An Analysis of Schedule Risk Factors of Structural Steel Work

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ABSTRACT

The risk factors and the uncertainties in construction are increasingly growing in line with the construction projects that tend to become larger, specialized and complex. Particularly, a schedule risk occurred in the structural steel work have negative impact on project, causing an extension in schedule and increase in cost. However, should such risks be dealt with at the pre-construction stage, the project is expected to complete as schedule. The study hence was intended to identify the process of the structural steel work as well as the schedule risk factors that may occur from the activities at each stage. The schedule risk management tool hereby proposed will provide the guidelines that will enable the site engineers with different levels of experience and expertise to identify the potential risks at early stage and to deal with the risks in timely manner, thereby mitigating the project risks as a whole.

KEYWORDS: Structural Steel Work, Schedule Risk Factors

1. INTRODUCTION

1.1 Background and Purpose of the Study

A high rise building in architectural projects attracts people's attention not only in construction industry but also from the economic and social standpoint. High rise building projects, however, are what requiring the involvements from many different areas for an extended period, imposing the burden of heavier risks on the projects than any other projects. The risk management to identify and deal with the potential risk in timely fashion.

Such risk management is indispensable for the high rise structures that require a high degree of expertise and rapid process, and when it comes to structural steel work, which is crucial in designing the high rise building structure, the schedule risk management to prevent the schedule slippage will be the key to achieving the successful completion. (Go, S. S., 2004)

But in the construction site, though the importance of schedule risk management is understood by all, a specific management procedure or tools need to be further developed. Reality is that the resolution of the problems occurred in the sites are still heavily dependent on experiences and intuitions of the construction managers.

The study hence was intended to analysis the work process as well as to identify the potential schedule risks in carrying out the structural steel work for high rise building so as to implement the efficient schedule risk management at the pre-construction stage. The outcome of the study will be used in establishing the measures to deal with the schedule risk to be implemented in the coming days.
1.2 The Scope and Approach of the Study

In the study, the scope was determined as follows in a bid to analyze the factors that will affect the schedule at the early stage of construction.

The risks, among the potential risks that may affect the schedule, were limited to those that should be put under the control of project participant and those controllable. And then the risk factors were sorted from those applicable to the commerce buildings with 20 stories or higher, which were mostly built with structural steel work.

The approach and sequence of the study are as follows.
1. Study on concept of schedule risk management
2. Review of existing studies and reports
3. Development of the structural steel work-flow based on evaluation of existing studies and interview with the experts
4. Identification of schedule risk factors through the analysis of work-flow.

2. PRELIMINARY REVIEW

2.1 The Concept of Schedule Risk Management

To understand the schedule risk management concept, the schedule management and the risk in construction industry were defined based on existing studies.

The schedule management, to complete the activities comprising the projects within a given time, is the process to analyze the information associated with the project, and determine the construction method and work out the schedule, and establish the plan with regard to equipment, material, manpower and resource mobilization, and eventually optimize all of those elements. (Samsung Corporation, 1999)

A concept of risk in construction industry is defined as the possibility of uncertain incident that might affect the construction purpose, positively or negatively. (PM BOOK, 2004)

The schedule risk management defined in the study is the systemized process to effectively deal with the factors, among the various risks, that might affect the schedule of each activity or the activities over the entire project.

2.2 The Trend of Studies at Home and Abroad

The studies in association with the schedule risk, as shown in Table 1, were performed in a variety of aspects such as analysis of risk factors in construction industry or risk management methods. However, the studies so far appeared to have faced two significant challenges.

First, it can hardly be applied to real works because its proposal was limited to the conceptual approach process for comprehensive risks.

Second, the activities subject to risk management were mostly about the earth and reinforced concrete work. Thus, development of specific schedule risk focusing on structural steel work, along with earth and reinforced concrete work becomes more than important than ever.
### Table 1. The Trend of Study on Risk Management at Home and Abroad

<table>
<thead>
<tr>
<th>Researcher</th>
<th>Year</th>
<th>Description</th>
<th>Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DOMESTIC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suh, S. W.</td>
<td>2002</td>
<td>Proposed a decision-making model to determine the optimal risk handling measures</td>
<td>Limited to risk response through CM</td>
</tr>
<tr>
<td>Park, S. Y.</td>
<td>2003</td>
<td>Analyzed the risk factors with a countermeasure model</td>
<td>A detailed study on application elements by activity</td>
</tr>
<tr>
<td>Chung, T. T.</td>
<td>2005</td>
<td>Identified the schedule risk at the stage prior to starting curtain wall installation and countermeasure</td>
<td>Lack of identification of risk factors in structural steel work and countermeasures</td>
</tr>
<tr>
<td>Ryu, H. K.</td>
<td>2005</td>
<td>Identified the risk factors in reinforced concrete work and countermeasures</td>
<td></td>
</tr>
<tr>
<td><strong>FOREIGN</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tetsuya Miyagawa</td>
<td>1997</td>
<td>Proposed a construction manageability planning system (CMY planner) to assist in identifying the risk factors and sequential decision-making from the start till the completion of the project</td>
<td>Lack of comprehensive management method and procedures. It's regarded to be the general risk management tool, rather than for a schedule risk management</td>
</tr>
<tr>
<td>B. Mulholl and J Chritian</td>
<td>1999</td>
<td>It described the measurement of uncertainties in construction schedule in a systematic way, and developed the model that evaluate the major key factors through the sensitivity analysis, thereby proposing a tool that will recognize the potential result of project risks</td>
<td>Lack of study on how to deal</td>
</tr>
<tr>
<td>Nasir</td>
<td>2003</td>
<td>It proposed the method that determines the activity duration for schedule risk analysis by PERT</td>
<td></td>
</tr>
</tbody>
</table>

### 3. ANALYSIS OF SCHEDULE RISK OF STRUCTURAL STEEL WORK

The analysis was implemented in a sequence that developing the work based on existing studies and interview with the experts, then analyzing the detailed work by discipline, before identifying the schedule risk factors by activity. As a result, the structural steel work-flow was divided into the pre-construction stage, shop fabrication stage and site erection stage, and the project participants were categorized into the supplier, constructor and client/supervisor.

(1) Pre-construction stage
A pre-construction stage of structural steel work, as illustrated in Figure 1, is further detailed into mobilization, drawing/specification review, project briefing, contract award, construction plan, and review.
## Work-flow and Risk Factors at Pre-construction Stage of Structural Steel Work

Figure 1. Work-flow and risk factors at pre-construction stage of structural steel work.

Among the schedule risk factors in the course of reviewing the dwg./spec. review, design error, error with review of material supply, and at contract award stage, missing of order item, too low award price, inappropriate subcontract award and bankruptcy. And the construction planning stage includes errors relating with construction method, work sequence/schedule, support facilities/equipment/lifting plan and payment schedule.

### (2) Shop Fabrication Stage

As the second stage of structural steel work, the shop fabrication stage is illustrated in Figure 2. The schedule risk factors that may be caused in the course of shop fabrication, inspection and shipping include schedule delay, inappropriate inspection (missing) and the rework causing the delay with delivery due to the problem with a lump sum-based supplier with the structural steel worker. In case of anchor bolt work to be implemented by the constructor, the risks include wrongly embedded anchor bolt, and wrong selection of anchor bolt (length). And in site delivery stage, non-fulfillment of JIT (just in time), fabrication sequence and wrongly fabricated material and so on.

Figure 2. Work-flow at shop fabrication stage.
Site erection stage

The structural steel work at the site is carried out in sequence that erection of column/girder/beam, temporary fabrication, plumbing, bolting/welding, laying rebar, concrete pouring, and fireproofing protection. The client and supervisor shall carry out the vertical/horizontal inspection, laying rebar inspection and fireproofing protection inspection.

![Figure 3. Work-flow at site erection stage](image)

The schedule risk factors, which are commonly caused during site erection, include damage to the material in store, inappropriate plan for storage and transport, substandard workmanship, and safety incident. Among other factors having impact on schedule are inattentive inspection, substandard quality of rebar work, and inappropriate work environment due to flying-dust and particles.

4. CONCLUSION

The study was intended to analyze the schedule risk management focusing on structural steel work, instead of earth and reinforced concrete work that is usually the object of the study in line with increasing construction of high rise buildings. The study was implemented, based on understanding of existing studies and the interview with the experts, to identify the detailed risk factors, after developing the work-flow at the pre-construction stage, shop fabrication stage and site erection stage. It’s necessary to further develop the countermeasures to deal with the schedule risks and evaluate the importance of the risk factors through the survey and importance evaluation mechanism, and the system for use more systematically.

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