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Development of A Computerized Risk Management System for International EPCS Projects

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Abstract: In these days, global construction market is speedily increasing and domestic construction companies have a chance of new contracts. In the meantime, international projects have been increasingly forced to cope with potential risks, which seriously impacted achieving the targeted time and cost. In this study, we introduce a computerized risk management system for international EPCS projects, which is constructed on the needs of practitioners and decision makers as an aid to proactively control the potential risks and to monitor continuously their status and variation. The system is called the Project Risk Management System (PRiMS) is useful for furnishing project managers with warning signals as a project is progressing and helpful for producing the total risk score and tracking risk variation.

Keywords: international EPCS projects, PRiMS, total risk score, tracking risk variation

I. INTRODUCTION

In construction industry, many stakeholders have looked for a practical risk management system to control realistically and effectively the uncertainties. The diverse systems developed by construction companies in Korea has still a difficulty to response proactively on the uncertainty, such that they are considerably exposed to the potentials of delays and overrun and in particular has recently experienced the large financial losses in international construction market. On the basis of the perspective of the market growth, an appropriate risk management system for the overall implementation of a large-scale EPCS (engineering, procurement, construction and start-up) project is a compulsive need (Joglekar and Ford, 2005; He et al., 2007). Neglectful risk-based variation analysis from the planned time and cost frequently results in fatal financial losses for owners and contractors. This study introduces a computerized system to assess quantitatively and control proactively the time and cost variations derived from risk events in implementing the said EPCS projects, called Project Risk Management System (PRiMS).

II. OBJECTIVES AND SCOPE

A large-scale international EPCS project is becoming extremely complicated, and the risk management during project implementation is a core part impacting the success of the project. In the PRiMS, the risk-based project time and cost forecasts were produced for probabilistic interpretation. The system was intended to be operated by project managers in forecasting and managing risk-based potential outcomes and aid in the successful completion of a project on time and within cost.

III. DEVELOPMENT OF A COMPUTERIZED PROJECT RISK MANAGEMENT SYSTEM

A. Classification of Risk Group, Class, and Element

The Delphi technique has been a popular decision-making aid in the group communication (Chan et al., 2001). In the PRiMS, the technique was used for deriving risk group, class, and element for EPCS projects by a universe group consisting of 11 members with sufficient experience. Risk group consists of the managerial and executional group. The preparation and support, contract and legal, financial and funding, country and region are involved in the managerial risk group. Also, the executional group is classified with the engineering, procurement, construction, and start-up class. Each risk class has a few elements, such that the risk breakdown structure (RBS) was structured and used for computing the total risk score (TRS) as a project is progressive.

B. Weights by the Analytic Network Process (ANP)

The ANP is powerful in modeling complex decisions and a variety of interactions and dependencies (Saaty, 1996). In Fig. 1, the links indicate outer dependence of the classes in the managerial group on the classes of the executional group. If the criteria are interrelated among themselves, the utilization of a network is more appropriate. Each entry of W_{PRiMS} indicates the possible inter- and outer-dependency, and was used to construct the supermatrix. In the W_{PRiMS} of Eq. (1), the entries w_{11} and w_{22} present the interdependencies for risk classes in the managerial and executional risk groups, respectively. The entries w_{12} and w_{21} represent the outer-dependencies between risk classes. To achieve convergence on the

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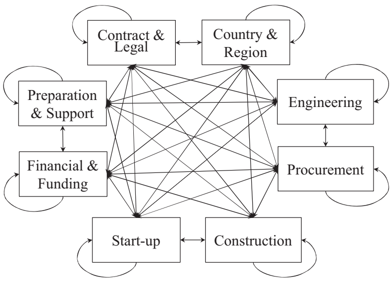
weights, the limited supermatrix is derived from the weighted and unweighted supermatrices with the power of 2k+1, where k is an arbitrarily large number.

$$W_{PRiMS} = \begin{bmatrix} w_{11} & w_{21} \\ w_{12} & w_{22} \end{bmatrix} \quad (1)$$

Figure I. NETWORK STRUCTURE BETWEEN THE RISK CLASSES IN PRIMS



C. Qualitative and Quantitative Assessment

Qualitative assessment provides a convenient way to identify, describe and characterize the risks, and utilizes relative degrees of 'likelihood' and 'impact' of each identified risk event in descriptive nonnumeric terms (Cox, 2008). The individual risk score (IRS) of each risk event was computed and integrated for calculating the TRS, which was computed by the IRS, using Eq. (2).

$$TRS = \sum_{k=1}^{n} \left(\frac{\sum_{i=1}^{m} IRS_{k,i}}{m} \right) \times w_k \quad (2)$$

In Eq. (2), n is the number of elements in RBS, m is the number of risk events of each element, and w_k is the weight of the k^{th} element. The use of quantitative assessment techniques ensures a better and more reliable analysis. Three-point estimate (minimum, most-likely, and maximum values) technique is useful for a better representation of the uncertainty and hence leads to improved estimates (Dikmen et al., 2008). In the PRiMS, the Monte Carlo method has been used with three-point estimate to compute the overall time and cost distributions to point out the effects of many uncertainties.

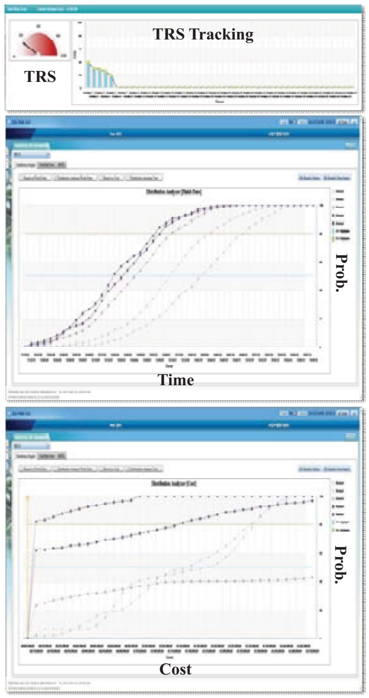
D. Scenarios-based Illustrative application

The PRiMS was tested with the scenarios-based operation derived from the EPCS project. This project was a coal silo plant project, which was constructed from February 2010 to September 2011 at a cost of about $5.3 billion. The number of activities is 1,858. The relations-based and cost-loaded schedule for the project was applied to conduct the qualitative and quantitative assessment.

E. Results Explanation

Fig. 2 shows the expected time and cost that resulted from the identified risk events at 10 revisions. The results allow a project manager to be more flexible in decisions or management actions under the consideration of the current situation and conditions. At each revision, the impact of the response on the identified risk events could be quantitatively tracked, as the project progresses. Also, the PRiMS produced the TRS as the result of a semi-quantitative risk assessment, and hence, could provide an entirely reasonable assessments as well as a variation analysis in tracking the risks on an ongoing project.

Figure II. TRACKING THE TRS AND VARIATION ANALYSIS OF FORECASTS



IV. CONCLUSION

This study introduced the PRiMS for large-scale international EPCS projects to monitor, track, and control the potential impacts of risk events. The system was illustrated to show the effectiveness and capability with the scenarios on the basis of real situations. The results showed that the PRiMS has sufficient capabilities to analyze and forecast the variation resulted from risk events and the changes of impact by risk events on the planned time and cost. Furthermore, this system provided project managers with quantitative early warning signals for helping them take a timely management action.

REFERENCES

[1] Joglekar, N.R. and Ford, D.N. (2005). "Product development resource allocation with foresight." European Journal of Operational Research, Vol. 160, pp. 72-87.
[2] He, X., Tong, J., and Chen, J. (2007). "Maintenance risk management in Daya Bay nuclear power plant: PSA model, tools and applications." Progress in Nuclear Energy, Vol. 49, pp. 103–112.
[3] Chan, A.P.C., Yung, E.H.K., Lam, P.T.I., Tam, C.M., and Cheung, S.O. (2001). "Application of Delphi method in selection of procurement systems for construction projects." Construction Management and Economics, Vol. 19, pp. 699-718.
[4] Saaty, T.L. (1996). Decision making with dependence and feedback: the analytic network process, RWS Publications, Pittsburgh, USA.
[5] Dikmen, I., Birgonul, M.T., Anac, C., Tah, J.H.M. and Aouad, G. (2008). "Learning from risks: a tool for post-project risk assessment." Automation in Construction, Vol. 18, pp. 42-50.