Risk Management Model of Construction Projects Using WBS Generator linked 4D CAD

Chang Hak, Kim
Assoc. Prof. Dept. Civil Eng., ERI
Jinju Nat. Univ., Jinju, Korea
ch-kim@jinju.ac.kr

Sang Bok, Jee
Prof. Dept. Civil Eng.
Gyeongsang Nat. Univ., Jinju, Korea
Lskang@gsnu.ac.kr

Yang Kue. Lee
Prof. Dept. Civil Eng.
Daelim College, Anyang, Korea
yklee@daelim.ac.kr

Seo Young, Park Hyun Suk, Moon
CM & IT Lab., Dep. Civil Eng.
Gyeongsang Nat. Univ., Jinju, Korea
(Car2112, gitadae)@hanmail.net

Abstract

The results of the study include a computerized system and a systematic process model for risk management and analysis. This study analyzes the present status of risk management in the construction industry, and then suggests reasonable methods for improved risk management plans. This study defines risk management procedures as preparation, identification, analysis, response and management to manage potential risks in the construction project. The modules for computerizing in this system consist of planning, construction, application of WBS (Work Breakdown Structure) and RBS (Risk Breakdown Structure). The methodology for analyzing construction risk uses fuzzy theory, and the scope of developed system is focused to the contractors. The risk management system suggested in this study operates on the internet, for providing contractors with a useful risk management tool by online system, with web-based menus that is helpful for practical application.

Keywords

Risk Management System, Work Breakdown Structure (WBS), Fuzzy, 4D

1. IINTRODUCTION

Modern construction projects in nature do not allow uncertain factors and risks depending on the experiences and intuition of the contractors and project owners. Because of this, the necessity of risk management is getting increased in construction industry and contractors are paying more attention to the methods and procedures to manage risks systematically. In particular, they are realizing that they can maximize profits only when they can identify and analyze the risks not after but before happening. There are not many established studies regarding the construction of computer system for risk management in construction industry. However it is a very important in construction management and it is really an active construction project management method to identify and remove the risk factors before dangerous situations are actually made. As there are many risk factors and uncertainties in construction projects, contractors should have appropriate management and analysis process to manage and respond to them. However existing risk analysis methods do not reflect the characteristics of construction projects accordingly. Therefore, in this study, we propose the development of risk management model that suits for the characteristics of construction projects and prototype risk management system.

In this study, we have reviewed the problems of the analysis methodologies used to analyze various risks in construction industry and proposed appropriate analysis methodology for risk management and analysis of construction projects. Additionally, in order to identify and analyze risk factors that are latent in construction projects and to establish theoretical system to respond to them strategically, risk management procedures, risk breakdown structure and risk breakdown structure and 4D CAD relation methods were reviewed and then an integrated risk management computing model for construction projects has been proposed.

2. OVERVIEW OF CRMS

In this chapter, I/O information flow was reviewed by creating a computing model according to risk management procedure using IDEF0 technique. As the model using IDEF0 can summarize information I/O and processes in details, it can reduce the errors in risk management system construction substantially.

The most emphasized factor in this model is the risk identification. The most important thing of the risk management is how easily and accurately it can identify the risk factors that are scattered inside and outside of the

project. In this study, checklists comprising with phased project evaluation system were used to identify risks. In particular, if the checklists that are predesignated to evaluate domestic and foreign environments and can be easily ignored by project managers are checked throughly, project exterior environments can be evaluated. They are called Global Risks. CRMS provides good communication between field sites and headquarter using web-based architecture. It is structured to deal with current situation of the project, quality control and cost management concurrently by identifying global and local risk factors based on checklists. Additionally, it can be used as basic materials for construction management because it allows us to identify construction status and risk factors by construction type by connecting the construction type oriented local risks with WBS.

The purpose of web based CRMS development is to allow real time communication between field and headquarter. For this, server is operated based on Internet and database. Figure 1 shows the phased information flow of CRMS using IDEF0. The architecture of basic model of phased CRMS is composed of the following 5 procedures as shown in the picture. The composition is as follows;

- Phased model composition of CRMS
  - Project Information Phase Model
  - Risk Identification Phase Model
  - Fuzzy Risk Analysis Phase Model
  - Risk Action Phase Model
  - Risk Report Phase Model

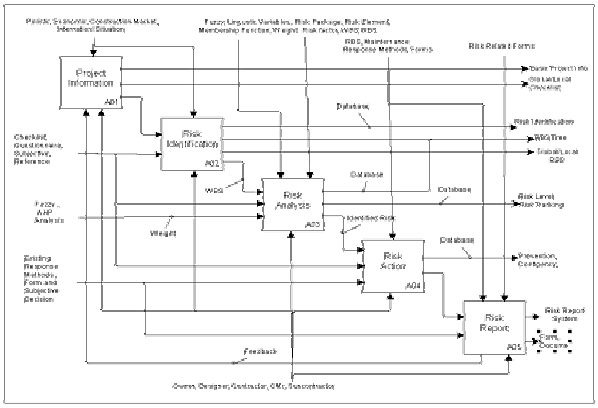

Figure 1. The phased information flow of CRMS

In the project planning phase, domestic and overseas environments are evaluated according to the preset evaluation system. This evaluation is performed by risk analyst and corresponding project manager. This process is composed of the processes to help project managers to understand domestic and overseas construction environments systematically. After the project is evaluated through checklists, identified global risks are entered and the analysis is performed. In case of local risks at the construction phase, WBS is constructed and then local risk factors connected with WBS in each process are identified. The identified risks were screened to identify core risk factors and prioritize them through setting weight and performing fuzzy evaluation. Lastly countermeasures can be developed, if needed.

3. RISK IDENTIFICATION

Risk identification is very important process to identify the risk factors related to a certain construction project, to classify them systematically according to standards and to select the core risk factors that should be mainly considered in risk analysis stage. In this study, we focused on how to perform risk factor identification most efficiently. If risks are not identified in this stage, the next processes are meaningless. Even though we have the best analysis system, we cannot make big influence on the project, if we fail to identify risk factors in this stage. Risk identification in this study is based on the subjective judgement of checklist analysts and experts who compose each evaluation system as shown in Figure 2.

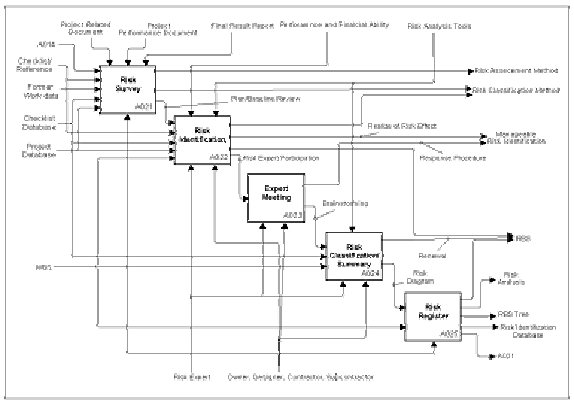

Figure 2. Risk Identification Procedure

In this study, information flow was analyzed to construct computing system and the result of the analysis is shown in Figure 2. Figure 3 shows the risk identification process that identifies local risks connecting with WBS. In case of local risks, it would be the most proper to identify risk factors using visualized WBS.

(1) Connection between WBS and RBS

In order to make integrated management and analysis of WBS and RBS in risk identification stage, a code system was developed and WBS and RBS were integrated. When looking into the code system of WBS, facility classification code can be classified into by functional and by style. WBS code has 4 step classifications and looks like Facility classification Code, Space Classification Code, Part classification code and Element Classification Code. Figure 4 shows the code concept for connection between WBS and RBS. In this system can make WBS automatically using WBS generator, this WBS code linked 4D CAD and RBS, So risk analyzer can identify visually risks to may exist in work items.

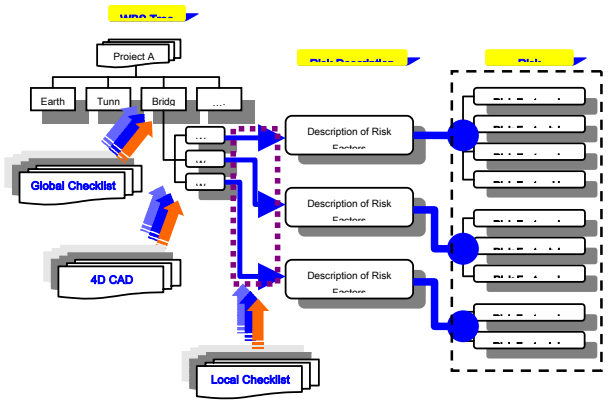

Figure 3. Risk Identification Process of Local Risks.

Figure 4. WBS Generator Linked 4D CAD

4. RISK ANALYSIS MODEL

The composition of risk analysis model is shown in Figure 5.

Once data entry is done through data collection and evaluation in risk identification stage, provisional evaluation on the risks is performed as the next course. Provisional evaluation is performed by risk data identified during the risk identification process, cost and schedule information, WBS and subjective management of experts. This course is to save time and money necessary for risk analysis and it selectively classifies risk factors identified by judgment of experts before full-scale risk management. Unmanageable risks are composed of force majeure risks, contingent risks due to carelessness and unexpected risks during the construction process. These risks pass over risk analysis stage and qualitative analysis is made using fuzzy analysis. If the risks are manageable, they are the risks related to past records or empirical and subjective judgement of field experts. They go directly to risk response stage not going through the risk analysis process and countermeasure are sought after to deal with the identified risks. Unmanageable risks are quantified through language variance of the experts and then risk level and priority are determined. Based on these result values, countermeasures against the risk factors will be established and managed. These risk analysis processes are not performed through one time execution but they are analyzed and managed in a continuous feedback cycle.

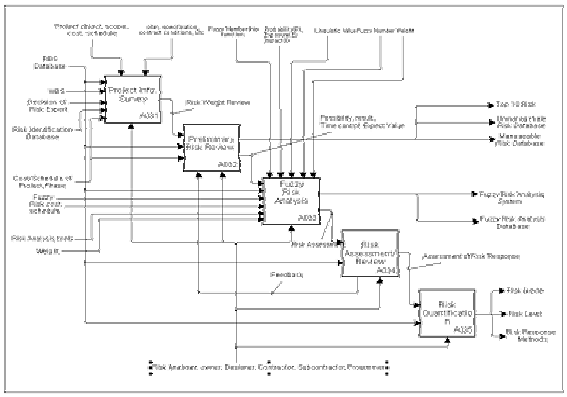

Figure 5. Risk Analysis Procedure

(1) Fuzzy Analysis Procedure

Fuzzy analysis procedure of CRMS is shown in Figure 6. In order to perform fuzzy analysis, we need to preset membership function values using trapezoid function and enter those values. The preset entry items are membership function values and fuzzy number of language variable group regarding the danger value. Users are not required to enter these values.

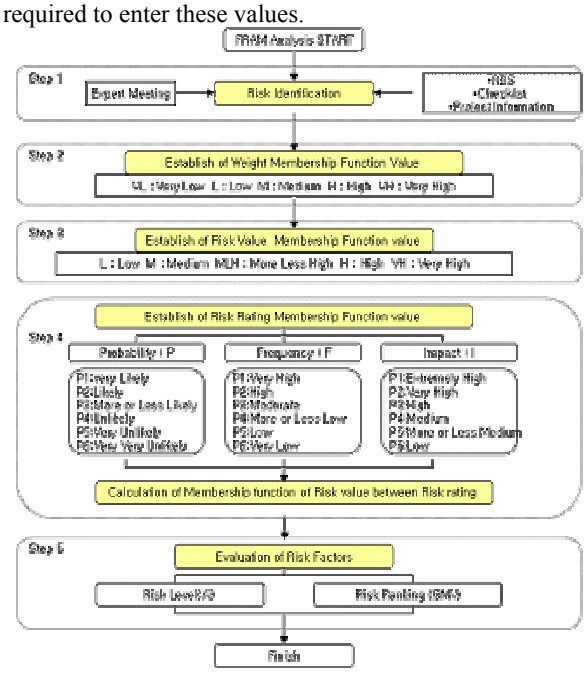

Figure 6. Fuzzy Analysis Procedure of CRMS

These values are set by experts who have experiences and expertise in fuzzy theory. They will modify the value after comparing with other records after judgment. It is allowed to change the membership function value because subjective judgment on a certain risk can be different and every project has different project environments. However, general users do not need to enter those values at all. Once they enter occurrence rate and risk intensity, the danger level and priority can be analyzed.

5. RISK RESPONSE MODEL

Once risk analysis is done, we need to seek for countermeasures. Before identifying countermeasures, we need to identify causes of the risks. For this procedure, CRMS made users record major causes. The procedures of risk response model in Figure 7 show how to deal with unmanageable risks and manageable risks by establishing countermeasures.

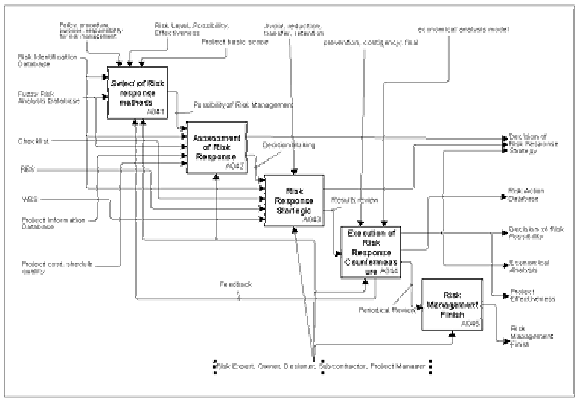

Figure 7. Risk Response Procedure.

Risk countermeasures are established based on the risk evaluation and review process result of the risk analysis model. Risk response countermeasures are made based on the results established through the evaluation and review process of the risk analysis model. In the risk response model, countermeasures are established by integrating and interpreting all the materials analyzed previously. They are required to be entered through the subjective judgment of the users and the reference to the previous records. It comprises response cost, response schedule (construction period), preventive phase, contingency phase and other corrective actions. Items stored in DB after risk identification and risk analysis are used. Risk response model is to establish countermeasures based on the results of risk evaluation through fuzzy analysis. The countermeasures are to be established to have preventive phase, contingency phase and final practice phase. Other items to be entered are risk response cost/ construction period, and people responsible for countermeasure establishment and execution.

6. RISK REPORT MODEL

Risk report model which is the final execution stage of CRMS is to identify comprehensive outputs of the previous phased model and to prepare the report that can manage them. All data regarding risk identification, analysis result and risk response are integrated and summarized through fixed report forms. The procedures of the risk report model are composed as shown in figure 14 and in CRMS it is possible to distinguish risk values by risk management phase and enter them according to their category just shown in figure 8.

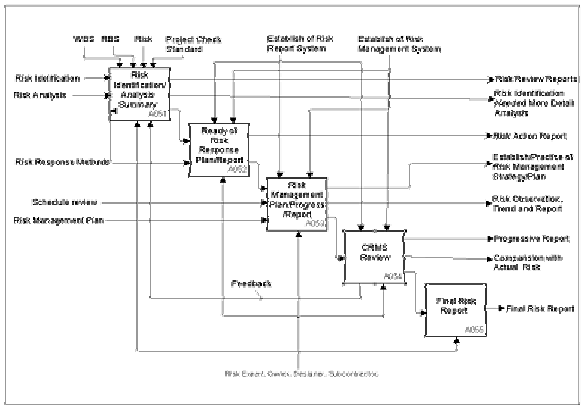

Figure 8. Risk Report Procedure.

This report system is configured to enable the integrated results of the risks to be confirmed. The report items include project information related, WBS and RBS related, project review standards and overall risk management materials.

7. CONCLUSION

In this study, CRMS, the system to integrate and manage procedures regarding risk identification, analysis, response and management for construction projects was constructed. In order to make the risk identification easier, RBS construction was proposed and to utilize it the connection with WBS was also proposed. Additionally, problems of existing risk analysis methods were reviewed and fuzzy analysis method was proposed to improve these problems. As CRMS is a web based system, information can be exchanged very easily between field and headquarter. As it allows easy exchange of information, it can be utilized not only as risk management tool but only as a part of project management system.

7. ACKNOWLEDGEMENTS

The authors would like to thank the Ministry of Construction and Transportation of Korea for financially supporting a part of this research under 2006 R&D program.

8. REFERENCES

[Sang Yun Jung(1998)], Determination of Risk Level Using Fuzzy Multi-Criteria Decision Method, Journal of the Korean Institute of Industrial Engineers, Vol 24, No. 4, pp. 627-638.

[J.H.M.Tah&V.Carr(2000)], Information Modeling for a Construction Project Risk Management System, Engineering Construction and Architectural Management, 7/2, pp. 107-119.