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A new method for Project risk identification: Case study of a real construction project

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Abstract: Compared with many other sectors, a construction project is a subject to more risks due to its specific characteristics such as long period, complicated processes, abominable environment, financial intensity and dynamic organization structure. Managing risks is recognized as a very important management process in order to assure its successful delivery. It aims at identifying sources of risk and uncertainty, determining their impact, and developing appropriate management response. This paper presents a new method called "Three-Dimensional Risk Identification" (TRI) proposed for the identification of a construction project risks. A case study of a real construction project is used to illustrate this approach.

Keywords: Construction project, Project risk management, Risk identification, Risk typology, Three-dimensional Risk Identification (TRI).

Introduction

A project risk is "the possibility that a project does not run according to the forecast completion date, cost and specifications, these deviations from the predictions are considered less acceptable or unacceptable" [1]. The project risks become even more worrying as projects are more complex, either by their technical nature, or by their multiple stakeholders [2].
The complexity of construction projects is due to the following features:

- The variety of stakeholders: with different visions of the project, simultaneous actions, and sometimes conflicting objectives. [3]
- The dynamics of system caused by the strong influence of the environment (ground, weather ...) and the interactions required with third parties.
- The prototypical character of the works because of the difference of site and physical environment from one project to another.
- The projects duration, which increases the likehood of undesirable events that impact their performance (change of standards, evolution of the objectives, economic, political and social constraints …) [4]

Risk management is an important step in a project success. It is the process of identifying, classifying, analyzing and assessing of inherent risks in a project [5].

Managing risks is involved in applying managerial resources with a coordinated and economical effort so as to minimize the probability and/or impact of unfortunate events and to maximize the realization of project objectives. It also may lead the project manager to several benefits such as identification of favourable alternative course of action, increased confidence in achieving project objective, improved chances of success, reduced surprises, more precise estimates (through reduced uncertainty), reduced duplication of effort (through team awareness of risk control actions), etc.[6].

To achieve these objectives, the risk management process is structured in four basic phases (fig.1):

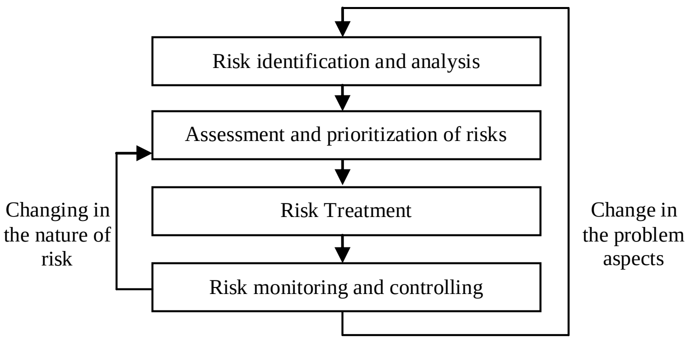

Figure1. Risk management process

In this paper, we focus on the risk identification phase by presenting a new method called TRI "Three-dimensional Risk Identification"

Literature Review

The risk identification phase consists in a systematic search for initial causes that could defeat the project objectives [7]. It is the most important step in the risk management process because the identified risks that will be analyzed, assessed and treated. The success of the risk management process depends on the quality of this phase. [8] However, risk identification is a delicate task due to its inaccessibility: The project risk listing is an extrapolation work that consists in anticipating and imagining the situations that can threat a project because of its nature and its environment. [9]. Its difficulty is also related to the common practice of applying risk management in the initial stage of the project that is the stage of draft, when the schedule is still a prototype[10]. Moreover, there is no formal reference of potential risks related to a project. A variety of generic methods are used for the risk identification : incident reporting, checklists, interviews, the Delphi method, Brainstorming, expert judgment, Fault Tree analysis (FTA) or events (ATE), Failure Mode and Effects Analysis (FMEA), Risk Breakdown Structure (RBS) or Matrix (RBM), SWOT analysis, NGT method ...

Several other alternatives are possible to identify risks such as risk typologies [7]. Indeed, some authors recommend dividing the project into several themes and then analyzing it according to these topics. This analysis identifies the risks associated to each theme [11]. In this context, [12] presents a set of characteristics of a project risk. Apart from the probability and severity, he classifies the risks following their :

- Nature: technical, financial, human, organizational, managerial ...
- Origin: country led, customer, product, supplier, government ...
- Consequences: customer dissatisfaction, abandoning project...
- Detectability: the ability to predict the risk occurrence.
- Controllability: differentiation between selected risk and risks incurred.

AFNOR standard distinguishes internal risks associated to endogenous project processes and external risks associated to exogenous processes. The proposed typology is structured as follows [13]:

- Internal Risk:
  - Management
  - Social / Organizational
  - Design Techniques
  - Contractual
  - Operations / Maintenance

- External Risk:
  - Political / Strategic
  - Legal/ juridical
  - Industrial policy
  - Security
  - Financial
  - Media
  - External technology
  - Technological Evolution

Another approach proposes a specific classification for construction projects. It decomposes the project risks into [5]:

- External Risks
- Operational risks
- Risks related to project management.
- Risks related to engineering
- Financial Risks

In addition to these methods proposing a risk typology based on a risk expertise, there is another type that characterizes the sources of risk following the project progress. It divides them into two sections, those related to the project study and those related to project execution [14]:

- The study phase: The risks associated can be either internal caused by the vagueness of some tasks, ambiguity of objectives, inconsistency of specifications, poor planning of material and human resources… or external such as political risks, risks of commercial obsolescence, regulatory risks and risks related to relations with subcontractors, external partners and customers.
- The implementation phase: it includes the risks derived from the project dysfunctions (rules and procedures of project management, system of monitoring and controlling) and the risks due to a late detection of problems or to an erroneous diagnosis of the situation.

Using these approaches has some limitations in the case of a construction project that requires more delicacy in order to identify exhaustively all the possible risks. Indeed, the first three approaches permit a risk identification based on the concept of "risk" by considering the project as a single entity. However, the last approach uses only the project decomposition for identifying risks.

The “TRI” approach for project risk identification

The TRI method (Three-dimensional Risk Identification) is proposed to overcome the limitations presented above. It is based in a combination of two parameters: The classification of construction project risks, and their projection on the different project phases. Considering the multiplicity and diversity of stakeholders as a source of risk because of the multiple generated interfaces [15], we will integrate this parameter in this risk identification approach. The figure 2 defines the stakeholders involved in a construction project and their different interactions:
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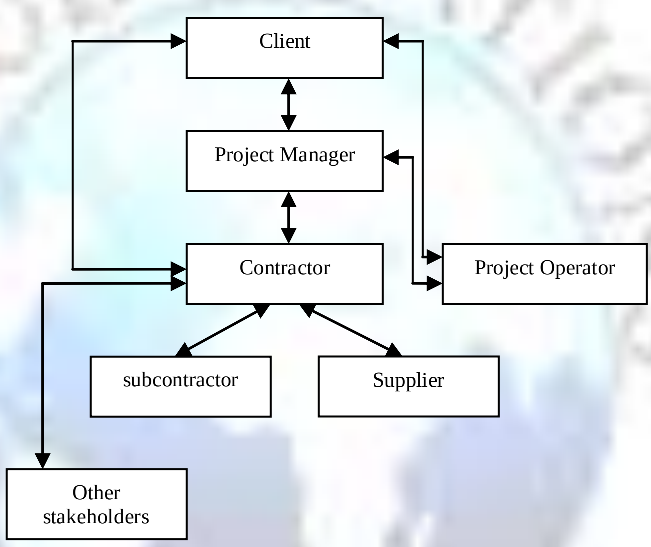

Figure 2. Stakeholders of a construction project

“Other stakeholders” indicates other actors involved in the process of a construction project either with contractual links such as engineering, Control Office, Insurance, Financing Establishment.... or administrative links such as regulatory authorities, technical committees The composition of this group differs from a project to another depending on the required specifications. The combination of the three concepts (Stakeholders, projects phases and risk typology) will be made with a matrix, which allows for each project phase to overfly various types of risk who can arise according to their typology.

So while filling the line-column intersection of this matrix we can define the risks bound to every phase of the project and related to the stakeholder studied.

A risk r will be described by the triplet (s, t, p) such as:

$$s \in S$$
$$t \in T$$
$$p \in P$$

Where :
S : Set of project stakeholders.
T : Set of project risk typologies.
P : Set of project phases obtained by a WBS decomposition.

We define the EXIST_R function whose parameters are the three elements s, t and p. it returns “1” if a risk is identified using this triplet and “0” if not.

We also define ADD_R function by :

```
FUNCTION ADD_R (ri ϵ R , R ϵ R ) : R
    if ∃ r ϵ R / r = = ri then R <= R
    else R<= R U {ri}
    End if
    Return R
 END FUNCTION
```

with R is the global set of risks.

Then, the TRI method is defined by the following function :

```
FUNCTION Ident_R( A, T, P ) : R
   R = {}
   for each a ϵ A do
      for each t ϵ T do
         for each p ϵ P do
            while exist_R (a, t, p) =1
                Add ( r, R)
            End while
         End for
      End for
   End for
END FUNCTION
```

Case study: Electrification Project

In order to demonstrate the presented approach, we propose an illustrative example of a real construction project.

A. Case study background

The studied project concerns the construction of a medium-voltage power line entrusted to a company specializing in electrical installations based in the Agadir city. This study focuses to the risks related to the implementation phase of this project. The Figure 3 presents the flowchart corresponding to this phase:

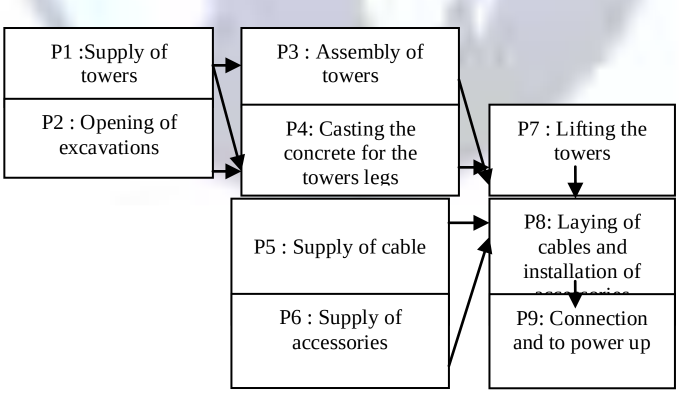

Figure 3. Steps for the implementation phase of the project

It should be noted that the steps P2 and P4 are entrusted to a subcontractor specializing in civil engineering. The objective is to identify the risks that could affect the implementation phase using the “TRI” approach. The team leading this mission consists of: The Technical Director, the Project Manager, the Head of Purchasing and Logistics, the Quality Manager and the works foreman. We have assumed the role of Riskmanager who will lead and guide the implementation of this method.

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B. **Implentation of the "TRI" Method**

Using the « TRI » method, we identified the 23 risks threatening the project objectives. Table 1 presents the obtained list :

Table 8: List of the identified risks

		P1	P2	P3	P4	P5	P6	P7	P8	P9
Other External Risks		R2	R3, R7, R13	R3	R3, R13	R2	R2	R3, R13	R3	R3
Client	**Operational risks**									
	Project management risks									
	Engineering risks						R5			
	Financial risks	R15	R15	R15	R15	R15	R15	R15	R15	R15
Project Manager	**Operational risks**	R22	R22	R22	R22	R22	R22	R22	R22	R22
	Project management risks									
	Engineering risks									
	Financial risks									
Contractor	**Operational risks**							R14, R16	R14, R16	R14, R16
	Project management risks	R9	R9	R9	R9	R9	R9	R9, R6, R20	R9, R6, R20	R9, R6, R20
	Engineering risks	R17	R12, R17, R21	R17	R17, R21	R17	R17	R17, R21	R17, R21	R17, R21
	Financial risks									
Supplier	**Operational risks**	R4, R8				R4, R8	R4, R8			
	Project management risks									
	Engineering risks									
	Financial risks	R1				R1	R1			
Subcontractor	**Risques opérationnels**		R14, R20		R10, R14, R20					
	Risques liés au management de projet.		R23		R23					
	Risques liés à l'ingénierie									
	Risques financiers									
Other stakeholders	**Risques opérationnels**		R11							
	Risques liés au management de projet.									
	Risques liés à l'ingénierie									
	Risques financiers	R19	R19	R19	R19	R19	R19	R19	R19	R19

R1 : price inflation of materials.
R2 : Vandalism of materiel.
R3 : Extreme weather conditions.
R4 : Out of stock.
R5 : materials not accepted by the client.

R6 : Unavailability of sufficient amount of skilled labour.
R7 : Hardness of the ground.
R8 : Non-compliance of the delivery time.
R9 : Lack of scheduling.
R10 : Unsuccessful concrete batch control.
R11 : Delay in the acceptance of excavations.
R12 : Mistake in the grid picketing.
R13 : Opposition to the passage on a land owned by a third party.
R14 : Long cadence of the execution team.
R15 : Delayed payment to contractor
R16 : Failure in equipment
R17 : Contractor's cash flow problem
R18 : Lack of communication
R19 : Lack of funding
R20 : Non respect for the rules of the art
R21 : Lack of coordination between project participants
R22 : High performance or quality expectations
R23 : Low management competency of subcontractors

Conclusion

Focusing on the identification phase of the project risk management process, the document proposed a new approach called "Three-dimensional Risk Identification" based on the three concepts: Risk typology, project phases, and stakeholders in order to draw up an exhaustive list as possible of risks that may occur in different phases of a construction project.
The next step in the research is to assess and prioritize the obtained risks in order to concentrate attention on the risks considered as the most critical. We will also treat the case of dependencies between risks that is relatively absent in the literature of risk management and that causes a "snowballs" effect amplifying their criticality.

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