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An integrated management approach of the project and project risks

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Abstract: Risk is an inherent property of every project. In many cases, project management and risk management are applied quite independently. The traditional tools of project management do not include the notion of risk and the tools of risk management focus on the representation of risks without explicitly representing the project, which leads to implement the risk management process independently of the project management process. This paper demonstrates the need to develop an integrated approach to project risk management and presents our approach which is able to represent the risks, but also the project, its components and its environment.

Keywords: Risk, Project management, Model, Innovation and System concepts.

1. INTRODUCTION

In the current context of market globalization, and in order to increase their competitiveness, companies have to offer innovative products. In this context, a particular attention is paid to project management tools and methods. Moreover, more and more companies use those tools and methods to manage their innovations and so to ensure a better product quality, better deadlines and lower cost (Marmier et *al.*, 2013). Every project, innovative or not, is subject to numerous risks. Being able to control them is a crucial issue in project management. Companies will need project management tools, especially if they develop innovative products. Thus, many tools and methods of risk management have been developed (Taillandier et *al*., 2011). A recurring weakness of these methods is that they do not represent the project and its environment, and therefore treat the risk in isolation, independently of other processes of project management (Neiger et *al*., 2006). However, there is no risk-free project. In the context of a project, and especially in an innovative and competitive market, project managers have to evaluate different developments (scenarios) of the project, paying attention to the set of potential risks. Risks being generated by the project and affecting it, it is necessary to take into account the interaction between the project management and the risks. Projects are facing a growing complexity. Indeed, project managers have to consider many and various parameters, which are strongly interrelated, inside and outside the project. This complexity leads to complex risk interactions and so to a decrease in the performance of conventional risk management tools (Marle, 2014).

An improvement track is the simultaneous representation in a common framework of the project in its environment and of risks, able to translate the richness and the complexity of the interactions between processes. Moreover, to comprehensively understand a risk, it is helpful to identify its cause as well as its consequence, and specially its interaction with other risks in the project. These observations motivate the research on methods of modelling risk project (Zur Muehlen and Rosemann, 2005).

This paper presents an integrated management approach of the project and project risks. Such an approach aims at anticipating potential events and at measuring their possible consequences on the project life and on the achievement of the project objectives.

The following section introduces the risk management and the project management, explores the existing tools and methods, and presents the need to establish a method of integrated management of risk project. Section 3 presents our model of project risk management, then section 4 shows a project case study in which academic researchers and an industrial company work with the aim of a better management of risks in project.

2. DEALING WITH PROJECT RISK MANAGEMENT

2.1 Risk management and Project management

A project is “a unique process, which consists of a set of coordinated and controlled activities with start dates and end dates, undertaken to achieve an objective conforming to specific requirements such as time, cost and resources constraints.” (ISO 10006, 2003).

If the project is a unique process, the views on the project may be multiple. The ultimate goal is to control the project complexity and to anticipate the behaviour to adopt and the actions to perform (Marle, 2002). This point is addressed by the systemic vision of the project. The project is then viewed as a set of interacting elements. It should be addressed by an external view which describes the environment with which it interacts, and an internal view that can show the components of the system (Sperandio, 2005). The analysis of the notion

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of project has led us to retain a set of eight concepts to describe it. Indeed, a project responds to the objectives by the realization of deliverables and achieving results. These results are obtained by performing activities supported by resources. It needs to make decisions in an uncertain and changing environment. Projects are becoming increasingly multi-company and multi-site, thus requiring an exchange of information between many actors with different interests.

Project management has many tools and methods to guide management toward achieving project objectives. Generally, these tools are based on a chronological and hierarchical description. However these methods of description neglect project complexity. Indeed, the problem is to highlight certain components of the project, making visible information that are not formalized on conventional tools (information relates to the component, as well as the interactions it has with others). The only interactions considered are hierarchical membership and sequential order, while other links (as for instance those between stakeholders and resources) are not formalized (Marle, 2002). Furthermore, the current project management tools insist on the description and optimization of a project situation fully known and controlled, ignoring the notion of uncertainty and therefore risk.

The concept of risk is highly polysemous and supports a large number of definitions (Breysse, 2009). In agreement with ISO / FDIS 31000 which is the reference for risk management, we define it as being the “effect of uncertainty on objectives” (ISO 31000, 2009). In the context of project management, project risk is related to the occurrence of events, from internal or external origin, which may affect the achievement of the initial target. Referring to ISO 31000 standard, risk qualifies the effect of these events on the achievement of project objectives. The anticipation of these events via the identification of internal or external factors which are the basic cause of risk, the evaluation of their impact on the project progress and the proposal of appropriate treatment actions are the purpose of risk management, whose different steps are described by the ISO 31000 standard. The deployment of this risk management process requires the handling of various tools available in the literature. After analysis of relevant literature and common practice, it is possible to consider that:

(1) The majority of tools used in the context of risk management is not applicable to the whole process of risk management (Breysse, 2013).

(2) The relevant methods for the identification, analysis, evaluation and treatment of risks, such as brainstorming, are unstructured, only handle qualitative information and are limited by users’ experience (Grimaldi et al., 2012).

(3) Risk is usually addressed independently of the project and its environment.

2.2 Integrated management of project risk

According to the previous section, it is possible to highlight the shortcomings of the methods of project management on the one hand and of the methods of risk management on the other. The most important pitfall is the fact that risk management and project management are carried out independently, thus preventing the integrated management of risk project.

Some tools for integrated management of project risk have been developed. They are typically based on a temporal representation of the project (PERT, Gantt) and therefore of risks. The project, limited in time, is broken down into activities associated with risks. These risks result in terms of additional lead time and cost overruns. These tools also make it possible to increase the resources allocated to an activity and by the way, to reduce its duration. We can mention in particular CVEP procedure established by WSDOT (Parker and Reily, 2009). The major drawback of this temporal representation is that the risks are related to activities and resources, while practice shows that risks are related to all components of the project (Rodney et al, 2014). Thus, these tools do not allow to integrate all aspects of risk and even less all project components. Our proposal is to develop a method of risk project management which must be applicable to the entire process of risk management, with a multi-view representation in order to consider all aspects of the project, with dynamic aspects to include the evolution of the project which is by no means frozen in time and finally multi-scale, to allow to adapt the level of detail desired.

3. PROPOSAL OF AN INTEGRATED METHOD OF PROJECT RISK MANAGEMENT

The model is based on the following main hypotheses: (1) the risk integration to the project management takes into account the deadlines, the quality and the cost criteria and (2) the project implementation depends on the user requirements and objectives. At any time, the objectives of the model implementation are to analyse the possible scenarios (must cover all considered risk factors and risk events in a given project), to evaluate the global risk level and to select the best treatment strategies.

The method involves the following phases:

(1) Definition of user requirements objectives.

(2) Modelling of the project.

(3) Identification of all risk factors and risk events. This identification is based on the literature and on the analysis of the project model.

(4) Generation of different possible scenarios of the project.

(5) Simulation of these scenarios considering potential risks.

(6) Estimation of the project cost, duration, quality and risk level.

3.1Model description: the modelling framework

A modelling framework describes the relative positioning in the model, and the dynamics of transition along three dimensions: the views, the instantiation and the life cycle (Fathallah, 2011). This framework inspired by the GERAM framework (IFAC–IFIP Task Force, 1999) is presented in Figure 1.

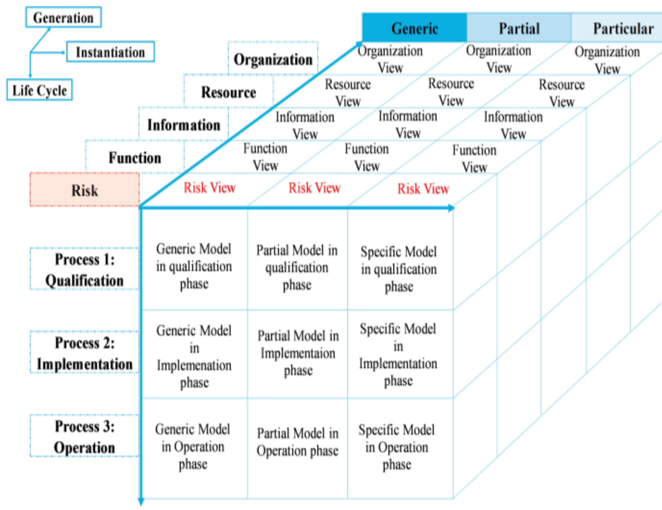

Fig. 1. The modelling framework

(1) The generation axis defines the modelling views (function, organization, resources, information and risk). These different views allow to have access to the model by focusing on some aspects. A modelling view point is a specific perception which underlines some aspects and makes the others transparent. It is thus a particular prospect to represent, then to observe a same project with the help of the model.

(2) The derivation axis identifies the stage of the project life cycle.

(3) The genericity axis permits to distinguish the range of applicability. It is made up of three levels: the generic level applicable to all types of projects, the partial level applicable to a particular field (typically construction projects), and finally the specific level corresponding to specialized model devoted to a particular project (the project case study presented below).

3.2Model description: the modelling views of the project

The stake is double: (1) to propose compatible different views of the project, (2) to add a risk view compatible with each of the above views. These views describe the concepts (entities) used, their properties and connections (Fathallah, 2011). They has to allow the description of the interactions among the components of the project, as well as the interactions between the latter and the risk in terms of causes and consequences. We have made the choice of using standards ISO 31000 (2009) and ISO 19440 (2004). In fact the latter defines a set of concepts allowing the process modelling. Added to this point, four different project views are considered, each of them taking into account different aspects of the project. The *function view* describes the processes and their structure. It represents a set of processes broken down into activities, and undertaken to get a result aiming at a desired objective. The execution responsibility of all or part of the activities by an actor corresponds to an operational role. The development of the process is backed up by a set of resources and conditioned by the occurrence of triggering events, of internal or external origin. The *resources view* (cf. Figure 2) represents the human and technical resources used throughout the different project activities. It concerns the set of necessary means to carry out the transformation of raw materials and components into finished products.

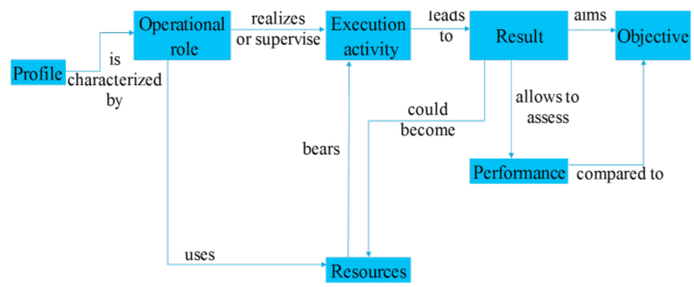

Fig. 2. The resources view

The *organization view* represents the different actors, as well as their responsibilities and individual or collective abilities. The different organizational units are made up of some profiles, each of them having an organizational role expressing their responsibilities and their authority, and an operational role corresponding to their experience as well as their abilities. It is noted that the view organization highlights the concept of decision, by an organizational role, with a set of information, selection criteria and a decision given power.

Finally, the *information view* represents all the necessary data and information to complete a given activity.

3.3Model description: the entities of the project

The model is composed of sixteen entities: Process, Event (process), Event (Activity), Activity (execution), Activity (decision), Result (process), Result (activity), Objective (process), Objective (activity), Performance (process), Performance (activity), Operational role, organizational role, Profile, Organizational unit and Resources. These entities were selected for their ability to take into account all the aspects of project and to allow a simulation of the project in a realistic way. In each view (Function, Organization, Information and Resources), only some entities are visible. All links between entities are visible in at least one view. All the entities are characterized by a set of attributes taking different values at time of the project. For example, the entity Resources is considered among others in the information and the resources view. The difference is that a resource belonging to the resource view is just a reusable resource, namely human resource or production equipment, or consumable resource as raw material. However, in the information view, a resource is immaterial. Another major difference is that the resources view is relative to execution activities contrary to the information view that considers both, the decisions and execution activities.

3.4Model description: the risk view

Risk is directly related to links between entities.

All attributes of an entity (entity known as source) as “risk factors” which may, in some conditions (change of value), induce “risk events”. These risk events will result in change(s) of one or several values of some attributes of impacted entities (entity known as target) (cf. Figure 3).

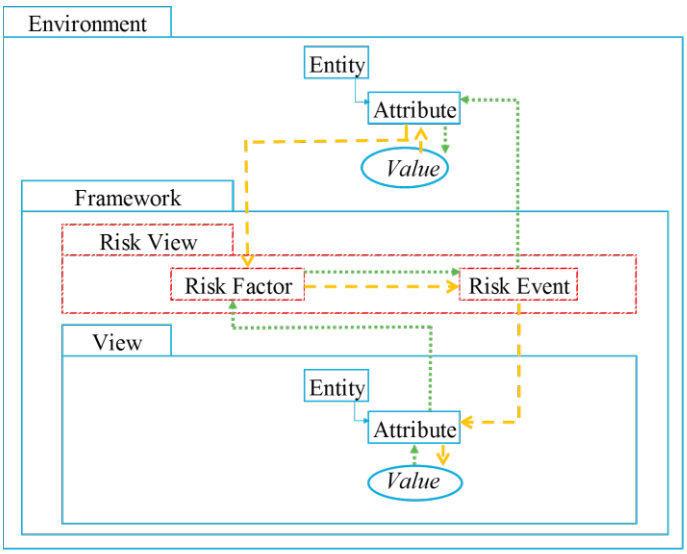

Fig. 3. Description of the links between the risk view and the modelling view of the project

The same rule applies to relationships between system entities and entities of the environment, each of them being possible as source or a target entity.

“Risk interaction” is not explicit in the model but is a direct result of these dependencies once time steps are considered since any change of value of any entity may create different risk factors at next time steps.

According to the general definition of the risk, the considered effects can be either positive (opportunities), or negative.

The dynamic nature of those project risks is due to the fact that some risks disappear (not achieving the hazard), and other lead to an undesired event during the project life (Mehdizadeh et al., 2012) (Hamzaoui et al., 2014).

4. A DEVELOPMENT PROJECT CASE STUDY

We will present an illustration based on a real project, taking place in the framework of the thesis. Results will be presented by resource view. It should be noted that although the formalism is set, the model is still in development.

4.1 CSP project presentation

Our application project is a real Concentrated Solar Power (CSP) project led by a French industrialist that we will not name for confidentiality reasons. For the same reason, some details will be intentionally omitted, such as the type of CSP technology and the localization. The CSP market interest is due to a combination of rising fossil fuel costs, firm renewable targets and substantial governmental subsidies. These factors have helped CSP technology to become commercially attractive, resulting in increased investment in CSP innovation projects. The management of the construction of a CSP plant has to be in accordance with the best practice of general construction project management. Therefore the aim is to construct the project to the required level of quality, and within the time and cost limits. During construction, issues like environmental impact or for example health and safety of the workforce must be carefully managed. The construction performance of a CSP plant depends on many factors, hence the interest to apply our method to this case. The use of such developed tool is a useful tool to assist the engineers to consider on the same time the project management, the associated risk and their evolutions.

From an organizational point of view, the project contract and the interfaces (depending on the contracting structure) management are of central importance. Indeed, to name only the civil works, the different stakeholders (Organizational units), internal or external to the project involved are among others civil contractor, Mounting or tracking system supplier, Central inverter supplier, Electrical contractor, Grid connection contractor and Security. In the function view, the project programme has different levels of detail and outlines the timescale of each activity, the ordering of the activities and the interdependencies between activities. The overall sequence of activities is: site access, site clearing, making site secure, foundation construction, substation construction, mounting frame construction, electrical site works and then testing and commissioning. Each of these works is broken down into a series of activities.

4.2 Implementation and simulation: example of an activity of the construction process from the resource view

We are considering here an activity of the construction process of the CSP plant. This activity consists in the onsite mounting of the assembly plant of some components (the reflectors) forming the solar field of the CSP plant. This activity takes place in parallel with the realization of civil works, and can be divided into the following two activities: mounting the structure and assembling the different processes inside the structure.

As we explained previously, the resource view represents all necessary means to carry out an execution activity. A profile (actor) is, in this view, characterized by an operational role which represents his abilities in terms of learning (knowledge, training), of know-how (experience / practice) and of life-skills (attitude / personal qualities). This operational role takes charge of an execution activity ending in a result aiming at an objective (in terms of cost, delay and quality) and reaching some performance (equally in terms of cost, delay and quality). This execution activity requires a number of consumable resources, human resources (differ from the profile by the fact that they have no power of decision) and production facilities.

It has been selected a particular activity with a budget of 61,600.00€ and the total allowed time of 14 working days. Two profiles are considered and twenty operators (human resources). The progress of the activity depends on different parameters: the amount of mobilized resources (human resources, production facilities and consumable resources) per time step (here by day), the efficiency and the qualification level of human resources, the Overall Equipment Effectiveness and the skills level of the operational role. Thus, according to the values of these attributes, the effective duration of the activity will be different from the initial duration (with optimal values of different attributes). Furthermore, the cost of the activity is directly related to its duration, but also to its location, to the use and the consumption of resources and finally to the mobilization of an operational role which provides oversight or realization. Regarding resources, consumables are characterized by the purchase cost, the transportation cost and the storage cost; production facilities by the purchase cost, the operation cost, the maintenance cost and the storage cost; and finally human resources through a salary. As for the quality of the activity, it depends on the resources (origin, storage area ...), on its location and on the skills and loading rate of the operational role. The activity quality evolves with the activity progress.

Once the project modeled, it is possible to identify various risk factors induced by the attributes of entities. Then identification of risky events from these factors is performed. Attributes values can be modified during the activity progress due to risk factors and risk events.

The table 1 presents some risk factors likely to be induced by the entities of the resource view.

Table 1. Risk associated with the project - Partial list of risk factors

Source entity	Risk factors
Consumable resources	Purchase cost per unit
Consumable resources	Transportation cost per unit
Consumable resources	Storage cost per unit
Consumable resources	Amount stored
Consumable resources	Quality of the storage area
Consumable resources	Quality of the supplier
Human resources	Number of operators mobilized per day
Human resources	Level of qualification
Human resources	Efficiency

A risk event would be that the activity cannot take place on a given day due to a lower number of operators than the required minimum.

5. RESULTS AND DISCUSSION

Table 2 presents the results obtained with this approach. Those results have been obtained by considering three risks factors related to *the level of qualification (RF1)* and *the efficiency of the local manpower (RF2) (human resources)*. We also considered *the number of operators mobilized per day (RF3)* (quality is not considered in this example).

The risk data have initially been characterized by experts referring to their experience. The different numerical data were slightly modified accordingly without any impact on the scientific logic of our approach.

Table 2. Activity performance

Activity performance	Duration	Cost
No risk	14 days	61,600.00€
RF1	18 days	74,550.00€
RF2	16 days	70,400.00€
RF3	17 days	74,800.00€
RF1, RF2, RF3	21 days	85,500.00€

Figures 4 represents the activity duration and the cumulated cost without risks (green dots) and with risks (RF1, RF2 and RF3) (red crosses). It should be noted that these results were obtained after a simulation.

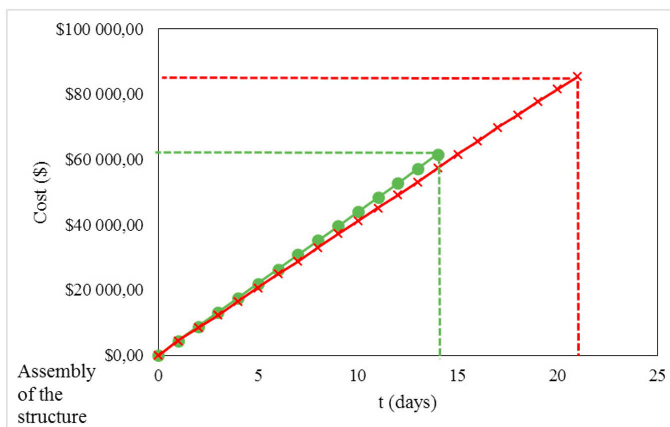

Fig. 4. Cost and duration of the activity.

The most damaging case overlooked the delay and the cost of the project is the combination of the three risk factors. Taken individually, the risk factor number 3 (number of operators mobilized per day) is responsible for the worst effects. What is important to note is that although the interactions between risks are not explicitly described, these appear in the results anyway. This is due to the structure of the model. The various deviations we observe between the costs and time limits referred and those finally obtained in the different scenarios of implementation of the activity show the interest this method. In addition, the results are presented here according to the view resource, but take into account all aspects of the project, defined in the other modeling views. The observed difference is due to the change in values of some attributes of the entities used for modeling of both execution activities. Two points can be discussed on this approach. To ensure the robustness of our approach, we have to test it with several real projects achieved. Indeed, this model required a lot of parameters defined by the users. This parameters are difficult to assess. The implementation of this approach could also allow us to know the influence of all this parameters on the results. More detailed results will be presented at the conference.

6. CONCLUSIONS

In this article, we discuss the need for an integrated management of risk project. Indeed, there are tools for managing risks, but they do not represent the project or its environment, and thus address independently the risks. On the other hand, conventional project management tools do not incorporate the concept of risk. Some tools for integrated management of risk project have been developed. However, they do not allow to integrate all aspects of risk and even less all project components.

Choose the best strategy in a project is often tricky, even more when the project should deliver a result presenting technology novelty (Marmier et al., 2013). Moreover, projects are in essence complex and the complexity is a major source of risk. As a consequence, the complexity of projects leads to the higher complexity of risks in projects which are interrelated with all components of the projects and of the projects environment. Each possible scenario of the project could have different planning but also different risks. To estimate the risk for each project scenario, we propose an approach to model, to simulate and to evaluate project risks in term of cost, delay and quality.

The main contribution of these approach is the nature of the model used. As part of a project, the complex nature of the risks is due to the fact that they affect several interrelated objectives, they are perceived differently by different actors who have divergent interests, they are interacting with various components of project as well as other risks and they manifest themselves differently depending on the level of abstraction of the project. The risk view allow the representation of its internal structure in terms of cause and consequence, and its relations with other project components.

The implementation of the proposed method aims to reproduce the behaviour of the project, evaluate its performance and anticipate its possible drifts while respecting the following specifications: be applicable to the entire process of risk management, be dynamic (taking into account the evolution of the project) be multi-views (consider all aspects of the project) and multi-scales (present different levels of detail). For this, this method uses an iterative process composed of several successive steps. The starting point is the modelling of a project at a t time with a set of views and entities (from the ISO 31000 and ISO 19440 standards) and an architectural framework (GERAM). The example presented here shows that our approach is well-suited to take into account the complexity of interactions among the risks and the project. Furthermore, such an approach allows us to estimate the project cost, duration, quality and risk level. The actual model is a prototype which is being improves by its implementation on different projects.

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