properly, or if there was an issue or a lack of resources, we could delay it to 2010. So instead of having to justify again to get the budget in 2010, we just had to transfer the money (Portfolio manager — Portfolio Fin1).*

There is pressure in all four portfolios to decompose the portfolio into projects under a given size. A guideline of

Table 2  
Differences in organizing mechanisms.

	Characteristics	<i>Company Soft</i>		<i>Company Fin</i>	
		<i>Portfolio Soft1</i>	<i>Portfolio Soft2</i>	<i>Portfolio Fin1</i>	<i>Portfolio Fin1</i>
Organizational context	Industry	Software development		Financial services	
	Main portfolio output	Complete systems incl documentation and support	Software platforms	Processes and tools	
	Level of uncertainty for portfolio management	Extremely high level of uncertainty	High level uncertainty	High level of uncertainty	High level of uncertainty
	Resources	Internal (matrix)		Mix of internal and external	
Organizing mechanisms	Size of project portfolio (number of concurrent projects)	Approx 50 projects	Approx 25 projects	Approx 50 projects	Approx 25 projects
	Transforming	Separate second-order sensing and seizing mechanisms		No separate second-order sensing and seizing mechanisms	
Organizing mechanisms	Second-order sensing and seizing mechanisms	Separate second-order sensing and seizing mechanisms		No separate second-order sensing and seizing mechanisms	
	Sensing mechanisms	Largest number and most active of sensing mechanisms	Limited number of sensing mechanisms	Limited number of sensing mechanisms	
	Balancing	Monthly resource balancing using sophisticated tool		Resource planning not a main preoccupation at portfolio level	
	Re-organizing	Capability planning		Frequent re-organizations despite project portfolios	
		Frequent re-organizations justified by the product life-cycles			

Table 3  
Organizing mechanisms replicated in all four project portfolios.

Characteristics	<i>Company Soft</i>		<i>Company Fin</i>	
	<i>Portfolio Soft1</i>	<i>Portfolio Soft2</i>	<i>Portfolio Fin1</i>	<i>Portfolio Fin2</i>
Managing scope	Pre-study machine Requirement request board Scope-in	Pre-study machine Requirement request board	Change control boards at project portfolio level Two types of change request	Change control boards at project portfolio level
Dedicated role for scope management	Group of product managers		Business analysts and integration business analyst	
Multi-project plans and roadmaps	Multi-project plans and roadmaps		Multi-project plans and roadmaps	
Managing dependencies between projects	Managed without specific tools by project management teams	Informal	Dependency matrix	Informal
Monitoring portfolio performance	Metrics mainly at project level Standard project reporting Integrated reporting		Metrics mainly at project level Standard project reporting Integrated reporting	
Shorter projects and iterations	Targets project less than one year an iterations less than 6 weeks Agile development		Target projects less than 1 million CAD\$	
Strict portfolio yearly budgets	Yearly budget approved 18 months rolling forecast		Yearly budget approved. Portfolio budget approved for 4 years.	Yearly budget approved.
Reserve for uncertainly	No reserves at project level Limited reserves at portfolio level		No reserves at project level Limited reserve at portfolio level	

projects of less than one million is given at *Company Fin* and of less than one year in *Company Soft*. Small projects are less complex and thus easier to manage but they require more project management overhead. In counterpart, bigger projects require less project management overhead but are generally more complex and harder to manage. The four portfolios attempted to find the project size which would balance overhead cost and project complexity according to the maturity of their respective organization. In addition *Company Soft* breaks down their internal deliveries into a number of iterations. This facilitates the planning and the control of the intermediate deliverables (in comparison to the waterfall approach which is based on a single deliverable at the end of the project).

## 7. Implications for the PMI Standard for Portfolio Management

The primary purpose of the PMI Standard for Portfolio Management (Project Management Institute, 2008b) is to describe good practices associated with portfolio management, which are applicable to most portfolios most of the time. Although it is not possible to generalize the findings from this qualitative research on a small sample to a large population, it does provide significant insights into the management of portfolios of software projects.

### 7.1. Additions of new components

The high level illustration of the portfolio management process flow in The Standard for Portfolio Management (Project Management Institute, 2008b, p.36) assumes that a list of components (projects, programs and other work) is available and must be prioritized, balanced, and authorized. Once this is done, the monitoring and controlling processes are activated. This model does not really cater to the inclusion and assessment

of new project requests or requests for new product features once the project portfolio is authorize. The sequence *identify–categorize–evaluate–select* is not appropriate in this case.

What is observed in the four portfolios, when new project requests are submitted, is an assessment of the consequences of the addition of this new project on the ongoing portfolio. This takes the form of scenarios being created and analyzed for consequences on other projects, access to resources, risks, etc. Most often a complete impact analysis by the project managers of the currently ongoing projects would follow the decision.

### 7.2. Feedback loops and portfolio adjustments

There are three feedback loops in the Standard for Portfolio Management (Project Management Institute, 2008b), one after *balance portfolio* in the *aligning* process group and two in the *monitoring and controlling* process group. Once the portfolio is authorized, the rebalancing of the portfolio can only occur based on the *review and report of portfolio performance* (process 4.9 and when there is a significant *business strategy change*).

Significant business changes are very rare and would bring a complete questioning of the whole portfolio, potentially even bring it to a close. Although a large number of events and changes were analyzed in this research, such dramatic strategy changes were not observed in the duration under study. However, regular adjustments to the portfolio are performed frequently due to changes in the environment. In this case, the business strategy itself might remain the same but its translation into the project portfolio must be modified to cater for new external conditions. Such adjustments are mentioned in the PMI standard in a section called *communicate portfolio adjustments* but the activities involved in producing these adjustments are not defined. This could include tools and techniques such as the establishment of a portfolio level change control board and change control process. This could also involve the use



of scenarios to assess impacts of changes on the ongoing portfolio. Finally the Standard for Portfolio Management should consider continuous assessment of changes and uncertainty as an intrinsic part of the process, not as an exception.

### 7.3. Uncertainty versus risk

This research adopted an *uncertainty management* perspective instead of *risk management*, a more established practice in the project management community. Although project managers and portfolio managers clearly faced risks and managed risks using the traditional tools and techniques, they are also exposed to an environment which was constantly changing.

Using uncertainty management instead of risk management draws attention to the need to understand and manage variability in the inputs to the project portfolio activities. This perspective also highlights the need to put in place different approaches and techniques to address uncertainty outside individual project contexts. Although risk management is appropriate in many portfolios, the concept of uncertainty and uncertainty management was considered more appropriate in the four portfolios studied. Arguably, they were particular cases having to deal with a high degree of uncertainty and complexity. However, risk management does not cover the complete spectrum addressed by uncertainty management. The inclusion of uncertainty management in the standard could be useful for managing many portfolios.

### 7.4. Human resource management

Human resource management is one of the knowledge area of the PMBOK Guide (Project Management Institute, 2008a) but it is absent from the portfolio standard. Based on the observations made during this research, the continuous balancing of supply and demand of the human resources would definitely be appropriate at the project portfolio level. The standard currently includes a section on balancing the portfolio but its main focus is on the selection of the best mix of projects (i.e. balancing risks, returns, complexity) in order to achieve strategic goals.

For PPM, human resource management goes beyond the allocation to individual projects. It might include some of the following items:

- Comparing the resource demands of all projects in the portfolio with the available resources.
- Estimating the total cost of human resources and matching it with the portfolio budget.
- Identifying if external resources are required.
- Ensuring the competence is adequate, short term and long term. On a longer term this might include some new capability development, transfers of competences or shut down of some areas.

It was observed that, in dynamic environments, human resource management involved a constant planning, monitoring, and controlling. At *Company Soft*, this activity was formally

executed on a monthly basis and required an enormous amount of efforts from management. The HR concerns related to PPM might be expanded to include the identification and development of the competencies required of the people involved in PPM at both the first-order operational level and at the second-order governance level.

## 8. Conclusion

This research undertook to investigate the area of PPM in dynamic environments using dynamic capabilities as a framework. The objective was to attempt to answer the following research question: *How is uncertainty affecting project portfolios managed in dynamic environments?* The ambition was never to answer this question entirely and thoroughly but to explore it through the qualitative study of four portfolios in two firms. It proposed to make some contributions to the understanding of the mechanisms put in place by organizations having to manage project portfolios while facing constantly changing environments. This provided sufficient material to contribute in at least four areas:

- To provide a better understanding of the management of project portfolios, more specifically of the operational activities involved once portfolio are authorized and launched,
- To analyze the relationships between the sources of uncertainty in dynamic environments and the mechanisms put in place by organizations to minimize their impact and to capitalize on opportunities,
- To develop ways to operationalize the concepts in the dynamic capabilities framework, and
- To suggest improvements to the dynamic capabilities framework.

One of the contributions of this research was to demonstrate that the dynamic capability framework can also be used to analyze operational levels of the organization, in this case to study PPM, as opposed to the strategic level, which is a more traditional field using this framework. The experience gained using dynamic capabilities as a conceptual framework, provides some suggestions for a better understanding of dynamic capabilities for researchers and practitioners. The initial sequence *sensing–seizing–transforming/reconfiguring*, which is the basic model of dynamic capabilities, was used to collect data and to structure the interviews but was enhanced during data analysis in order to capture the reality that was being observed. These theoretical contributions have been published separately.

In recent years, the topic of project selection seems to have dominated the literature on PPM. This includes tools and techniques to rank projects or optimize resource allocation under certain constraints. Although choosing the right projects is of the utmost importance, this research has shown that the ongoing monitoring and controlling of PPM process is also rich as an object of study. One of the objectives of this research was to provide a better understanding of the operational activities involved once portfolio are authorized and launched.

Managers involved in the daily planning and control of project portfolios spend great efforts in maintaining optimal resource allocation and at ensuring that the project efforts are not wasted due to uncertainties. In addition, planning the project scope is a continuous activity involving tremendous efforts and resources. Managing project portfolios involves creating structures, introducing new processes, introducing new business models, which goes beyond project selection. These activities are not static. The environment is often constantly changing and the projects being managed in constant flux and in need of constant oversight, support, and alignment.

As is often the case in this type of research, many additional questions have been raised during the course of this study. Exploratory work, like this one, paves the way for additional research around the following topics:

Third-order dynamic capabilities not covered in study: the study was limited to the first two orders of dynamic capabilities. A broader study might identify higher-order mechanisms which would offer additional insights.

Larger sample and measuring instruments (performance, turbulence): this qualitative study provides data which would benefit from being strengthened through quantitative studies on a larger sample. This could help understand the different types of environments in which project portfolio must be managed, what their sources of uncertainties are and what mechanisms are put in these different environments; questions that this study could not answer. A more quantitative research on portfolios would also require the development of measuring instruments for performance and turbulence.

As can be observed, much remains to be investigated to better understand how to manage in dynamic environments. Considering that “uncertainty appears as the fundamental problem for complex organizations, and coping with uncertainty, as the essence of the administrative process” (Thompson, 1967, p.159), it is hoped that this paper contributes to a better understanding of the topic of *organizing for uncertainty*.

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