

NEW METHODOLOGIES FOR INTEGRATED PROJECT SELECTION AND PROGRAMMING IN PROJECT PORTFOLIO MANAGEMENT

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Abstract

Project Portfolio Management is involved in selecting the “right projects to do”, so that the firm could achieve its financial and strategic objectives. To this aim, several methodologies have been developed (usually related to financial valuation) in order to find out the projects to be included in the portfolio, and how to build a hierarchy of them, according to their contribution to corporate objectives. Once the projects have been selected and ranked, projects must be scheduled and resources must be allocated (doing projects right).

In this paper we show that project selection and scheduling are not independent processes, as 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, resources, risk, cost, etc. of previous projects. For instance, a lower valued project could be funded instead of a better valued one, whenever it affects negatively the properties of the existing portfolio.

We show several examples, and we propose some ways to measure these facts. We suggest new methodologies for jointly selection and scheduling, in order to achieve appropriate solutions. Abstracts Book.

Keywords: *Project Portfolio Management, Project Management, Strategy and Resource Allocation.*

Resumen

El objetivo de la Gestión de Carteras de Proyectos (Project Portfolio Management) es determinar qué proyectos debe acometer la empresa para poder conseguir sus objetivos financieros y estratégicos. A tal fin, existen diversas metodologías de selección de proyectos (inspiradas fundamentalmente en la valoración financiera) que permiten obtener la composición adecuada de la cartera, así como la ordenación jerárquica de los proyectos según su contribución a los objetivos corporativos. Conocidos estos, se procede a la programación coordinada de los proyectos, asignando recursos y obteniendo sinergias.

En este artículo mostramos que los procesos de selección y programación no son independientes, pues la decisión de incluir un proyecto en la cartera no sólo depende de las características intrínsecas de dicho proyecto, sino también, de cómo este

interacciona con las características de riesgo, programación, coste, etc. de la cartera ya existente. En otras palabras, podría ocurrir que un proyecto con peor valoración financiera debiese entrar en la cartera en lugar de uno mejor valorado, pero que afectase negativamente a los ya existentes, en términos de riesgo, programación o coste del capital.

Mostramos distintos casos, proponiendo formas de medir estos efectos; sugerimos nuevas metodologías conjuntas de selección/programación que proporcionen soluciones satisfactorias ante estas situaciones.

Palabras clave: *F Gestión de carteras de proyectos, dirección de proyectos, estrategia y asignación de recursos.*

1. Introducción

Most of the literature in Project Management is concerned with managing individual projects. But in practice, firms must decide the set of projects to be done in order to maximize the firm value and to align the projects with corporate strategy, so that firm objective are achieved. Therefore, the field of Portfolio Project Management is involved in developing methodologies for valuing projects, selecting the best ones, balancing the portfolio in terms of risk, cost, etc, and coordinating the joint execution of individual projects, so that the set of limited resources is efficiently allocated among the most important projects. The output of this process is a set of projects to be done, ranked in terms of strategic and financial importance to the firm.

On the other side, multi-project management research has been related to project portfolio scheduling and resource allocation. The rank of accepted projects is the input to this process (output of the portfolio management process), whereas the schedules of all the individual projects become the output; operations research methodologies have played an important role to this aim.

In this paper, we show that both processes are not independent, as there are forward and backward feedbacks between scheduling and portfolio value. Project importance should be taken into account when resources are allocated among projects and schedules are determined, so that most important projects received more resources.

But whenever a new project becomes a candidate form part of the portfolio, the value of the portfolio itself might be affected by the interactions among project and portfolio schedules. In other words, that 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 resources allocation of previous projects. Moreover, we also argue that not only schedules should be taken into account, as the new project also could affect to other portfolio variables, as risk, capital cost, strategy goals, etc. We show some examples and we will propose some solutions to overcome these problems.

This paper is organised in the following way. First we will summarise the role of project portfolio management and how project strategy can be implemented by means of a

balanced portfolio of projects. We will also explain the contributions about multi-project scheduling under resource constraints. Then we will argue the reasons why portfolio decisions cannot be managed without realising that the value of the portfolio can be affected, not only by the value of the new project itself, but by its relations with scheduling, cost, strategy, etc. of existing projects. We will discuss some problems suggesting some solutions. We will finish with the main conclusions of our work.

2. The gap between project portfolio and multi-project management.

Following Payne (1995), up to 90 % of the projects are carried out in a multi-project context. However, project management and operations research literature have focussed in two separated fields: project portfolio management and multi-project management (Pennypacker & Dye, 2002). The former is mainly concerned with portfolio valuation and project selection, assuring that selected projects will be aligned to corporate strategy, increasing the firm value (Kendall & Rollins, 2003). Multi-project management faces problems related portfolio scheduling under resource allocation constraints, so that coordination among projects could be carried out efficiently. (Pennypacker & Dye, *op.cit.*).

CEOs and top corporate managers are responsible for defining and managing the firm portfolio, whereas multi-project management is carried out by project and resource managers, more related to tactical and operational decisions. Project management literature explains “how to do projects right”, whereas portfolio project management suggest “how to do the right projects”.

2.1 Estilos

Following PMI(2008) a portfolio is “*a collection of projects (temporary endeavours undertaken to create a unique product, service, or result) and/or programs and other work that are grouped together to facilitate the effective management of that work to meet strategic business objectives*”. Projects included in the portfolio should aligned to corporate strategy, so that firms could achieve their objectives.

Corporate portfolio may include both external (a client outside the firm) and internal projects (within the corporation). Internal projects may have different purposes: new product development, maintenance (e.g. updating information systems) or growth oriented, in order to increase the competitive position of the firm (e.g. opening overseas markets).

Project portfolio management is a dynamic and continuous process (see figure 1). Portfolio definition starts with the definition of corporate strategy. Firm culture, vision and mission suggest what projects should be rejected and what projects could became a candidate to form part of the portfolio. After the vision and the mission have been set up, firm environment and firm internal strengths and weaknesses are analysed, so that strategies and objectives are defined and ranked according to their importance. Strategies are implemented by means of firm “line operations” and by means of the project portfolio.

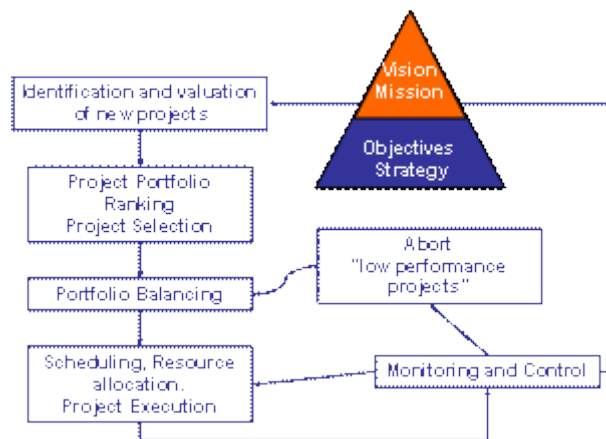


Figure 1. Project Portfolio Management dynamic process.

Once new projects have been identified, project evaluation takes place. 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 by means of the results from 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 Fernández 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 must be balanced. For instance, it makes not sense to have many short term projects and a small number of longer term ones; a balanced portfolio combines projects with different levels of risk, and it is necessary to have balance among projects related to R&D, growth, maintenance, etc.; it makes no sense to concentrate all our resources in projects related to one particular corporate objective, forgetting the others.

The purpose of “portfolio monitoring” is to check whether the projects execution contributes to the objectives of the firm, so that corrective actions could be done as soon as overruns take place (e.g. project abortion, re-scheduling, resource re-allocation, etc.). Projects execution gives important feedback to the 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 Managing multi-project environments.

Once the candidate projects have been defined and ranked according to their importance, each project has to be scheduled, computing starting and finishing dates of each activity. In practice, projects compete for the same 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).

In some approaches, the portfolio is considered a macro-project, whose activities are the single projects. Precedence relations between projects could be established, because of technical, strategic or portfolio balancing reasons. On the other side, we can find hierarchical approaches where in a first stage, resources are assigned to projects and then, each project is scheduled independently (see Speranza & Vercelis, 1993). For a deep review of the literature, see Has et al. (2007) and Herroelen (2005).

But, as suggested 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 re-working. 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.

Critical Chain methodology can also be used for multi-project scheduling. This methodology applies Goldratt's (1997) Theory of Constraints (TOC) to project scheduling under resources constraints. Cohen et al. (2004) study the application of the methodology to multi-project environments and Steyn (2002) suggest further applications in project management. Herroelen & Leus (2001) discuss about the merits and pitfalls of the methodology, arguing that the proposed rule for buffer sizing may lead to a serious overestimation of the required buffer protection. Anyway, the

methodology is becoming popular for managing multi-project environments, as it offers satisfying solutions in real problems. It has been also suggested by authors like Kendal & Rollins (2003) or Levine (2005), some of them close involved in portfolio management practice and consulting.

3. Filling the gap. Risk, capital cost and schedule.

As far as we understand, there is a gap between project portfolio methodologies, involved in the alignment of projects with strategy, project selection and ranking, and project balancing on one side, 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. As far as we understand, they are not independent, because there are forward and backward interrelations.

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 with 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. We will discuss some of these issues, stressing the problems and possible solutions. Anyway, we understand that bridging the gap might be the beginning of complete research program..

3.1 Portfolio risk.

As it is suggested in PMI (2008) portfolio managers should balance their portfolios including projects with different risk levels. When a new project enters into the portfolio, it affects the overall portfolio risk. We emphasise here that the new portfolio 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 (hedging project).

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.

If the aggregate portfolio cash flow structure depends on financing, a new project demanding high financial resources during all the stages of its life cycle will increase the interest-rate related risk of the whole portfolio. On the other hand, a project less capital intensive, could be more interesting.

In some cases, derivative markets (e.g. forward, futures and options markets) might help portfolio managers to hedge the portfolio against some raw material prices, foreign exchange rates or interest rates.

Financial portfolio theory shows us to diversify investments in order to reduce risk. Similarly, portfolio managers should monitor project portfolio risk and exposure to certain variables, so that they take into account these issues when deciding to undertake new projects.

3.2 Portfolio capital cost.

When a new project is included in the portfolio, new financial resources are needed. But usually, firms do not change their financial structure of equity and debt (except in the case of Project Finance, where debt is paid only with the cash in-flows generated by the project). As the portfolio risk changes, equity cost changes, and so it does capital cost. Again, the new project could affect overall portfolio capital cost.

As explained in previous section, the new project cash in-flow and out-flow structure also interacts with the existing portfolio structure; therefore, the decision to include the project in the portfolio should depend on this interaction. This is specially important in times of high interest rate levels. In some cases, short term projects with early positive cash-flows could finance the remaining portfolio.

3.3 Schedule interaction.

Firms usually have a limited amount of resources (asset, human resources, machines, etc.). Therefore, when a new project is included within a portfolio, the schedule and resource demanded by this project interacts 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 of financial properties, but on how its schedule interacts with the resource allocation of the existing portfolio.

It is clear that strategy alignment and project value should play an important role in scheduling and resource allocation rules. This means that, in case of conflicts, high priority projects should receive more resources, even at the expense of other low ranked projects. Therefore, multi-project methodologies should take into account portfolio priorities, but it is also true that multi-project scheduling issues also affect project priority.

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 organisation'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.

One way to face with this complexity is by means of distributed approaches, as multi-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 Kobbacy 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 al. (2007) use a combinational auction as a coordination mechanism.

In Arauzo et al. (2008), a multi-agent approach for dynamic scheduling and resource allocations is proposed. By means of a distributed structure, the model integrates strategic and scheduling issue within the same framework. Project priority is updated depending on how new projects interact with the existing portfolio.

Agents in the model are projects and resources (see figure 2.). 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 slot emerges endogenously as a result of supply and demand.

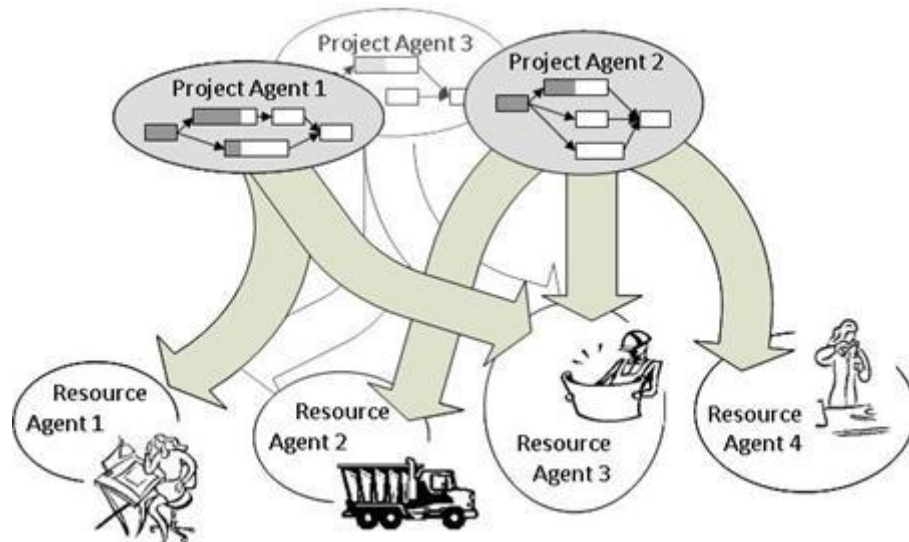


Figure 2. A multi-agent approach for multi-project dynamic scheduling and resource allocation.

Our approach helps us to address with 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.

3. Conclusions.

Usually, firms implement their organisational strategy splitting it into functional strategic plans, like marketing plan, financial, operations, etc. But there is a different way, which is becoming specially interesting for project oriented firms: translating corporate strategy into a portfolio of projects. Under this framework, top manager are encouraged to think in terms of results and deliverables (what to do), priorities (what is important and how much many I am going to provide), and time (when).

Therefore, the interest for project portfolio management has been increasing during the last years. But the researchers and professionals have focussed on two different issues: project portfolio, engaged in portfolio selection and raking on one side; project scheduling and resource allocation on the other. In this paper, we suggest that the gap has to be bridged, as the decision to include a new project in the portfolio not only depends on the properties of the new project, but on the interaction of the new project with the risk, capital costs, schedules, resources, etc. of the existing portfolio.

Bridging the gap is quite difficult, as some of the solutions from operations research have limited utility, because the complexity increases when both banks are included, and real constraints are difficult to translate into mathematical equations.

We suggest that distributed frameworks, as multi-agent systems could help us to get satisfying solutions to real project portfolio problems. As far as we understand, bridging the gap between strategy and project scheduling might be a promising research program.

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