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Judgmental risk analysis process development in construction projects

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Abstract

Various risks and uncertainties exist in construction projects. These may not only prevent the projects to be completed within budget and time limit, but also threaten the quality, safety and operational needs. In this context, risk analysis processes are the systematic methods to analyze the potential project risks and develop risk response strategies in order to cope with risks and achieve the desired objectives. This study proposes a new schedule risk analysis method named as judgmental risk analysis process (JRAP) and offers a different project duration equation through JRAP. The process (JRAP) can be defined as a pessimistic risk analysis methodology or a hypothesis based on Monte Carlo simulation that is effective in uncertain conditions due to its capability of converting uncertainty to risk judgmentally in construction projects. A case study has also been developed to show how the proposed process is applied on a construction project and to prove its validity.

Keywords: Risk; Risk analysis; Monte Carlo simulation; Schedule analysis; Construction management

1. Introduction

Each construction project has unique features that differentiate it from even resembling projects. Construction techniques, design, contract types, liabilities, weather, soil conditions, politic-economic environment and many other aspects may be different for every new commitment. This fuzzy atmosphere has been represented with the terms 'uncertainty' or 'risk' by construction managers and researchers, and they tried to control this systematically through risk management and analysis methods since the early 1990s [1]. Some researchers like Flanagan et al. [2] and Pilcher [3] put differentiation between these two terms. They have mentioned that uncertainty represents the situations in which there is no historical data; and risk, in contrast, can be used for situations where success or failure is determined in probabilistic quantities by benefiting from the previous data available. Since such a separation is regarded as meaningless in the construction literature, risk turns out to be the most consistent term to be used for construction projects because some probability values can be attached intuitively and judgmentally to even the most uncertain events [2]. The uncertainty represented quantitatively at some level is not the uncertainty any more; rather it is the risk henceforth and needs to be managed. In this context, this research aims to prove this hypothesis by developing judgmental risk analysis process (JRAP) and applying this process in the assessment of schedule risks of a construction project through a case study.

One important way of controlling risks in construction projects is to develop reliable project estimates and schedules [4]. Probabilistic scheduling through conduction of simulations on prepared models provides more powerful results fundamental to making decisions with regard to the control of project risks. Barraza et al. [5] has brought a stochastic approach to traditional *S*-curve project performance control method by using simulation

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techniques and probability distributions. Chehayeb et al. [6] has developed a different simulation-based scheduling method with continuous activity relationships to enable effective use of systems simulation in scheduling of construction projects. Similarly, Senior et al. [7] has discussed a new scheduling system based on statistical simulation. The reliability of probability distribution functions used as input data in stochastic scheduling systems has attracted the interest of researchers like Maio et al. [8] and Fente et al. [9].

Different methods have been used so far for measuring the variations in activity durations and modelling schedule risks of projects, e,g. Program Evaluation and Review Technique (PERT) [10], Probabilistic Network Evaluation Technique (PNET) [11], Narrow Reliability Bounds (NRA) [12] and Monte Carlo simulation (MCS) [2,10,13]. Activity durations in construction projects are likely to vary because of the inherent risks. For this reason, Dawood [13] and Ranashinghe [14] have also developed equations for quantifying and modelling the variation in activity durations and finding the overall project duration.

2. Risk analysis and risk management

Each construction project has its own technical characteristics that vary according to the construction type, execution time and its environment. This leads to a different risk atmosphere for each construction project. In this context, 'risk management can be defined as a systematic controlling procedure of risks that are predicted to be faced in an investment or project' [15]. However, it is neither an insurance system nor a magical risk elimination method. It only aims to identify the potential risks as early as possible and manage them for preventing the harmful effects of the risks to the project aims. The system utilizes the historical data, statistical knowledge, computer modelling-running power, human intuition, judgment, experience, gut feel, common sense and willingness up to a full extent [2].

In the course of time, the management of risk has become a key element for the completion of projects within time schedule and planned budget. It is now a common opinion that controllable and uncontrollable risks can only be responded by utilizing risk management process over the entire project, i.e. prior to the tender and subsequently, by controlling and updating the system periodically during the application of the predetermined plan.

Like every systematic procedure, risk management is a stepwise phenomenon. These steps can be summarized basically as risk identification, risk classification, risk analysis, and risk response [2]. Risk identification and classification comprise the qualitative investigation of the risks. In the literature, a number of risk identification and classification techniques are present such as brainstorming, check lists, organizational charts and mapping [1,16]. Risk analysis part is dominantly quantitative and, therefore, it includes mathematical and statistical operations [17]. Risk response is the last risk management step at which the results of the preceding steps are discussed and suitable risk mitigation actions are taken before facing risks.

3. JRAP methodology

The JRAP proposed in this research consists of a number of managerial steps to be carried out and an equation that offers the variation in each activity's duration in the schedule network. The characteristics of JRAP make this methodology effective in uncertain conditions of which there is no or little previous data and increases its applicability for converting high level of uncertainty to risk judgmentally. Since, judgmental decisions based on experience and intuition would insert additional risks to the project network model, a pessimistic way has been followed in analyzing the overall project duration. In other words, the pessimistic characteristic of JRAP decreases the effect of planning engineer's making inaccurate data estimation during risk modelling. This pessimism is created through the computing characteristics of the proposed equation that is introduced within JRAP.

Another important point that should be mentioned about JRAP is that it is not a whole risk management system, rather it is considered as an analysis stage that is performed during the configuration of a risk management system. JRAP can be defined as a pessimistic risk analysis methodology or a hypothesis that is effective in schedule risk modelling of even the most uncertain situations in construction projects.

Fig. 1 illustrates the logic and steps of JRAP and clarifies the process's relationship with the other risk management stages. The tasks labelled as D, E, F and G represent the steps of JRAP. They make up the risk management system together with the other tasks, which are B, C, H and I. The task labelled as A, in contrast, represents the classical approach, i.e. the arrangement of project content by deterministic schedule planning. JRAP methodology comprises the analysis part of overall risk management system as seen in Fig. 1. In other words, JRAP can only be applied just after identifying and classifying the risks that would influence the activity durations of the shedule.

Deterministic way of schedule analysis prior to setting up a risk management system (refer to Fig. 1) leads to a more appropriate risk-modelling environment for any project, even though deterministic approach avoids the use of statistical data and assumes certain fixed values. The need for the deterministic model arises from its