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Offer Elaboration: New Confidence Indexes to take into account Uncertainty

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Abstract: In order to respond to a call for tenders, bidders must define and evaluate potential solutions, based upon the specifications of customer's requirements and their capabilities (skills, existing solutions, resources … etc.). The definition and the evaluation of potential solutions are not trivial activities. The lack of relevant information makes the evaluation imprecise and uncertain. Therefore bidders choose the most suitable solution based upon the standard indicators (cost, performance and lead time) and their subjective feeling. Unfortunately, this may leads to the choice of unfeasible solution regarding customer's expectations (cost, performance and delivery time). Therefore, the aim of this paper is twofold: (i) first, to clarify the notion of imprecision and uncertainty in the evaluation of potential solutions; and (ii) second, to propose two Confidence Indexes (CI) in order to take into account uncertainty in offer elaboration. The first one (CI_S) characterizes the confidence in the technical system solution and the second one (CI_P) the confidence in the implementation process of the technical system. The proposed CI_S and CI_P will enable bidders to choose the most relevant solution not only based upon the standard indicators but also considering the confidence in the potential solutions.

Keywords: Bidding Process, Offer Elaboration, Systems Engineering, Uncertainty, Confidence Index (CI), Technology Readiness Level (TRL), Activity Risk Level (ARL), Human Factors.

1. INTRODUCTION

The call for tenders or bidding process is a process in which, a customer puts into competition several potential suppliers in order to choose the best one for the acquisition of a product/system or service (Vanwelkenhuysen 1998). In order to respond to a call for tenders, bidders (potential suppliers) must define and evaluate potential solutions, based upon the specifications of customer's requirements and their capabilities (skills, existing solutions, resources … etc.) (Krömker, Thoben, and Wickner 1997). In this paper, we only focus on call for tenders referring to the acquisition of a product/system and not that of a service. Therefore, all the proposals presented in this paper are relevant for any product/system development but not necessarily for services.

The bidding process, including the definition and the evaluation of potential solutions, corresponds to the first phase of the product/system development (Chalal and Ghomari 2008). The bidding process is often characterized by stringent and tight deadline for the submission of offers (Kroemker et al. 1997) and (Botero Lopez et al. 2012). Therefore, it is difficult to bidders to establish a detailed design (description) of all potential solutions. In some cases, it may be opportune for bidders to avoid detailed description of all potential solutions in order to reduce efforts and resources involved, especially in the cases in which the offers are not accepted (Sylla et al. 2017). Given all these previous elements, it is clear that the definition and the evaluation of potential solutions are not trivial. The difficulty can vary depending on the context of the definition of potential solutions. In the Make-To-Oder (MTO) or Assembly-To-Order (ATO) contexts, relevant solutions already exist. No design or engineering activities are necessary. At the opposite, for the Engineering-To-Order (ETO) context, some design and engineering activities are necessary in order to define novel solutions that are relevant to the customer's expectations. In both MTO/ATO and ETO situations, the evaluation of offers in terms of cost, performance and delivery time, may be imprecise and uncertain. The imprecision and the uncertainty are more important for novel solutions as the knowledge about the solutions for both the technical system and its implementation process are less available and less accurate (Brown and Chandrasekaran 1985) and (Sylla et al. 2017). The presence of imprecision and uncertainty makes the choice of the most relevant solution to be sent as an offer to the customer very difficult. Then, the choice of the relevant solution is based upon the standards indicators (cost, performance and lead time) and the subjective feeling of bidders. This may leads to the choice of unfeasible offer with regards to customer expectations (cost, performance and delivery time) (Leśniak 2016).

Therefore, the aim of this paper is twofold: (i) first, to clarify the notion of imprecision and uncertainty in offer evaluation; and (ii) second, to propose two Confidence Indexes (CI) in order to take into account the uncertainty in offer elaboration.

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This will enable bidders to compare the potential solutions in terms of confidence and to choose the most relevant one to be sent as an offer to the customer not only based upon the standard indicators but also considering the confidence. The rest of the paper is structured in four sections. The second section is dedicated to the notions of imprecision and uncertainty in offer evaluation. In the third section the proposed confidence are presented and discussed. The fourth section presents an illustrative application of the proposed method for the assessment of the confidence indexes. And the last section presents some conclusions and future works.

2. IMPRECISION and UNCERTAINTY in OFFER EVALUATION

Each phase of the development of a product/system is characterized by the presence of both imprecision and uncertainty (Wood and Antonsson 1990). Several efforts have been dedicated to the clarification, modelling and treatment of imprecision and uncertainty in many fields. According to the field and the application, different concepts, definitions and classification have been proposed in the scientific literature (Thunnissen 2003), (Dantan et al. 2013) and (Klir and Folger 1988). In this paper, in the same sense as in (Dubois and Prade 2012), imprecision is related to the content of information, to the values of design attributes or performance indicators (e.g. cost and duration). Uncertainty concerns the confidence in the values of a design attribute or performance indicators. Let's consider the following evaluation of the cost of an engine: the engine possibly costs 10 K€ ± 3. If we consider this information as a quadruplet of (object, attribute, value, confidence) as suggested in (Dubois and Prade 2012), we can easily identify respectively (engine, cost, 10 K€ ± 3, possibly). The imprecision is "± 3" composing the value of the cost and the uncertainty (confidence) is "possibly". These two notions of imprecision and uncertainty encompass several concepts and have various definitions. The figure 1 below depicts some concepts related to imprecision and uncertainty. The concepts presented in this figure 1 are not exhaustive. Thunnissen (2003) provides more concepts related to imprecision and uncertainty.

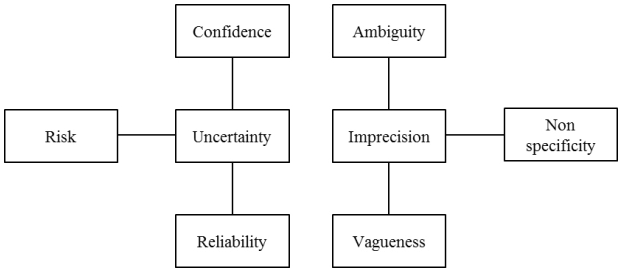

Figure 1: Concepts related to Uncertainty and Imprecision

Confidence: is a kind of measure of the feasibility of a solution (Vareilles et al. 2014).

Risk: is defined as a measure of the uncertainty of achieving an objective (Haskins, Forsberg, and Krueger 2006).

Reliability: is related to the truth of an information (Dubois and Prade 2012).

Ambiguity: is associated to situations in which the choice between several alternatives is left unspecified (Klir and Folger 1988).

Vagueness: is associated with the difficulty of making precise distinctions in the world (Klir and Folger 1988).

Nonspeficity: can be seen as an ambiguity (Thunnissen 2003).

The presence of imprecision and uncertainty in the evaluation of potential solutions makes the evaluation imperfect, and then often leads to the choice of unfeasible solutions with regards to customer's expectations (cost, performance and delivery time). The source of uncertainty and imprecision can be epistemic or aleatory (Dantan et al. 2013). The epistemic uncertainty and imprecision are due to any lack of knowledge whereas the aleatory uncertainty and imprecision are due to the inherent variability of the characteristics of the considered artifact (Thunnissen 2003). According to the offer definition context (MTO/ATO or ETO), the imprecision and uncertainty can be more or less important (Sylla et al. 2017). The table 1 below depicts a classification of imprecision and uncertainty based upon the offer definition context and the source of the imprecision and the uncertainty. In the context of MTO/ATO, relevant solutions (systems) have already been designed, implemented and successfully deployed. All the relevant knowledges for the design and the implementation of these solutions are completely available and accurate (Brown and Chandrasekaran 1985). Therefore, we assume that, there are no imprecision or uncertainty due to any lack of knowledge (epistemic uncertainty or epistemic imprecision). In the context of ETO, all relevant knowledge for the design and the implementation of the solutions (systems) are not available. This lack of knowledge is the source of the epistemic imprecision and uncertainty in ETO situations.

Table 1. Imprecision and Uncertainty in Offer Evaluation

Context of Offer Definition	Source of Imprecision and Uncertainty
MTO and ATO	Aleatory
ETO	Aleatory and Epistemic

The inherent variability of some characteristics of the solutions (e.g. variability of component's cost and variability due to the properties of a specific material) may lead to an imprecise and uncertain evaluation of these solutions. Therefore, the aleatory imprecision and uncertainty are always present in offer definition and evaluation for both MTO/ATO and ETO situations.

The epistemic imprecision and uncertainty are more important in first phase of product/system development and then in offer elaboration. This kind of imprecision and uncertainty can be reduced by more analysis and efforts (Perry, Amine, and Pailhès 2015). In this paper we focus on the epistemic uncertainty. We propose two Confidence Indexes (CI) in order to take into account the epistemic uncertainty in the choice of relevant solutions to be sent as an