Knowledge retrieval for configuring risks when answering calls to tenders or direct customer demands

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Abstract. This short article provides the first ideas and results about the configuration of risks when answering tenders or direct customer demands. Indeed, when an offer is defined, it becomes more and more important to analyze possibilities of risks occurrence and their consequences. Most of the time, this analysis is conducted manually thanks to a risk expert. In this paper, we propose to assist the expert with a risk configuration tool that relies on a knowledge base and that allows to define and evaluate: (i) the risk probability, (ii) the main risk impacts and (iii) the interests of various corrective and preventive actions to mitigate it. We first detail the problem. Then we propose a generic model of risks for calls for tenders. Then we describe some knowledge retrieval queries that support the configuration of risk characteristics. As preliminary studies, we will not be able to discuss hard theoretical results but should be able to show a nice a demo of a first software prototype.

Keywords: Customer/supplier relation, offer elaboration, risk configuration, knowledge based system, knowledge model, case base reasoning

1 INTRODUCTION

This short article deals with offer elaboration when answering call for tenders or direct customer demands. The offer concerns physical product or mechanical systems, called indistinctly in the rest of the paper 'systems'. The customer/supplier relation is assumed to be in a B2B context and in a "light" Engineer To Order situation (ETO) [1]. By light ETO we mean that more than 75% of the systems are configured to order (CTO), either Assembly or Make To Order (ATO or MTO); the 25% left are engineer to order (ETO). Globally, such systems are mainly standard but allow some customer specific options that are non-standard, also called ETO options [2]. These ETO options are a strong point for the supplier's competitiveness.

During the offer elaboration, as there is no guarantee that the customer accepts the offer, we assume that the supplier doesn't study in detail: (i) the design of every ETO option, (ii) their integration with the standard solution and (iii) their production process. The supplier configures in detail the CTO part of the system but just characterizes the key parameters of the ETO options (among them performance and cost). As a consequence, if the customer accepts the offer, the supplier must design in detail every ETO option, their integration and production process before launching production. This is where the risky point lies as explained by [3]. As the offer has been submitted and accepted with given performance, cost and due date, without a detail study of the ETO options, the supplier takes the risk of not being able to match what he has promised and sold. This means that the final delivered system might be more expensive and/or longer to produce than expected.

We assume that the offer elaboration is achieved thanks to a concurrent system/process configuration [4] activity supported by:

- a system configuration software in order to configure the CTO part of the system that has some kind of a "design gate" for ETO enabling the user to capture the rough ideas about the solution relevant to ETO options [5], [6].
- a delivery process configuration software in order to configure the design activity (for ETO options) and the production activities (for the whole system, from sourcing, assembling up to installing and test) [7].

The risk, previously characterized, is therefore attached to the delivery process. Therefore, following the system/process configuration activity, a second activity is concerned with what we call the risk configuration relevant to the delivery process as shown in Fig.1.

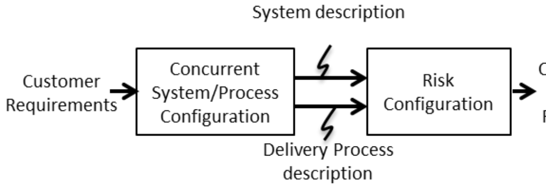

Fig. 1 - Offer elaboration and risk configuration

Similarly to knowledge fundamentals relevant to configuration key ideas [8] we consider that it should be possible: (i) to gather risk knowledge and risk processing knowledge in a knowledge base, as a kind of generic model, and (ii) to propose a knowledge interactive process that allows to support risk configuration for a specific risk. In this purpose, the rest of this article goes as follows: in a second section, we identify the knowledge involved in risk configuration. In the third section, we define the risk generic model and the risk configuration problem. In the fourth section, the first ideas relevant to knowledge retrieval queries that can support risk configuration when elaborating offers are proposed.

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2 RISK IDENTIFICATION IN DELIVERY PROCESS

According to [9], risk processing in new product development projects can go as follows. The delivery process is considered as the main input. In our situation, the delivery process gathers a set of tasks as: finalize design, source sub-systems and/or raw-materials, manufacture, assemble, test and deliver. Each of these tasks is analyzed by a risk expert who identify for each task: (i) the negative event that can be associated to the risk with its occurrence probability [17], (ii) the impacts as modifications of the cost or duration of some tasks, (iii) the possible corrective or preventive actions, in order to counter the risk and (iv) the impacts reductions and/or risk probability reductions as a result of these corrective or preventive actions. Our goal is so far to establish a knowledge model and an interactive process to support the person in charge of these identifications that we call risk configuration.

With regard to risks in the customer-supplier relationship domain, most of the works are based on marketing approaches, logistics issues or supplier selection [10] or [11]. We retain the work of [11] because: (i) they propose a classification of the risks according to the type of customer-supplier relationship, (ii) they clearly differentiate the risks "buyer" and "seller" and (iii) they stress the need to consider the supplier's point of view. Our work is fully in line with this last point. Regarding the risks in offer elaboration, we did not find any work addressing the problem as we formulated it. On the other hand, there is more works and normative elements concerning the risks in project management [12]. We are part of this workflow and especially in the continuity of the approaches proposed in [9] and [13], where a notion of risk processing strategy is proposed.

Regarding the modeling and exploitation of risk knowledge to support offer elaboration in customer-supplier relationship, the work is much rarer. Some works exist in civil engineering [14] or in information system project [15]. As far as we know, only [14] proposes knowledge modeling elements for risks. We join in this type of contribution and will propose elements of knowledge models.

As seen previously, the delivery process logically constitutes a first input of risk configuration, because the risks and their impacts and treatments are defined with respect to the tasks of this delivery process. We describe this process as follows:

- The delivery process is associated with a system that is the subject of an offer. A same system can be associated with several delivery processes, in order to compare process variants.
- A process is broken down into tasks linked by precedence constraints. Each task i is performed by a key resource (resource needed to perform it) and is characterized by a cost, ci, and a duration, di, (other metrics could be defined) as shown in Fig. 2.

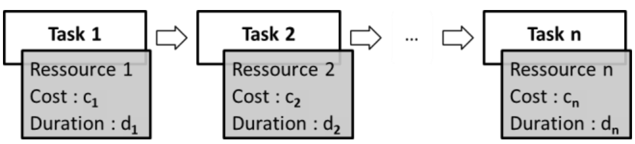

Fig. 2 – Process subject to risk configuration

These data are not sufficient to perform the risk configuration. Other data relevant to the engineered system or the general context of the offer have to be taken into account by the expert. System characteristics impacting the risk configuration can be for example: the complexity or the size of the system, the maturity of the technologies employed, the reliability of the components used, etc. General context of the offer impacting the risk configuration can be for example: the importance of the customer, the recurrence of the demand, the workload of the supplier, etc.

The risk expert has the knowledge about these characteristics and their impacts on the tasks of the delivery process. They strongly modulate the values of risk probabilities, impacts and impact reductions. We propose to describe these characteristics using the triplet:

(1) Conceptual element, for example: crane system, engine component, offer, customer, etc.

(2) Attribute describing the conceptual elements, e.g. crane complexity, engine maturity, offer recurrence, importance of customer, etc.

(3) Value of the attribute describing the concept, for example, very strong / strong / weak / very weak, high / medium / low.

Of course for example : (i) an offer of a high complexity crane with a low maturity engine will be more risky and (ii) risk processing and impact reductions will be stronger if the customer is important.

As a conclusion two inputs will be used by the expert, the delivery process description and the conceptual elements attributes that impacts risk configuration.

3 RISK CONFIGURATION AND GENERIC MODEL

We consider a risk as a pair (task, event), meaning that the event that occurs during this task correspond with the risk. This is questionable but makes it possible to dissociate the analysis of the consequences of the same event on different tasks. For example, this allows the event "Snowfall and blocked road" to be analyzed differently, depending on whether it occurs during a "Component sourcing" task or during a "Final delivery to customer" task. Remark also that a same task can be the source of several risks. For example, a "Finalizing the design" task can be subject to two risks "Task more difficult than expected" and "Key resource unavailable".

A risk is associated with a set of impacts. An impact is defined for a single risk with:

- the impacted task, i.e. the task itself, or some others tasks of the delivery process,
- the nature of the impact: cost or duration (or other metrics),
- the method of calculating the impact: either additive (+) or multiplicative (*),
- the value of the impact.

For example, the risk " Finalizing the design task more difficult than expected" can have two impacts, one on the "Finalizing design" task by adding two additional days to its duration and the other on the "Assembling and testing" task by multiplying its cost by 1.5. Let's note that a given task can be the object of several impacts resulting from different risks Ri.

A risk is characterized by the probability of occurrence [0, 1] of the associated event, on the studied task [17]. This probability can be link to the general context of an offer and some system characteristics. For instance, the probability of occurrence of the risk " Finalizing the design task more difficult than expected" will be higher for a new customer and a very competitive market, rather than for a regular customer with a stable market.

A risk can be mitigated thanks to several preventive and corrective actions. Each corrective or preventive action is a task related to the tasks of the delivery process by precedence constraints. A corrective or preventive action can be associated with different local strategies of the same risk. Each corrective or preventive action is characterized by duration and cost. For example, a preventive action to mitigate the risk "Task more difficult than expected" on the "Finalizing the design" task can be to "train the designers on specific software or design method".

The generic model of a risk is presented in Fig. 3.

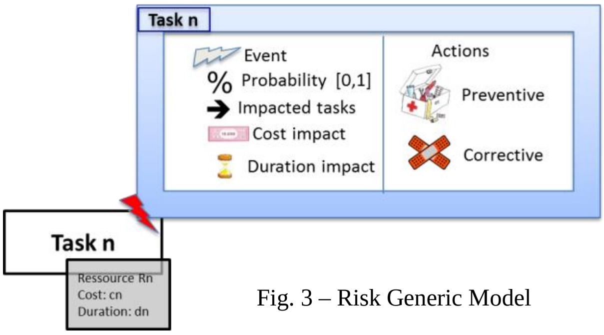

Fig. 3 – Risk Generic Model

In a similar way of product configuration [18], we therefore define **Risk Configuration** as:

- Given a general context of an offer, some system characteristics and one task of the delivery process,
- Given that a generic model of a risk gathers:
  - i. a set of events,
  - ii. a set of possible impacts,
  - iii. a set of impacted tasks,
  - iv. a probability of occurrence,
  - v. a set of preventive actions,
  - vi. a set of corrective actions,
- Given a set of constraints linking general context, system characteristics and risk model items,
- Risk configuration consists in (1) characterizing a risk and its impacts on the delivery process, and (2) finding the set of preventive and corrective actions to be added to the delivery process to mitigate the risk.

This configuration activity can be done either by using constraints satisfaction problem or by the exploitation of past cases stored in a database thanks to case-based reasoning (object of this short paper).

For instance, the instantiation of the risk "Task more difficult than expected" on the "Finalizing the design" is presented in Fig. 4.

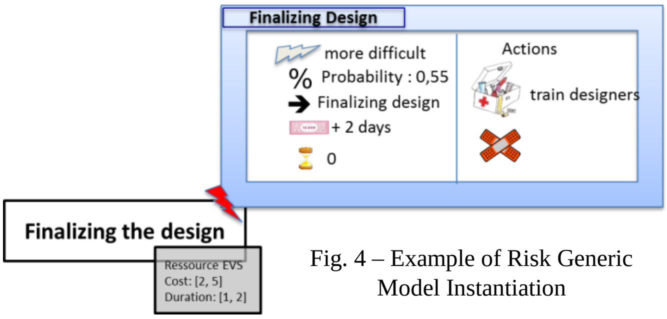

Fig. 4 – Example of Risk Generic Model Instantiation

4 AIDING RISK CONFIGURATION WITH CASE-BASED REASONING

Based on the principles of reasoning by analogy or case-based reasoning [16], our idea is to store in a case base all the information describing the effective realization of past delivery processes (these processes correspond to offers accepted by the customer, the process would not be realized). Then, in the presence of a currently studied offer, the objective is to look for similar items in the case base and retrieve the risk information pertaining for risk configuration in order to provide it as a suggestion to the person in charge of the risk configuration. Three examples of queries relevant to risk, risk impact and risk strategies are proposed.

The first query proposes, for a given task, possible risks with probabilities as follows:

- for a given task of a current process offer,
- select in the case base, the risk associated to the tasks similar or identical to the given task,
- select from the selected risk events, the risk event and its probabilities with conceptual element attributes same or similar to those of the current offer, propose these results to the person in charge.

The second query proposes, for a given risk, possible impacted tasks with impacts values as follows:

- for a given pair (task, event) of a current process offer,
- select in the case base, the impacted tasks affected by a same or similar pair (task, event),
- select from the selected impacted tasks, the impacted tasks and their impacts values which are the same or similar to those of the current offer, propose these results to the person in charge.

The third query proposes, for a given risk, possible strategies with corrective/preventive actions as follows:

- for a given pair (task, event) of a current process offer,
- select in the case base, the impacted tasks affected by a same or similar pair (task, event), in a similar way as for the second query,
- select in the case base, the risk strategies with their corrective/preventive actions which are the same or similar to previously founded impacted tasks,

- select from selected risk strategies, corrective/ preventive actions with conceptual element attributes same or similar to those of the current offer, propose these results to the person in charge.

These three queries are given as examples. Other one can be established. They provide a strong support to the person in charge of risk configuration in the sense that they avoid him to rely only on his own knowledge or risk expertise.

5 CONCLUSION

The goal of this short article was to provide first elements in order to set-up to a knowledge-based support system for risk configuration when answering tenders or direct customer demands. Risk configuration knowledge has been identified, a generic model of risk was provided as well as a risk configuration definition. Some examples of queries to assist risk configuration by the use of past cases have been also provided.

Two main interests of this proposition are:

- to support and to give confidence to the risk expert suggestions,
- to allow being less human expert dependent.

In a more operational and industrial level, another key interest of this proposition is to allow companies:

- to reduce the level of expertise required to engineer conventional risks (with a junior risk expert for example)
- to leave more time to senior experts to focus on unconventional risks (new risks or critical risks, for example).

Given all these elements and according to the approach advocated in [9] that proposes to use a discrete event simulator, the expert is now able to:

- configure the risks of a given delivery process taking into account the offer context and system characteristics,
- simulate the delivery process with all possible combinations of risk occurrences taking into account corrective and preventive actions
- and evaluate for each combination of risks, the relevant metrics and probability of occurrence.

These simulations allow the expert to evaluate all the scenarios from the worst one (with all the risk occurrences and no relevant preventive and/or corrective actions) to the best one (no risk occurrence and no additive expenses or loses of time due to preventive or corrective actions), and to give for each of them the probability of occurrence and the value for the relevant metrics (cost and duration). Therefore, in this study, this first level of risk configuration/simulation allows the expert to know "what could happen if things don't go as they should with and without preventive and corrective actions".

As far as we know, we did not find any scientific work relevant to this problem. We are at the present time beginning to prototype and test this knowledge base system with four companies from industrial and service sectors. The next issue is to add some rule-based decision aiding, assuming that some generic risk configuration rules can be extracted from the case base.

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