New Methodological Approaches To Project Portfolio Management: the Role of Interactions Within Projects And Portfolios

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Abstract

Project Portfolio Management (PPM) has been mainly concerned with aligning projects with corporate strategy, focusing on methodologies for project valuation, selection and ranking. The output of PPM is a collection of selected projects, ranked according to their contribution strategy. On the other side, multi-project management (MPM) is focused on operative issues, like resource allocation, scheduling and risk.

In this paper, we argue that PPM and MPM decisions are closely related, as the decision to include a new project into the portfolio not only depends on its contribution to strategy or financial value, but also on how the candidate project interacts with the existing portfolio in terms of risk, schedule or cash-flow; project value should be computed taking into account the inter-relation with the existing portfolio. Therefore, new methodologies should be developed in order to deal with project-portfolio interactions. In this paper we suggest a research agenda to deal with these interactions and we show the new methodological approaches we are developing within the INSISOC research group. We conclude that the composition of firm portfolio is dramatically changed when taking into account those interactions.

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1. Introduction

Project Portfolio Management (PPM) can be considered as a managerial approach for helping firms to obtain corporate objectives more efficiently. This approach underlies the concept of the firm as a set of projects implementing corporate strategy. And this approach also focuses on the possibility of obtaining higher levels of efficiency by means of a better and more rational allocation of resources; higher than the efficiency obtained when the projects are managed separately.

Therefore, PPM should include alignment and operational processes. The former are related to aligning projects to corporate strategy, so that projects are coherent and implement firm objectives. This includes project valuation, project ranking and selection, portfolio balancing and portfolio risk analysis. The output of these processes is a set of candidate projects to form part of the portfolio, ranked according to its contributions to firm value and strategic objectives.

Operational processes are related to multi-project management, that is, to the coordination of the joint execution of individual projects and therefore, they include project scheduling in multi-project environments, resource allocation among projects, integrated cost management, etc.

PPM literature has been more concerned with strategic issues (alignment processes), whereas operational processes have turned to methodologies from the Operational Research field. Thus, for instance, the Standard for Portfolio Management by the Project Management Institute (PMI, 2006) focuses on alignment and monitoring and controlling processes groups, being out of scope more operational issues.

Furthermore, both kinds of processes have been frequently considered as two independent and separate fields (Pennypacker & Dye, 2002). The set of ranked projects to form part of the portfolio is the output of the alignment processes and also the input of the operational processes.

In this paper, we show that both groups of processes are not independent, as there are interactions between some of the most important project variables like schedule, risk or cash flows. Those interactions change the composition of the “optimal” or most valued portfolio.

Furthermore, the decision to include or not a project in a portfolio not only depends on the financial and strategic value of this particular project, but it also depends on how the new project could fit into the structure of schedules and allocation of resources of previous projects; and it also depends on how the cash flow term structure and capital cost interacts with the cash flow structure and capital cost of the existing portfolio. We also address the interactions between project risks and how it affects to portfolio risk.

In this paper we suggest a new research agenda to cope with those kinds of interactions and we summarize some of the methodologies and results we are obtaining.

This paper is organized in the following way. First we will summarize the role of project portfolio management in relation to project strategy implementations and how it is related to operational multi-project management. Then we explain the importance of the links and interactions between project variables and portfolio variables, emphasizing the cases of risk, cash flows, capital costs and scheduling. We will finish with the main conclusions of our work.

2. Corporate strategy, project portfolio and multi-project environments.

CEOs and top corporate managers are responsible for defining and managing the firm portfolio as they are responsible for the strategy to be defined and implemented. On the other side, more operational issues concerning project management and coordination of multiple projects is carried out by program, project and resource managers, more related to tactical and operational decisions.

2.1. Project Portfolio and Corporate Strategy.

Traditionally, firms implemented corporate strategy by means of splitting the general strategy into functional strategies (marketing, financial strategy, human resources, production, etc.) or into business units strategies. PPM can be considered as a complementary way for translating corporate strategy into a portfolio of projects. This new
approach underlies the role of results (deliverables) and importance (time and cost), therefore it helps top managers to develop a view that links strategy with a closer final picture of the desired results.

PPM is a dynamic and continuous process (see figure 1). Portfolio design starts with the definition of corporate strategy. Firm vision and mission should be consistent with the culture and values of firm owners. After the vision and the mission have been set up, firm environment and corporate internal strengths and weaknesses are analysed, so that strategies and objectives are defined and ranked according to their importance.

![Fig. 1. PPM as a dynamic process.](image-url)

Project identification can be performed top-down (as the last stage of all the strategy development process) or bottom-up (as a result of human resources proposals). Once new projects have been identified, they must be evaluated. Most common evaluation methodologies are check-lists, multi-criteria scoring and mathematical models. Main evaluation criteria are strategy alignment (contribution to organisational goals), financial (ROI, Net Present Value, Pay-back, etc.), technical issues, marketing (market share), etc.

Projects can be prioritized according to the results obtained during the evaluation process, or by means of other methodologies like Multi-attribute Utility Analysis, the Analytical Hierarchical Process (AHP) proposed by Saaty (1980) or Mathematical Programming (see Fernandez Carazo et al. (2008) for a deep description of evaluation and ranking methods). Constraints related to human resources, financial capability, firm assets, etc. should be taken into consideration. Portfolios should be balanced in terms of time (long and short term), kind of project (innovation, R&D, growth, maintenance, etc.).

The purpose of “portfolio monitoring” is to check whether the projects development contributes to the objectives of the firm, so that corrective actions could be taken as soon as overruns take place (e.g. re-scheduling, resource re-allocation, etc.). Project runtime gives important feedback to top managers, so that, strategies and objectives could be changed or enriched.

This process is dynamic, as continually new projects become candidates to belong to the portfolio. Project ranking changes over time, as new projects enter the portfolio and other exit because of underperformance or because of corporate strategy changes. Overruns and priority changes take place in parallel, and as consequence, conflicts among projects emerge, since individual projects compete for the same scarce resources.
2.2. Multi-project management and resource allocation.

Once the candidate projects have been defined and ranked according to their importance, each project has to be scheduled. In practice, projects compete for shared resources, so the literature has been focussed on the resource-constraint multi-project approach. As the underlying scheduling problem is NP-hard, the research has been mainly focused on the development of heuristics for static environments (Anvari-Isacow & Golany, 2003).

Several approaches have been developed in order to model the complexity of real portfolios. For instance, the portfolio can be considered as a macro-project, whose activities are the single projects. Precedence relations between projects could be established, because of technical, strategic or portfolio balancing reasons. Other methodologies are based on steps: In a first stage, resources are assigned to projects according to its strategic importance and, in a second step, each project is scheduled independently (Speranza & Vercelis, 1993). And finally other methodologies are based on heuristics. For a deep review of the literature, see Has et al. (2007) and Herroelen (2005).

But, as explained in figure 1, in practice, project portfolio is not a static process but a dynamic one. Continually, new projects become candidate to be included in the portfolio, as new market, technical or strategic opportunities emerge. Unfortunately, the research in the dynamic scheduling problem has not converged to one solution or scheduling rule robust enough to hold in the general case (Anavi-Isakov and Golany, op.cit.).

In practice, multi-project problems are extremely complex, because of the complex constraints concerning particular projects and the firm as a whole. For instance, although in theory resources could be moved from one project to other to optimise portfolio performance, in practice, human resources cannot be moved without reducing his/her productivity. Kruger & Scholl (2009) propose to include resource-dependent transfer times, which represent the setup activities performed when a resource is removed from one project and reassigned to another (or from one job to another within the same project).

Moreover, within the same portfolio, some projects might be very sensible to the finishing date, where others need intensively a particular resource. Multi-tasking makes people to increase mistakes, and mistakes mean reworking. Individual project delays and over cost are common issues in real projects, because of under-estimation and uncertainty.

For all the reasons explained here, multi-project scheduling and resource allocation problems are difficult to model, and the rigorous solutions from Operational Research have limited utility in real portfolios because, beyond its NP-hard intrinsic nature, it is difficult to formalise mathematically both objective functions and constraints.

3. Links and interactions between project and portfolio variables.

PPM has been more concerned with strategy than with operational issues. As a consequence, there is a gap between project current portfolio literature (involved in the alignment of projects with strategy, project selection and ranking, and project balancing), and project scheduling and resource allocation among projects (multi-project management) on the other. Although the output of the portfolio management is (or should be) the input of multi-project planning, both fields seems to be independent.

In this paper, we argue that they are not independent, because there are forward and backward interrelations between them.

The decision to include a new project within the existing portfolio not only depends on the new project features as strategic alignment, financial value, ROI or risk, but it also depends on how the new project interacts with the existing portfolio and affects some properties of the existing portfolio. In particular, we will concentrate of how the candidate project schedule interacts with the schedules and resources of the projects belonging to the portfolio, and how it affects to other variables as portfolio risk or capital cost. As far as we understand, addressing the role of interactions between projects and its influence in portfolio behavior needs a research agenda.
3.1. Interactions between portfolio and project risks.

Portfolio risk management is concerned with the analysis of events that could affect the objectives of the portfolio as a whole. But if PPM implements corporate strategy, then portfolio risk management should be related to risks affecting directly to variables like return on investment, profits, value, market share, etc. On the other side, project risk management is concerned with events affecting the success of individual projects. Therefore portfolio and individual project risks are related, but as far as we understand, the links between them are not always properly addressed.

When a new project enters into the portfolio, it affects the overall portfolio risk. But the new portfolio whole risk not only depends on the risk of the new project but on how this project interacts with the sources of risk of the existing portfolio. In other words, a project with a particular level of risk, could increase dramatically the risk of a portfolio A, without affecting too much the risk of a portfolio B; even it could be possible that the new project could reduce the portfolio risk. We call this kind of project “hedging projects” as they can reduce the risk of a portfolio at the same time they increase its economic and financial value.

For instance, suppose that a portfolio is very sensible to oil prices or to interest rates. A new project requiring high quantities of raw materials related to oil prices will increase dramatically the (oil-related) risk of the project. Something similar applies to exchange rates, so that we should give preference to new projects whose sensitivity to a currency hedges the exposure of the existing portfolio.

In figure 2, we illustrate this idea. We represent how the value of projects and portfolios change (risk exposure) according a risk variable p (for instance, the price of a raw material or a foreign exchange rate). An existing portfolio (blue line) is very sensitive to increments in the price p. Firm managers are considering to include a new project into de portfolio (red line). In figure 2(a), the new project value is also sensitive to the increments of p, and therefore, the resulting portfolio (green line) has a higher risk exposure to p when the new project in included into the portfolio. However in figure 2(b), we show a case of a project that is also sensible to p, but in this case, in the opposite direction than in the previous case: The value of the project increases when p is higher. As a consequence, the final portfolio is less risk sensitive to p.

Derivative markets (e.g. forward, futures and options markets) might help portfolio managers to hedge the portfolio against some row material prices, foreign exchange rates o interest rates. Buy anyway, when we add hedging projects to the previous portfolio, we are also increasing the value of the portfolio (whenever the individual project net value is positive).

![Figure 2. Risk exposure to a variable p. (a). Higher risk (b). Hedging project.](image)

3.2. Interactions related to cash flow and capital cost.

From the financial point of view, a project can be modeled as a term structure of cash in-flows and cash out-flows. Usually, during project lifecycle (project runtime), the project demands cash all the time periods. After the
In a portfolio, there are different interactions among the cash flows of the projects belonging to the portfolio. First, a new project cash-flow demands could overload the current financial needs of the existing portfolio while other candidate project could contribute to finance it. Second, the interactions among the term structure of the cash flows of the projects belonging to the portfolio can change the capital cost and therefore the total value of the portfolio. This is particularly important when there are strong capital limitations.

Beyond the application of the traditional cash flow discount valuation methods for single projects, new methodologies should be developed in order to cope with the role of interactions and capital cost.

In Hernandez et al. (2011) we show how the optimal project to be included in an existing portfolio is not necessarily the project with the highest present value. The interactions between cash flow structure and the project capital cost can affect dramatically the value and capital cost of the final portfolio. We introduce a new metric, the project value to portfolio value (PV2PV) to assess the added value of a new project to the value of the firm’s actual portfolio of projects.

In order to compute the impact of the new project in the portfolio value, we update the value of the capital cost for every term within the portfolio evaluation period. Then we compute the total capital cost (after taxes) and we use this capital cost value to discount the expected value added flows (free cash flow less financial expenses). Although essentially the methodology is based on the traditional financial discount methods, it highlights the role of the interactions between project and portfolio cash flows and capital costs, so that we can compute how a new project contributes to the value of an existing portfolio.

3.3. Interactions related to scheduling and resource allocation in multi-project environments

Firms usually have a limited amount of resources (assets, human resources, machines, etc.). Therefore, when a new project is included within a portfolio, the schedule and the resources needed by this project interact with the schedules and resources previously allocated to the existing portfolio. Other factors equal, a strongly ranked project during the portfolio evaluation phase could affect negatively the schedules and resource availability of the whole portfolio, whereas another project, maybe with less priority, could complement the portfolio resources structure in periods of low resource usage. For this reason, the priority of a project should depend not only on its strategy alignment or financial properties, but also on how its schedule interacts with the resource allocation of the existing portfolio. Again new methodological approaches are needed, in order to face the interactions between resources and project single schedules.

Building frameworks integrating portfolio strategy and multi-project allocation decisions are still an open promising research area. Ghasemzadeh et al. (1999) propose and a zero-one integer linear programming model for selecting and scheduling an optimal project portfolio, based on the organization’s objectives and constraints such as resource limitations and interdependence among projects.

However, in practice, mathematical and heuristic models exhibit limited usefulness because of uncertainty, project over-costs and delays, and the intrinsic dynamic nature of the portfolio processes. For this reason, we advocate for distributed approaches, in order to include real portfolio complexity.

One way to face with this complexity is by means of muti-agent systems. Indeed, we know that some complex socio-economic problems are solved by means of distributed procedures, like markets or auctions (Hernández et al. 2008). The distributed approach has been proposed for project scheduling by Kobacey et al. (1996) and Yan et al. 1998). More recently, Kumara et al. (2002) and Lee et al. (2003) have proposed a multi-agent dynamic resource scheduling in multi-project environments and Confesore et at. (2007) use a combinational auction as a coordination mechanism.

In Arauzo et al. (2010), a muti-agent approach for dynamic scheduling and resource allocations is proposed. By means of a distributed structure, the model integrates strategic and scheduling issues within the same framework. Project priority is updated depending on how new projects interact with the existing portfolio. The process of allocating resources to projects and to project activities is modeled by means of an auction.
Agents in the model are projects and resources. Projects have scheduled work to be done by different resources. Resources are endowed with some capabilities (knowledge, work force, etc.) that are needed to do the work. Projects demand resources over time and resources offer their capabilities and time availability. There is an auction process, and the price of resource-time slots emerges endogenously as a result of supply and demand.

Our approach helps us to address some of the problems faced in multi-project environments: Dynamic allocation of resources, the role of capabilities, flexibility, portfolio decisions, etc. And it opens a research agenda to explore more complex environments.

4. Conclusions.

In this paper we show that the interactions between individual project variables can affect dramatically the composition of a portfolio, beyond its strategic and financial objectives. Traditional project portfolio methodologies do not cope with the role of interactions, as they are based on the assumption that portfolio strategic and financial value can be computed as the sum of the values of individual projects.

As far as we understand, this assumption is very strong, because the influence of interactions is generally very important in real portfolios.

Therefore, new methodological approaches should be developed in order to cope with the role of interactions. In this paper we have summarized the research done in relation with the interactions affecting risk, capital cost, cash flows, scheduling and resource allocation. Of course, the research remains currently in its initial phases and should be improved, at least, in two different directions: The study of other interactions and the improvement of the initial methodological approaches.

The new methodologies will contribute to fill the gap between the strategic point of view of project portfolio managers and the more operational (and day-to-day) view of project managers.

The role of interactions (correlation) between assets in a financial portfolio has been widely addressed in the financial literature since Markowitz (1952) and, Sharpe (1964). It is up to time to export some of those ideas from finance to real projects!

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