A Review on Simulating Uncertainties in Construction Projects

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Abstract: Uncertainty certainly affects the performance of a construction project. The exact definition of risk and uncertainty is still not known. Everyone has their own perspectives. Though, it is accepted as the results and outcomes are likely to differ from expected values. The values can be considered to be Time, Quality and Economy of the project depending upon the project needs. Therefore, in construction project management, the effects of unidentified risks and uncertainties hamper the project time, quality as well as its economy and ultimately obstruct the project management and thus its development. Identifying the uncertainty and quantitatively analyses the impact on the project performance can notably enhance the exactness, validity and reliability of a project plan. This paper describes a methodology to systemize, model, and diminish uncertainty. Uncertainty management is one of the major problems faced in construction. Most of the solutions aim to solve the problem but it has to meet demands of all project criteria. The uncertainty is always evaluated at the start of the construction project but it should be continuing process with solutions at the time of whole project life cycle. The application of risks and uncertainties management is practiced in construction in developing countries and thus the result poses massive challenges in the project development and management. Therefore, this study provides a brief idea of various research taken place to simulate the identified uncertainties in construction projects. It also recommends the idea of uncertainty and risk and their consequences on construction projects management as one of the challenges faced in the construction industry of developing countries.

Keywords: Risks; uncertainties; simulation; construction projects; management

I.   INTRODUCTION

Generally, risk is a choice in an environment rather than a fate. BS 6079 (British Standard Institution 1996) [1]. defines risk as 'It is the uncertainty inherent in plans and possibility of something happening that can affect the prospects of achieving, business or project goals'. The word ''risk'' was known in the English language in the 17th century. It is believed that the word was originally a sailor's term that came from the Spanish and meant ''to run into danger or to go against a rock'', each and every activity we do involve risk, only the amount of risk varies. Construction projects are characterized as very complex projects, where uncertainty comes from various sources. (Gould and Joyce, 2002). Construction projects gather big number of stakeholders, which makes it difficult to study a network as a whole. There have been several studies on the Risk and Uncertainties Techniques. Previous research suggests that construction activity is particularly subject to more risks than other business activities because of its complexity; a construction project usually requires a multitude of people with different skills and interests and the coordination of a wide range of disparate, yet interrelated, activities. Such complexity is further compounded by the unique features of a project and many other external uncertainties. And also, in general, there is an absence of literature that has focused on the practices, results or development of risk assessment and management techniques for Indian construction projects the review of literature includes books, journal articles, magazines articles, and internet articles on Risk Management and risk analysis techniques in Construction in order to support efficiently the present document. This study describes the essential features of uncertainties generating risk at construction project [2,3] and managing the process of correct decision making that face faced and suffered at every construction stage of project [4]. Initially when the causes and sources are identified then the required actions and measures to overcome and reducing the uncertain factors are to be analyzed. It must explain the process of managing the risk and appropriate solution for management of the entire project life cycle [5]. Along with the further reasons to the questions how, when, what steps to be taken so as to ease the decision making process to withstand uncertain circumstances. [6]

In previous years' scientists defines the ill-mannered planning approach towards construction process leads to uncertainties which integrates risk management [2]. Theoretically uncertainty can be defined as a situation involving ambiguous information [3].

Uncertainty management is concerned with managing the unpredicted uncertain opportunities, threats, and risk, whereas, simultaneously working over the sources causing the same. (Chapman and Ward, 2002) [4]. Uncertain situations give rise to uncertain parameters along with unknown range for probabilistic approach, whereas at risky situations the uncertain parameters are known for the decision makers by the probability distribution (Snyder, 2005) [5]. Mathematically stated differences between uncertainty and risk are important, but in this article these the two terms will be used interchangeably because both describes uncertainties in construction project management. Parts or even entire construction project can be treated as the same to accomplished similar construction projects [7,8]. However, these assumptions are not always correct and their bias degree is quite high in comparison to actual obtained parameters after the construction project implementation [7, 9]. It is because every construction project is unique [10] and every project includes a high degree of uncertainty. The uncertainty taking place at the construction project are attracted by the various different sources involving many external and internal factors of the project. [7, 9]. Failure to recognize this responsibility by the owner or manager often leads to undesirable results. That is why risk management is the means by which uncertainty are systematically formatted to manage the increase of likelihood to meet project objectives [6,9,11]. Most of scientist emphasize that the key word is systematic [2, 5, 6], because the more disciplined the approach, the more we are able to control and reduce the risks [7].

Probabilistic methods assess the degree of compliance within various constraints, including duration, cost, and quality and their associated uncertainties. Independent processing is, therefore, required. The program evaluation and review technique (PERT) (Malcolm et al. 1959) [12] was a first step toward applying uncertainties to activity duration. Activities use the beta probability curve to calculate the most likely duration and variance. The project variance is the sum of the critical path activity variances. Martinez and Ioannou (1997) [13] mentioned that despite the probabilistic aspect of PERT, activity duration was still optimistic. PERT is also unable to make a correlation between durations. In addition, errors may occur in cases of multiple peaks or discontinuous distributions. Murray (1963) [14], MacCrimmon and Ryavec (1964), [15] and Grubbs (1962) [16] have suggested alternatives to the PERT method. Different extensions emerged, taking cost and reliability into account. Other researchers, such as Halpin and Riggs (1992) [17], Pritsker (1995) [18], and Lu and AbouRizk (2000) [19] suggested applying simulation to the PERT network. Daji and Reiar (1993) [20] developed the back-forward uncertainty estimation (BFUE). This method introduces uncertainties to the duration of noncritical activities. To calculate the total duration of the project, this method takes into account the likelihood that any path will become critical. BFUE is based on the fact that noncritical paths may, during the work, becoming subcritical or critical depending on how the margins of activities are used. Han et al. (2007) [21] proposed a value addition rate (VAR), a time-scaled metric to capture the activities that consume time or resources without increasing value. Overall, these network -based scheduling techniques consider only a single activity sequence. The chronographic model studied the dynamic time-scaled dependencies that allow continuous probabilistic simulations based on the internal variation of the production rate (Francis et al. 2013) [22].

As a conclusion from the literature review, it has been found that problems in risk and uncertainties management were derived from a narrow perspective. Uncertainty management is one of the main problems in construction. Most of solutions are more or less solving this problem but it must meet demands of all project participants. The uncertainty is always evaluated in the beginning of the construction project but it must be continuing process with solutions during whole project life cycle.

II.   UNCERTAINTY MANAGEMENT

Over the last years' progress and growth of information technologies in the sector of construction industry, [9, 11, 23] the process of simulation and management of uncertainties [24] has broadly accepted along with essential modern tools [7, 9] to fulfil the requirements of the construction project. [25, 26].
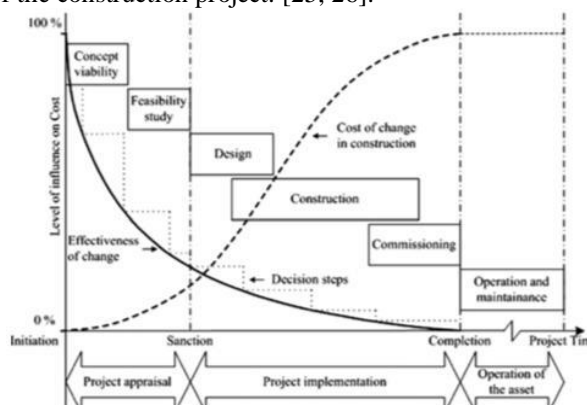

Fig. 1. An influence of changes to cost of project (Migilinskas and Ustinovicius, 2006)

From the Fig. 1, the management of risk and uncertainty begins from appraisal phase, first the objectives and demand are defined in feasibility study. After conceptual stage the thorough description of construction decision's and solutions is preceded. It is advisable to take all possible design decisions in the beginning of evaluation phase before obtaining of construction permit, because later the effectiveness of change decrease and the price of changes increase. As we see from Fig. 1. (Migilinskas, Ustinovichius, 2006) [27] design decisions made in project initiation are economically rational and have bigger influence than the decisions made later. To solve the project uncertainties and design ambiguities it is recommended to use an expert service, it can ensure the professional opinion with evaluation of alternative solutions [7, 8, 10] at the very beginning of project implementation [26]. In general, the project's risk or reserve are in foreseen in cost and included in estimate as percentile expression. This decision is not the best solution, because money spent in project beginning as early problem solving is 5-10 times more effective than the money for actual problem solving in a hurry.

III. SIMULATING UNCERTAINTIES

Modelling and simulation tools makes the complex part of the world simpler to understand, define, and imagine. These tools require certain aspects from real world and utilize various modelling tools for its purpose. Most suitable model should be allotted the that particular required parameter to make optimum utilization of the tool.

Fig. 2 shows the parameters of simulating uncertainties in construction projects, based on the previous data which ultimately predicts the uncertainties and experienced authorities required to resolve certain risk factors taking place during project execution.
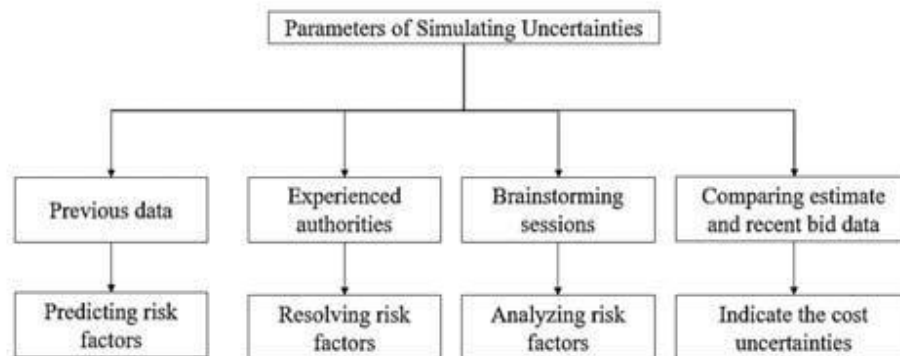

Fig. 2. Parameters of simulating uncertainties (Francis, 2016)

From the above Fig. 2, it has been observed that, brainstorming sessions and comparing estimate versus recent bid data required to analyses the risk factors and indicating the uncertain cost respectively.

IV. SIGNIFICANCE OF STUDY

The criteria of decision making of project based on human judgements can cause the construction industry to hesitate the approach towards simulation-centered decision making rather the than that of human-centered. A significant addition factor to this problem is that very often simulation models are designed even when with limited availability of information and knowledge about project and its conditions. The upgradation leads the project to progress, thus it doesn't make the decision more reliable and credible decision making tools. While facing these challenges a systematic approach is expected to empower models to regular get through with the real system. Simultaneously learnings from the dynamic events must emerge and accordingly adapt to the surroundings expectations. The application of risks and uncertainties management is practiced in construction in developing countries and thus the result poses massive challenges in the project development and management.

V. SUMMARY AND DISCUSSIONS

From the above literature, the following discussions are drawn:

1)   Managing uncertainty and risk has always been major issue at the time of project implementation.

2)   The decision maker has to analyses the factors which hampers the budget, time schedule, construction equipment, manpower and weather conditions etc.

3)   Simulation models tends to ease the uncertain factors taking place for the particular project.

4)   It provides different solutions for every uncertain factor considering every aspect such as contractual obligations, lack of management tool, lack of information, low qualification of personnel and unprofessional behavior, unestimated work and unclear responsibility limits.

5)   The review conducted tends to design the decision in such a way that it results are feasible, so that the risk decreases.

6)   The acceptance of the risk is necessary for making the appropriate decision.

7)   The simultaneous preparation of methodology is generally expected. Also, for accurate results the estimation has to be precise which can avoid consequences of increase in budget

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