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A risk oriented model to assess strategic decisions in new product development projects

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ABSTRACT

The project management team has to respect contractual commitments, in terms of deadlines and budgets, that are often two antagonistic objectives. At the same time, the market becomes more and more demanding as far as costs and delays are concerned while expecting a high quality level. Then, the project management team has to continuously consider novelty and a risk management strategy in order to determine the best balance between benefits and risks. Based on the principles of a synchronized process between risk management and project management, and on the concepts of risk scenario, we propose a decision-making tool to help the project manager choose the best way to improve project success rate while controlling the level of risks. As a finding, the project manager would be able to evaluate and compare different novelties or development strategies taking into account their repercussions on potential risks and risk treatment strategies. Finally, a case study in the aerospace industry and specifically on satellite integration and tests is developed to validate this approach.

1. Introduction

In the current context of market globalization, and in order to increase their competitiveness, companies have to offer innovative products. They also have to change their ways of production to improve their profitability and reactivity. More and more companies use project management tools and methods for managing their innovations, to ensure a better product quality, better deadlines and lower costs. In this context, particular attention is paid to project management methods by decision-makers and academics.

Every project type faces risks, whatever the size or topic concerned. Several characteristics of the project such as the innovation level, high constraints, multinational and political stakeholders, changing environment,… can increase the project risk level. Therefore, the project manager must find a compromise to make sure the novelty rate achievable. To reduce the level of risk, the resources used must then be adequate to the ambition. Professional organizations as well as standard bodies have produced guides and books on project management and good practice for several years [15,16,29]. These reference framework documents present the process required for management. Turner [31] proposes a review of progress on the global project management body of knowledge. He states that, even if the internal breakdowns may not be always appropriate, the guide to the PMBoK contains the core elements used by all project managers. The following dimensions are systematically mentioned in the reference framework documents: integration, scope, time, cost, quality, human resources, communication, risk and procurement management.

In the context of a project, and especially in a competitive market, the manager has to continually change his response to risks in order to increase the success rate. He has to take into consideration the set of potential risks before the launching of the project, as well as when running the project. The manager has to evaluate different developments of the project when choosing between exclusive technological novelties for a product. The risk treatment strategy must take into account the repercussion of the novelty on the set of potential risks, to keep the project on budget and on time. Therefore risks have to be correctly evaluated and the strategies correctly chosen to obtain a realistic estimate (cost/duration) of the project.

This paper is specifically interested in approaches that take risks into account in managing projects. These approaches aim to anticipate potential phenomena and to measure their possible consequences on the project life or objectives. In the case when the objectives seem to be reachable, the manager pilots the project by selecting the appropriate risk treatment strategies. If the objectives are not reachable, the approach helps identify the elements of the target that have to be renegotiated (cost, time or technical specification).

In the first section, we present a literature survey on risk management methodologies, which shows the diversity of the existing approaches; some are dedicated to specific domains while others are generic. We illustrate the evaluation problem of the influence of risk on project schedule. In the second section we describe our methodology, that deals with the difficulty of choosing development strategies and/or treatment

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strategies in a technological innovation context facing potential risks. Finally a case study from the aerospace industry is detailed, we discuss the results obtained and present our conclusions to this research work.

2. Literature

2.1. Dealing with project risk management

In the literature, the risk management methodologies refer to a standard process presenting the well-known steps: risk identification, risk evaluation and quantification, risk mitigation for treatment and/or impact minimization and risk monitoring [1,8,17,29]. Tixier et al. [30] propose a classification of 62 existing approaches. They sort methods as being deterministic and/or probabilistic, but also qualitative or quantitative.

In a project context corresponding to this work, a risk occurrence may introduce in a project: (1) the modification of existing tasks related to the risk influence on duration or cost and (2) the modification of the project structure by treatment strategies (treatment actions are represented by new tasks in the planning). This therefore impacts project planning: cost and duration. The specificities of the project context are: the notion of uniqueness (there is no recurrence in the projects), the notion of limited horizon (there are different milestones and contractual commitments), and the notion of a multi-expertise environment (numerous actors with different skills, perceptions and points of view working together). Uniqueness leads to use methods, such as the brainstorming, that are based on the expertise (very limited returns of experience and very few databases are available). The fact that time is limited forces the use of simple methods. Finally, the high number of actors implies that the model must share the information and help obtain a consensus.

Several academic research works propose methods to complement the different phases of the previously presented global approaches, such as the optimization of different criteria during the schedule or after the identification phase. As an example, Kiliç et al. [19] propose an approach to solve a bi-objective optimization problem where the makespan (or project duration) and the total cost both have to be minimized. Different preventive strategies are possible for each risk and a multi-objective genetic algorithm is used to generate a set of pareto optimal solutions. Van de Vonder et al. [32] are interested in generating robust projects by inserting buffers in the project schedule. Using heuristics, their approach aims to minimize project duration and maximize project robustness, which are antagonistic objectives. Depending on the project characteristics, this strategy can be an interesting way to increase solution stability.

In parallel to these global approaches, several authors propose methodologies to manage the risk in projects. Gourc [14] proposes a reading grid of the risk management approaches following two families: the symptomatic approach and the analytic approach. The first group of approach, called risk-uncertainty, is associated with approaches where project risk management is transformed into project uncertainty management [33]. The second approach family considers risk as an event that can affect the achievement of the project objectives [3]. According to ISO-Guide73 [18], "Risk can be defined as the combination of the probability of an event and its consequences". Risk is described as an event, which has occurrence characteristics (potentiality to occur) and consequence characteristics on the project objectives (impact in the event of occurrence). Nguyen et al. [25] propose ProRisk, which can model and evaluate the impact of risks on the project cost and the schedule cost. They define the concepts of risk scenario, treatment scenario and project scenario. This project management approach uses synchronized processes of project schedule and risk management [28]. Fang and Marle [12] proposed a simulation-based model to evaluate risks and then to support project managers in making decisions regarding risk response actions. The model integrates the risks and their interactions. The risk interactions are represented by a risk structured matrix [21]. This allows the risk network structure to be described. On that basis the decision maker can be supported in selecting an optimal risk treatment plan considering interactions between risks [13]. They investigate the difficulty of choosing which action should be carried out to deal with the risk, where there is a known budget constraint. Thus, we notice that these models lead to choices being made. Consequently, the whole decision problem becomes an issue.

2.2. The decision process in project risk management

Risks are intrinsic in new product development (NPD) in all industries [20]. Thus firms need to take initiatives to reduce risks that are related with NPD. The risk management framework should integrate the three most important risk factors that affect NPD performance: technology, marketing, and organization [11]. However, in such an innovation context, it remains difficult to acquire knowledge about the sources of uncertainty to decide the way of reducing the risk of failure of the project or resulting product and manage efficiently NPD risk [7]. In NPD management, decision-makers have to choose exclusively one orientation as a strategy development according to a global risk level tolerance. As an answer, decision trees (DTs) are regularly used in the literature on decision [5]. DT is a structure that represents decision problems with exclusive and competing solutions. It enables optimal solution to short time dynamic decision problems [6]. Dey [10] illustrates the use of DT to choose strategies of risk mitigation using the expected monetary values (EMVs). Based on decision variables, decision trees help choosing one way and to react accordingly in front of an event. It's dynamic from the left to the right knowing that decision has already been taken, but being able to imagine new ones. New evaluations are possible during the project development and future decisions can differ from the initially planned ones. In the backward induction, the plan is done ahead but studied consequences backward from the possible future end nodes to the imminent decision [9].

Many companies use project in order to develop innovative products. Even if projects are characterized by uniqueness, the expertise provides familiarity with practices. To increase the efficiency of innovative projects, two main ways are possible: modifying the product, modifying the project structures and then practices. Both these perspectives lead to modifications of the risk level and it is difficult to evaluate the balance between risks and benefits. If the first way requires specific and technical skills to reduce for example conception risks, there is no tool helping the project manager evaluate the project risk level when integrating the studied variants of the project and its consequences on (1) the planning of the project, (2) the risks and its associated treatment strategies.

As shown in this literature review, little account is taken of risk and the strategies to deal with it regarding their repercussions on planning. The ability to present the project manager with a range of alternative risk treatments in a risky situation, and the further ability to provide information on the consequences on decision criteria such as project cost and duration should improve the decision-making process. Therefore, there is a need of methodological tools to help measure the repercussion on the risk level of modification on the project structure. In this research work, we make the link between project planning, project management and risk management. To our knowledge, only a few methods can. They mainly apply risk management to an object, but the repercussions on planning are rarely modeled.

By taking into account the fact that well-managed technology risk leads to better NPD performance [22], our objective is to propose a complete framework helping decision-makers to decide novelty and risk prevention strategy. This tool should facilitate the decision-making process by making the link between project management and risk management and by analyzing the consequences of a risk "as an event" in a project. It should permit the evaluation of consequences of the changes in practices on project management, particularly on the deadline and cost dimensions. In addition, this environment will be

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