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RESEARCH PAPER

Project Risk Factors Facing Construction Management Firms

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Abstract Very little is known about the project risk factors that affect construction management (CM) firms, which often struggle due to a lack of effective risk management practices. This study investigates the risk factors critical to project execution in CM firms and ranks them using the analytic hierarchy process (AHP) and failure mode and effects analysis (FMEA) methods. Interviews with executives at the top 15 Korean CM firms are carried out to identify major risk factors in the CM sector, and a survey is used to develop priority ranking. We find that payment delays and project delays are the two most critical risk factors affecting CM firms because of (1) lack of communication between headquarters and field offices, (2) shift of responsibility from headquarters to a field office, (3) absence of regular monitoring of project progress, and (4) ex-post management practices. The findings presented in this study should assist CM firms in establishing more robust risk management practices, thereby improving firms' profitability, project performance, and customer satisfaction.

Keywords Risk management · Construction management · Risk factors · Analytic hierarchy process · Failure mode and effects analysis · Korea

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1 Introduction

The global economy has evolved rapidly with the emergence of new trade structures and changes in financial markets [1]. As bidding competitions have become increasingly fierce with the continued recession following the 2008 global financial crisis, the rate of return within the construction industry, which has not been immune to these rapid global changes, has decreased and project risks have increased [2, 3]. Furthermore, the industry's overall competitiveness has been impacted unfavorably in areas such as customer satisfaction, service quality, cost competitiveness, and risk management [4]. Therefore, for construction firms to adapt to globalization in the 21st century, they must establish effective management practices integrating costs, information technology, design, knowledge, and risk management [5, 6].

The total value of contracts awarded to Korean construction companies has declined since 2007, as the total value of domestic construction dropped to $107 billion in 2011, down 9% from the previous year [7]. The Korean construction management (CM) market has exhibited the same trend. The CM market experienced epochal growth of $444 million in 2007, but the total contract value awarded decreased by over $97 million following the global financial crisis. The

cost-cutting bidding strategy implemented by CM firms in the wake of the global economic turmoil has led to a sharp decline in the Korean construction industry.

During the 1970s and 1980s, low labor costs and efficiency of production systems were the main drivers of profitability of Korean construction companies. As a result, companies defensively managed project risks. During the 1990s, however, the importance of risk management practices grew as market competition increased and such practices became recognized as efficient ways to increase firm value. Thus, companies adopted systematic risk management practices to maintain profit and minimize the chances of financial loss [8].

Systematic risk management starts with the identification of risk factors that might occur during project operations. However, very little is known about the project risk factors specifically affecting CM firms. Based on this knowledge gap, this study investigates the risk factors critical to project execution in CM firms and ranks them using the Analytical Hierarchy Process (AHP) and Failure Mode and Effect Analysis (FMEA) methods. The AHP can evaluate the preference of alternatives and importance of various assessment factors, and rank a number of alternatives systematically, thereby analyzing their weights. FMEA is a method to manage high-priority risk items intensively, thereby preventing work failures and minimizing the effect. Thus, the present study notes the evaluation items between rating scales as pairs to perform a paired comparison between rating scales for each risk factor and indicates a level of importance to analyze the importance, thereby analyzing the priority for each risk factor using the FMEA. The research data and findings presented herein will thus assist CM firms in establishing more robust risk management practices, thereby improving firms' profitability, project performance, and customer satisfaction.

Although this study investigates project risk factors in a single region, the organizational structures and business models of Korean CM firms have their roots in CM firms of the United States. Therefore, the findings of this study are expected to be generalizable globally. Indeed, we expect that this research will facilitate industry practitioners and decision-makers worldwide to make informed decisions and improving their risk management practices.

2 Literature Review and Research Steps

2.1 Literature Review

The success of a construction project is determined by whether the expectations of interested parties are satisfied [9]; managing the risk factors that could deviate the project from its planned path is thus a significant task [10]. Authors such as Akintoye and MacLeod [11] have suggested that risk analysis and management are mostly based on intuition and experience. Accordingly, many recent studies focused on the risk management sectors in the construction industry are on project risk management (PRM), which provides the importance of project management through priority control of cost, time, safety, quality, and environment, and enterprise risk management (ERM), which is the approach to achieving strategic, operations, reporting, and compliance objectives [12].

Major research topics related to PRM have focused on: (1) the evaluation of risk by project and improving the functional performance of project management, (2) measures of risk recognition and response by construction firms, and (3) strategy for risk management of overseas construction projects [13]. For example, Van Wyk et al. [14] proposed a risk management method for power companies by analyzing the status and problems of their risk management processes. Lyons and Skitmore [15], based on survey data, proposed an advanced coping strategy that includes a risk management plan and document management; however, they also found that risk detection may require a brainstorming method and risk aversion entails insurance. Baccarini and Archer [16] identified seven major risk factors and proposed a project risk ranking. A number of studies have analyzed risk factors, in detail. Bing et al. [17] analyzed risk factors in terms of international joint ventures and classified them into three groups: government policy, economic conditions, and financial aspects. Aydogan and Koksal [18] categorized risk factors as government policies, legislative systems, political stability, social and economic stability, inflation, and type of construction. Choudhry and Iqbal [19] classified problems related to risk management practices in the Pakistani construction industry into management techniques, the perspectives of major interested parties, and risk management organizational systems. It was discovered that the risk factors related to PRM were site conditions, client–contractor agreement, client conditions, sub-contractor conditions, project execution, project preparation and planning, administration and contracting procedures, and outer risk [20].

Enterprise risk management aims to distinguish, evaluate, and manage the risk of all major enterprises based on an integrated framework, and it was applied as a basic paradigm to manage the portfolios of organizations facing risks [21]. In this context, Zhao et al. [22, 23] analyzed the impact of enterprise risk management (ERM) execution according to regulatory pressure, firm ownership, and firm size through surveys of 35 Singapore-based Chinese construction firms (CCFs). Zhao et al. [24] defined the CCFs ERM best practices and important ERM criteria using a fuzzy technique. Li et al. [25] analyzed correlations of how effective ERM influenced corporations' value based on a data sample of 135 insurance companies that are under the control of the Chinese Insurance Regulatory Commission (CIRC). They

concluded that the risk factors related to ERM encompass strategic, market, operational, financial, and compliance risks [26].

Recently, several works have investigated risk factors in public–private partnership (PPP) projects. Cheung and Chan [27] determined and defined risk factors in Chinese PPP construction projects using Kendall's concordance analysis, while Li and Zou [28] used AHP to study risk factors in PPP projects. Li et al. [29] compared AHP with improved AHP to develop risk factors during a subway station construction. Finally, Zou and Zhang [30] analyzed the occurrence, importance, and impact of risk factors by comparing safety management practices in the Australian construction industry with those in the Chinese industry. The results led them to suggest that efforts are required to revise construction-related laws and procedures for enhancing construction safety management.

The construction industry has conducted studies on measures of efficient management through identification and analysis of risk factors via various methods for efficient risk management. As a result, the construction industry has discovered differences among the objectives, scope, and risk factors, and expended considerable effort on the success of projects and improvement of enterprise competitiveness through systematic risk management. However, most studies have focused on measures of risk management according to building project executions published in previous studies, and a few studies have been conducted on efficient management measures of risk factors that occur during site operation management of CM firms. According to the status of yearly CM performance published by the Ministry of Land, Infrastructure and Transport (MOLIT) of Korea, the growth in CM performance was \$532 million in 2014 and \$622 million in 2015, and is likely to grow to \$900 million in 2018. Although the CM market has grown rapidly, most CM firms continue site operation management based on cost, time, and quality, and great effort and investment are required for systematic risk management. Accordingly, research regarding prioritization of management by risk factors is needed through analysis of the definition, effect, and importance of the risk factors that occur when performing site operation management. Thus, the present study aims to propose the importance of risk management in CM firms through identification and analysis of risk factors that occur during site operation management of CM firms in Korea, a country that has experienced rapid growth in the CM market for the last 20 years.

2.2 Research Method and Scope

Despite the numerous studies on this topic, a few authors have defined the risk factors specific to project operations of CM firms. To bridge this gap in the body of knowledge, this study determines and ranks risk factors by applying systematic risk analysis techniques. In particular, the main research objectives are achieved through a five-stage research methodology summarized in Fig. 1. The project risk factors were investigated by employing both an in-depth literature search and thorough review (Step 1 of Fig. 1) and a series of face-to-face interviews with senior management personnel working in the top 15 Korean CM firms (Step 2). The top 15 firms were targeted for the study, because MOLIT annually releases the top 15 CM firms based on their annual revenues (revenues of about \$9 million or higher). The interviews aimed to identify deficiencies in the current risk management practices of Korean CM firms and determine representative risk factors in this sector. Fifteen executives responsible for project operations in their firms were selected for interviews. Semi-structured interviews were conducted either in person or in writing between September and October 2013.

We also surveyed targeted employees in the 15 sampled CM firms to collect sufficient data to determine the priority ranking of the eight investigated risk factors based on the AHP and FMEA techniques (Step 3). Totally, 75 copies of the survey were distributed from February 18 to March 4, 2013 via email; 58 copies of the survey were completed (a response rate of 77%). The survey responses were then analyzed using the AHP analysis software Expert Choice 11.5 to determine the importance of each risk factor. AHP, a robust multi-criteria decision-making technique [31, 32], can be used to analyze weight by systematically ranking several alternatives. The survey was structured to allow for one-to-one comparisons between the eight factors in terms of their importance. Survey responses were further assessed using FMEA, a risk analysis method that evaluates the likelihood and impact of risk factors and prioritizes them [33]. The FMEA resulted in the determination of the occurrence, detection, and severity of each risk factor based on a 10-point Likert scale. The priority ranking of risk factors

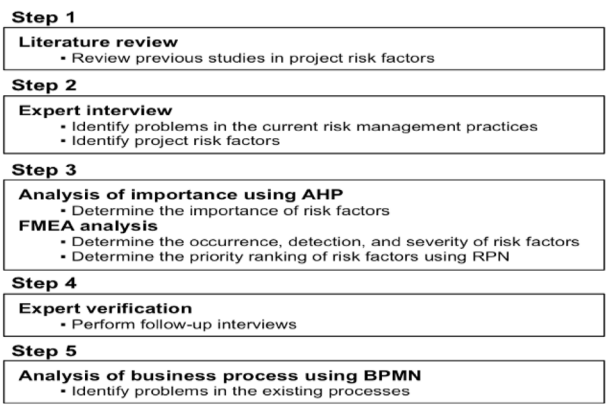

Fig. 1 Research methods and steps

was then determined by multiplying the risk priority number (RPN) by the level of importance.

Step 4 involved conducting follow-up interviews with the same 15 executives interviewed in Step 2. The objective of the second set of interviews was to obtain perspectives on the priority ranking of the risk factors. Finally, during Step 5, the existing business processes were analyzed using the Business Process Model and Notation (BPMN). The process analysis focused on the two risk factors ranked highest in the FMEA.

3 Analysis of the CM Market and CM Firms' Risk Factors

3.1 Current Risk Management Practices

In the early 1990s, the Korean construction industry sought to improve the overall quality of construction projects by implementing a special inspection practice that focused on the management of construction safety and quality [34, 35]. However, the inspection practice was limited to the construction process, and it was found to be ineffective in managing the lifecycle process of construction projects. As a result, the need to implement advanced CM practices arose, and consequently, CM was legislated as a contracting method [36].

Similar to the definition of the Construction Management Association of America (CMAA), CM in the Korean construction industry is defined as a management service adopted to support construction projects in programming, feasibility studies, designing, procurement, contracting, construction, inspection, and warranty [37]. The primary structures and business models of Korean CM services originate with CM for fee practices in the United States, where a CM fee is guaranteed, and the CM firm acts as the project owner's agent.

In 2015, the MOLIT in Korea assessed the capabilities of Korean CM firms, based on domestic contracts of $394 million (82%) and overseas contracts of $84 million (18%) [38]. Due to a few mega projects and an increase in overseas CM contracts, total CM contract value jumped to $478 million in 2012, a 50% increase over 2011, and this could be a sign of a gradual recovery from the global recession. Figure 2 illustrates the revenue trends of the top 15 CM firms (i.e., the interviewees in this study) from 2012 to 2014.

As illustrated in Fig. 2, the revenues of these CM firms have recovered significantly over the past few years. However, the expert interviews (Step 2) revealed that only one CM firm actively adopted a risk management practice that provided employees with systematic risk management manuals and processes. The interviewees also agreed that most companies base their risk management practices on experience, intuition, and ex-post management. The absence of risk management practices in CM firms is due to a number of factors such as (1) lack of understanding, (2) absence of risk management systems, (3) lack of specialists, and (4) lack of technical assistance from headquarters. The deficiency appears to prevent CM firms from effectively and efficiently coping with project risks, which can negatively affect customer satisfaction and financial performance.

3.2 Investigation to Derive Risk Factors of CM Firms

Investigations were conducted to derive the main risk factors that occur during site operation management concerning heads of departments in the 15 firms.

The investigation was conducted using one-on-one interviews or written responses from heads of departments in site operation management in every company, and risk factors that occurred commonly in every company (out of the list of derived risk factors) were re-derived through expert consultation. Next, each risk factor was defined through

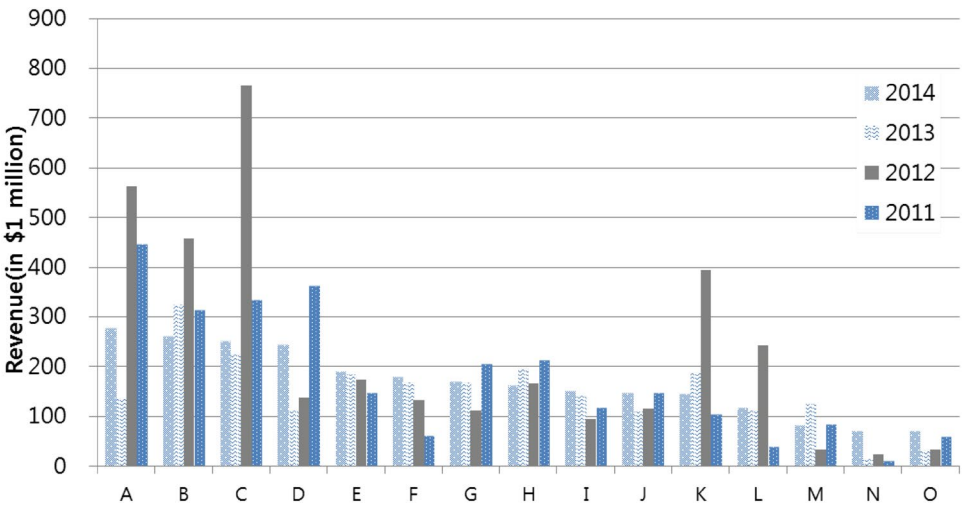

Fig. 2 Revenue trends of the top 15 CM firms in Korea (revenue data from [38])

consultation with the heads of the departments. An overview of the interview investigation is presented in Table 1.

3.3 Risk Factors Identified in the Study

The interviews led to the identification of eight major risk factors related to contracts, funding, schedules, workforce, customer satisfaction, and disputes that significantly affect the project operations of CM firms. Table 2 defines each risk factor.

3.4 Survey to Analyze the Importance of Each Risk Factor

A survey to analyze the importance of each risk factor was conducted over the course of about 3 weeks with executives and employees in the 15 firms responsible for site operation management. For the survey method, assessment items between rating scales in the eight risk factors were placed alongside each other, and subjects selected a rating scale to conduct a pairwise comparison of the rating scales in terms of effectiveness and convenience. It was to investigate the level of importance among the risk factors based on the RPN.

75 questionnaires were distributed (five for each company) and 58 of them were collected (a 77% collection rate). An overview of the survey is presented in Table 3.

3.5 Importance of the Risk Factors

As seen in Table 4, the most important risk factor according to the AHP analysis was payment delay (0.226), followed by

Table 1 Overview of interview investigation to derive risk factors

Category	Main contents of interview with experts
Goal of the investigation	One-to-one individual interview or written response method to derive main risk factors that occur during site operation management
Subjects and interview	September 9–23 in 2013
Subjects and interview contents	Head of the department of site operation management Risk factor derivation occurred during site operation management Definition of each of the risk factors
Survey method	First step: verification of head of the department of site operation management for each company Second step: introduction of interview contents through phone call and verification of interview participation Third step: delivery of interview contents through visit and interview investigation Fourth step: written response investigation for heads of the departments who were difficult to engage in a face-to-face interview
No. of surveyed heads	Total number of interviewees: 15 heads (interview: 14 heads; written response: 1 head) Response rate: 100%

Table 2 Definition of the risk factors

Category	Risk factor	Definition
Contract-related	Contract revocation	The suspension of a project or cancellation of a contract because of a client's dissatisfaction with the CM service or a lack of funding
Fund-related	Payment delay	Financial difficulties in company operation occurred due to delayed payment from project owner
Schedule-related	Project delay	A risk related to a project delay caused by other parties, including owners or contractors
Workforce-related	Lack of available workers	The difficulty in securing workers with appropriate skill sets
Customer satisfaction-related	Customer dissatisfaction with field service	A client dissatisfied with the field services provided by a CM firm, resulting in the client filing a claim
	Customer dissatisfaction with headquarters' technical assistance	A client filing a claim regarding the level of technical assistance (e.g., Value Engineering or Design Review) provided by a CM firm's headquarters
Dispute-related	Legal dispute with a client	Project owner sued for indemnity incurred due to professional negligence of CM
	Legal dispute with a partner company	A legal dispute with a partner company, stemming from disagreements about shares and work

Table 3 Overview of interview investigation to derive risk factors

Category	Main contents of interview with experts
Goal of the investigation	To derive priority of risk factors that occur during site operation management through importance analysis
Survey period	October 7–28 in 2013
Survey method	First step: Introduction of survey contents through phone call and verification of survey participation Second step: Delivery of survey contents via visit and collection of survey results Third step: Analysis of survey results and expert advice regarding analysis results
Special note and analysis method	Five questionnaires per company are distributed, because the number of staff in the site operation management department for each CM firms is less than five [i.e., one department head (at least 20 years of experience), one deputy department head (at least 15 years of experience), two section heads (at least 10 years of experience), and one deputy section head (at least 5 years of experience)] Evaluating the importance using AHP analysis

Table 4 Risk factors sorted by importance

Risk factor	Importance
Payment delay	0.226
Legal dispute with a client	0.178
Project delay	0.169
Contract revocation	0.150
Customer dissatisfaction with field service	0.138
Legal dispute with a partner company	0.075
Customer dissatisfaction with headquarters' technical assistance	0.033
Lack of available workers	0.032

legal dispute with a client (0.178), project delay (0.169), and contract revocation (0.150). The overall inconsistency ratio was determined to be 0.03, confirming the overall logical consistency of the responses.

3.6 Priority Analysis of the Risk Factors

The next step of the investigation was to apply FMEA to the survey results to perform a priority analysis (see Table 3). The analysis involved determining the occurrence, detection, and severity of each factor; performing a Cronbach's alpha reliability analysis; and determining the ranking of the risk factors. Survey participants indicated their perceptions about the occurrence, detection, and severity of each factor using a 10-point Likert scale. The reliability of the data was validated using Cronbach's alpha reliability analysis, a widely used approach to determine the degree of consistency when an object is measured several times with a number of measuring tools or repetitively with one measuring tool [39]. The Cronbach's alpha coefficient, a reliability measure for internal consistency that takes a value between zero and one, was computed using the following equation:

$$\alpha = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum_{i=1}^{k} \sigma_i^2}{\sigma_t^2}\right), \tag{1}$$

where α = Cronbach's alpha; k = number of risk factors; σ_t^2 = variance in total scores; and σ_i^2 = variance of component i.

The higher the Cronbach's alpha coefficient, the more reliable are the data. In general, 0.8–0.9 is considered desirable and 0.6–0.7 acceptable, while values below 0.6 indicate a lack of internal consistency [40]. Our Cronbach's alpha values for occurrence, detection, and severity were determined to range from 0.699 to 0.728, indicating that the survey data were considered to have "acceptable reliability" (Table 5).

The next step was to calculate the RPN of each factor to rank the eight factors. While a traditional RPN is calculated as a multiplication of occurrence, detection, and severity, this study used a modified version as follows:

$$\text{Modified RPN} = \text{Importance} \times \text{Occurrence} \times \text{Detection} \times \text{Severity}. \tag{2}$$

As shown in Table 6, the occurrence of customer dissatisfaction with field service had the highest occurrence rate at 5.275, followed by project delay (5.258) and payment delay (5.224), both of which occur nearly as often. As for the detection of the risk factors, contract revocation (7.672), legal dispute with a client (7.482), and payment delay (7.068) were the three risk factors most difficult to detect before their occurrence. In terms of severity, risk factors regarding contract revocation (8.189), legal dispute with a client (7.965), and payment delay (7.758) were the three factors with the most severe impact on CM firms.

Based on the modified RPNs shown in Table 3, CM firms should focus on the following risk factors in descending order of priority: payment delay (64.738), project delay (37.140), legal dispute with a client (33.096), customer dissatisfaction with field service (32.736), contract revocation (27.452), legal dispute with a partner company (7.142), lack of available workers (2.885), and customer dissatisfaction with technical assistance from headquarters (2.413). Figure 3 depicts the results of the priority analysis in a spider-web diagram.

Table 5 Reliability analysis results

Risk factor	Assessment	Effective number/%	Cronbach's α
Payment delay	Occurrence	57/98.3%	0.728
	Detection		0.709
	Severity		0.711
Project delay	Occurrence		0.708
	Detection		0.712
	Severity		0.724
Legal dispute with a client	Occurrence		0.716
	Detection		0.699
	Severity		0.707
Dissatisfaction with field service	Occurrence		0.715
	Detection		0.725
	Severity		0.718
Contract revocation	Occurrence		0.723
	Detection		0.716
	Severity		0.708
Legal dispute with a partner company	Occurrence		0.716
	Detection		0.715
	Severity		0.728
Lack of available workers	Occurrence		0.700
	Detection		0.705
	Severity		0.713
Customer dissatisfaction with headquarters' technical assistance	Occurrence		0.707
	Detection		0.709
	Severity		0.699

Table 6 Results of the FMEA analysis

Ran-King	Risk factor	Importance (A)	Occurrence (B)	Detection (C)	Severity (D)	Modified RPN
1	Payment delay	0.226	5.224	7.068	7.758	64.738
2	Project delay	0.169	5.258	6.482	6.448	37.140
3	Legal dispute with a client	0.178	3.120	7.482	7.965	33.096
4	Customer dissatisfaction with field service	0.138	5.275	6.620	6.793	32.736
5	Contract revocation	0.150	2.913	7.672	8.189	27.452
6	Legal dispute with a partner company	0.075	3.758	5.017	5.051	7.142
7	Lack of available workers	0.032	4.500	4.724	4.241	2.885
8	Customer dissatisfaction with headquarters' technical assistance	0.033	4.310	4.206	4.034	2.413

3.7 Analysis of the Risk Factors Based on Follow-up Interviews

3.7.1 Importance of the Risk Factors

The interviewees agreed that a late payment (e.g., because of a client's funding situation) could significantly affect the success of a project. In addition, a client's dissatisfaction with the field services provided by a CM firm could increase the chances of a contract revocation or legal dispute.

3.7.2 Occurrence of the Risk Factors

The FMEA indicated frequent occurrences of customer dissatisfaction with field services, project delays, and payment delays. According to the interviewees: First, frequent conflicts between clients and CM firms stem from clients' demands for additional services and administrative duties beyond the contract terms. Such unreasonable demands arise commonly as clients may lack an understanding of CM contracts and CM firms' technological incompetency or insufficient customer service. Second, the frequency of

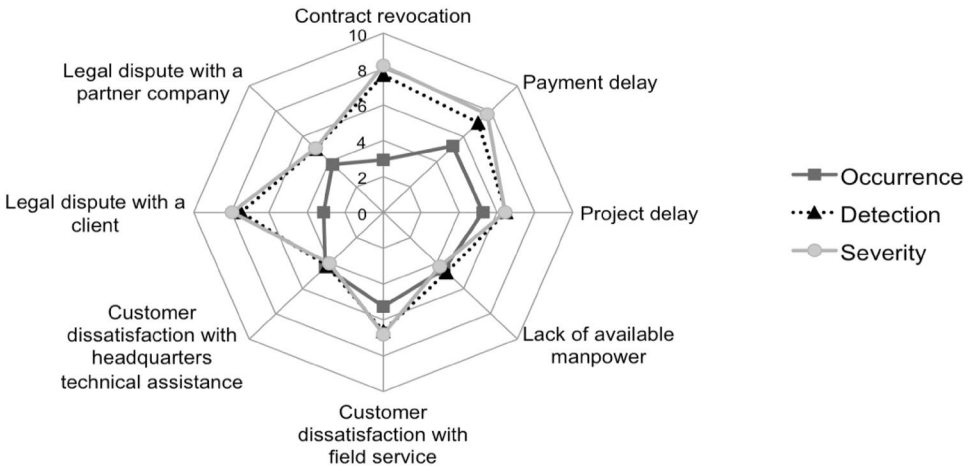

Fig. 3 Results of the priority analysis

project delays has increased since 2008, because clients have reduced or closed their facilities-related capital investment due to the global financial crisis. Third, in the same context, delays in clients paying CM firms have increased since 2008. As the business nature of CM firms typically involves high labor costs, such payment delays significantly affect the cash flow of CM firms.

3.7.3 Detection of Risk Factors

According to the analysis, contract revocation, legal disputes with a client, and payment delays are relatively difficult to detect. The interviewees stated that contract revocations occur under various circumstances, including project delays because of a client's inadequate capital and dissatisfaction with CM services. Hence, they are difficult to forecast. In addition, legal disputes with clients can occur during project operations for unforeseen reasons such as a payment delay or warranty for quality deficiency, which also makes them difficult to predict. Payment delays can also occur because of unforeseen changes in clients' financial situations.

3.7.4 Severity of the Risk Factors

Severity analysis of the risk factors illustrated that the impacts of contract revocation, legal dispute with a client, and payment delay are relatively severe. The results showed that the risk factors of high detection possess high severity, while those of low severity coincide with risk factors of low importance, which include lack of available workers and customer dissatisfaction with headquarters' technical assistance.

Owing to the continuing recession in the construction industry, interviewees did not experience any difficulty in securing the staff needed to complete projects. In addition, upon project completion, extra staff at headquarters was used to provide the client with technical services. Moreover, in most CM firms, rich data accumulated from continuous CM services over the years enabled quality technical assistance services through effective knowledge management practices, thus reducing the severity of customer dissatisfaction with headquarters' technical assistance.

4 Discussion

The discussion section consists of three sections. Section 4.1 presents the problems that occur when payment delay, project delay, legal dispute with a client, customer dissatisfaction with field service, and contract revocation—the five highest risk factors—take place, by analyzing the current task management process in CM firms based on the BPMN analysis method. Section 4.2 examines the importance of the risk derived from the CM firm's field operation management and the legitimacy of the presentation of the necessity of systematic management, and these are compared with the risk management cases of other industries. Finally, Sect. 4.3 presents the limitations of this work and opportunities for future research.

4.1 Business Process Analysis of the Risk Factors

Based on the RPN analysis, payment delay, project delay, legal dispute with a client, customer dissatisfaction with field service, and contract revocation were selected as the top five risk factors for business process analysis. The BPMN methodology was selected for the analysis, because it provides an effective graphical representation of a business process [41–43]. This section summarizes the results of the BPMN analysis based on the follow-up interviews conducted in Step 4 of this research.

4.1.1 Existing Business Process in the Case of a Payment Delay

Figure 4 depicts the existing business process for handling payment delays and highlights a number of issues. First, the current process makes it difficult to designate a responsible party to manage the incident and respond with an appropriate action plan. A few interviewees confirmed that the concerned departments often pass their responsibilities to the field office to avoid the issue. Second, shifting responsibilities within departments connotes that understanding the reason for a payment delay can take time, and this leads to a delay in collection. Third, there is a lack of coordination and communication between the finance department and the field office in managing an account with a payment delay, and this could result in difficulties in planning and managing the collection processes.

In summary, upon the identification of a payment delay, the headquarters and field office should immediately collaborate to implement mitigation measures in a timely manner. However, when the concerned department at the headquarters shifts its responsibilities to the field office, and when the field office solely develops an action plan and reports to the headquarters, the effectiveness of the action plan reduces significantly. Overall, the interviewees agreed that few CM firms have appropriate risk management plans in place to effectively deal with payment delays.

4.1.2 Existing Business Process in the Case of a Project Delay

Figure 5 depicts the existing business process in the case of a project delay, showing that the headquarters review the impact of a project delay on overall project performance, while the field office analyzes the causes for the delay and reports them to the headquarters. According to the interviewees, the existing process contains the following problems. First, when a project delay is caused by a client's lack of funding or construction issues, the field office may deliberately report a "false positive" to the headquarters to reduce its responsibility or the chances of withdrawal from the project. That may hinder the process of coordinating with the client or timely withdrawal from the project. Second, few CM firms monitor the progress of their projects regularly; instead, they initiate monitoring after the fact (i.e., when a problem has been reported by one of the projects). Third, an on-site decision-maker is rarely available to discuss important issues such as client coordination or a withdrawal schedule, preventing appropriate action plans from being established.

The problems related to the risks of payment delay and project delay are caused by the lack of specific and detailed management response plans for each risk factor, leading to confusion and evasion of responsibility among departments. The failure to agree on an appropriate early response to risks causes additional problems. Therefore, for effective and systematic management, executives' and employees' attention

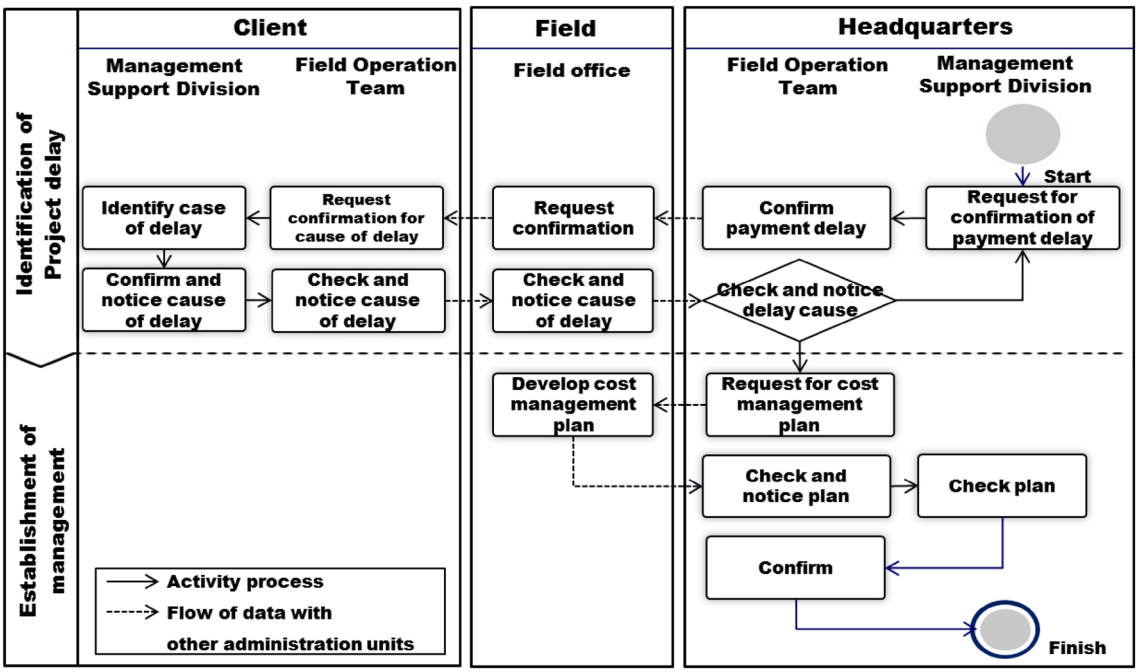

Fig. 4 Business process analysis for a payment delay

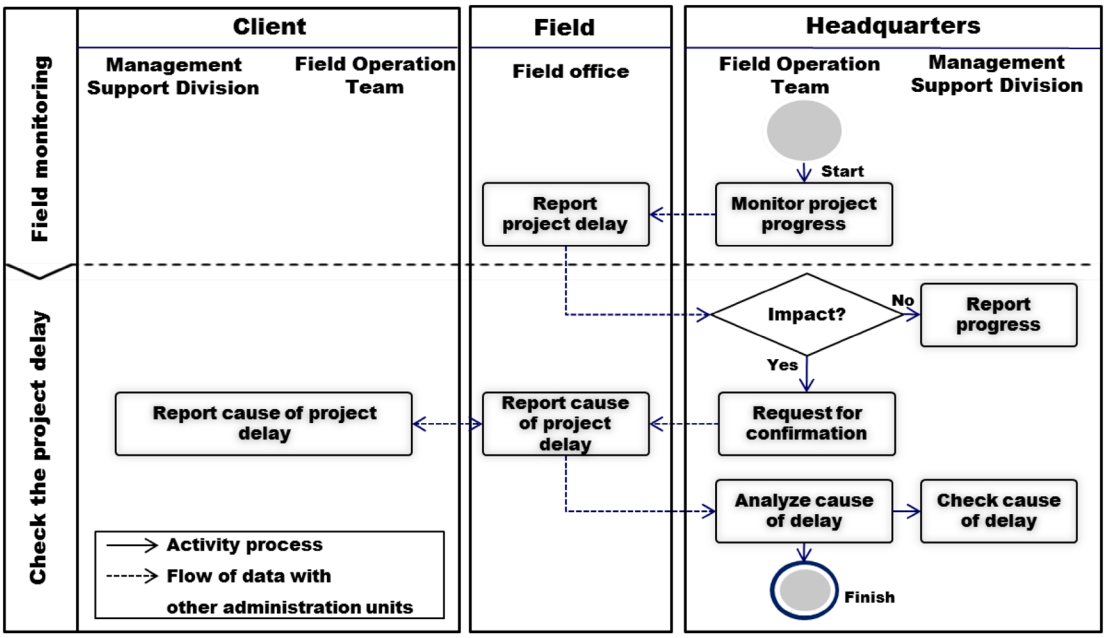

Fig. 5 Business process analysis for a project delay

to and investment in risk management must be first realized; then, a task performance and risk management system should be implemented by establishing a standard task system for each risk factor.

4.1.3 Existing Business Process in the Case of a Legal Dispute with a Client

According to the MOLIT, the number of disputes in the Korean construction industry has increased by more than 30% over the last 3 years, which signifies an initial response system for dispute management. In general, when a client decides to resolve a dispute through a lawsuit, the client delivers its intention of lawsuit to a CM firm via an official document. Upon confirming the intention of the client's dispute, the department in charge confirms/reports it to the director and establishes a response plan. This business process has a few problems, as shown in Fig. 6.

First, there is a lack of interview and discussion with the client. There can be signs before the client decides to resolve a dispute through a lawsuit, and the risk increases due to lack of proper responses of the CM firm.

Second, there are no decision-makers in the field operation team. When a problem with a client occurs, the field operation team only reports the intention of the client to the management and experiences difficulties in initial response, because there is no on-site decision-maker.

Third, responsibilities among departments are not clearly defined; there is no clear establishment of accountabilities and no division of roles among the departments or team members. As a result, the departments and individuals shift the work to others to avoid responsibility.

4.1.4 Existing Business Process in the Case of Customer Dissatisfaction with Field Service

When a client is dissatisfied with CM service, he or she presents a business improvement notice at the CM site. Upon accepting the notice, the site establishes a service improvement plan and reports it to the client. Then, the client checks the progress of the field service improvement. If the improvement plan is not implemented, the client notifies business improvement at the site once again. Apart from this, the CM firm can perform a customer satisfaction survey for the client and notify the field operation team of the survey result, which is checked and is reflected in the evaluation score of each site. Figure 7 shows the related business process. This business process has a few problems as follows.

First, customer dissatisfaction is not notified to the responsible department. As a result, response to the customer dissatisfaction item is not processed properly.

Second, there is no continuous monitoring about customer dissatisfaction with the field service. The improvement items related to the monitoring of client satisfaction are not reported back to the client. Thus, it is difficult for the client to check the corresponding improvement in CM services.

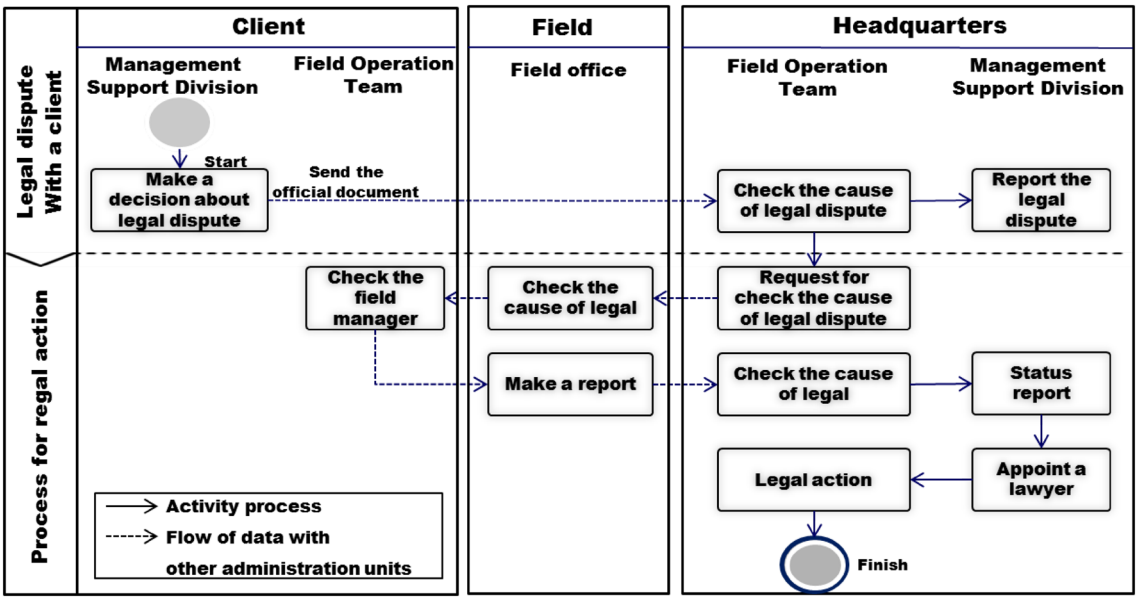

Fig. 6 Business process analysis for a legal dispute with a client

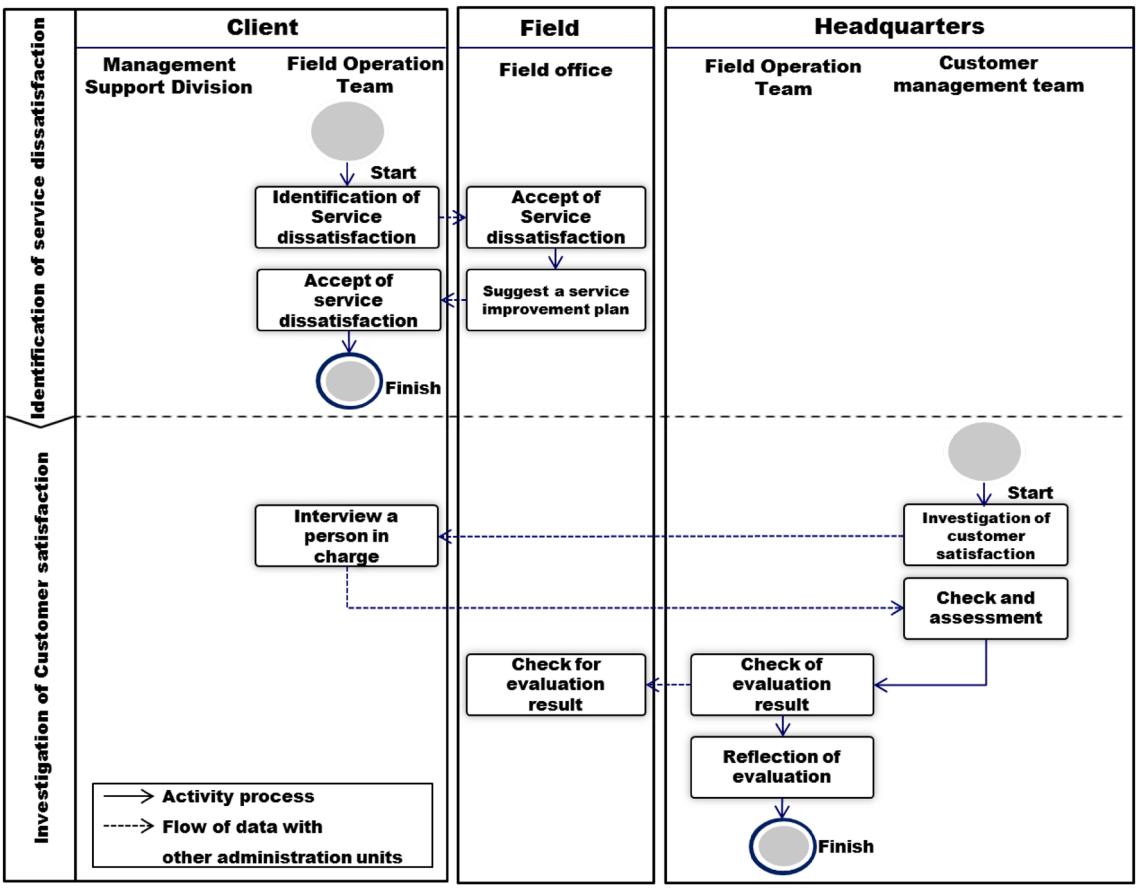

Fig. 7 Business process analysis for customer dissatisfaction with field service

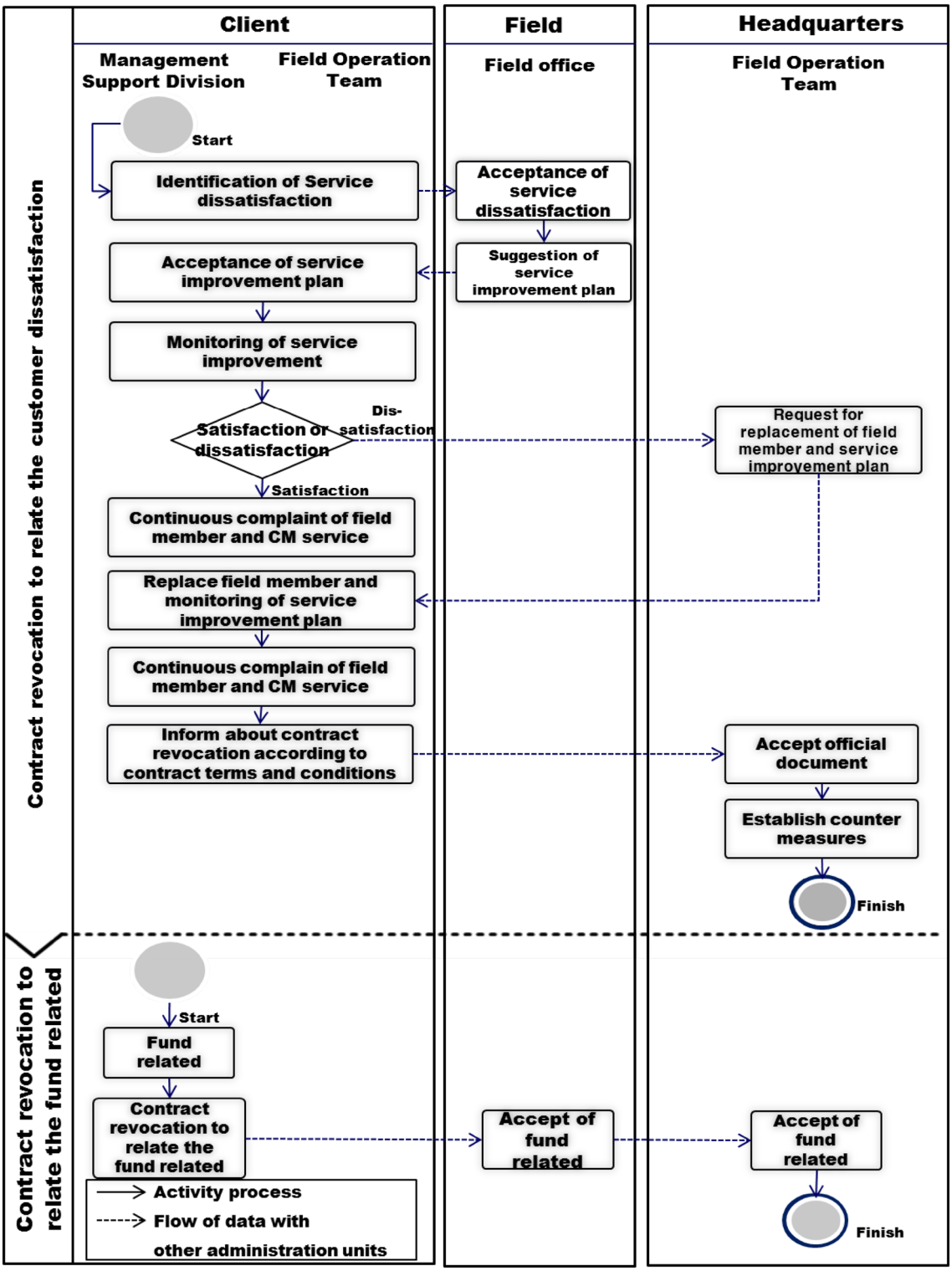

Fig. 8 Business process analysis for a contract revocation

4.1.5 *Existing Business Process in the Case of a Contract Revocation*

The client notifies contract revocation to a CM firm when the client is dissatisfied with the CM service or has financial problems. The related business process is shown in Fig. 8.

Before canceling the contract due to dissatisfaction with the CM service, the client requests business improvement at the site. If the improvement items are not implemented, the client urges improvement and fulfillment of CM services again. If the client's dissatisfaction is not resolved even after CM firm's significant efforts such as replacement of field personnel, the client notifies contract revocation. Contract revocation due to the client's financial problem refers to a case where the client notifies contract revocation to the CM firm, because the client has difficulties in executing the project.

4.2 Importance of Risk Management in CM Firms

According to the accounting information and disclosure criteria of the Financial Supervisory Service in Korea, companies are classified as high risk if their valuations have changed by more than 30%. Based on the definition, the high-risk industries in Korea include the construction, communication, and mining, with changes in valuations of 67.9, 81.6, and 77.5%, respectively [44]. The domestic construction industry is particularly sensitive to economic changes, raw materials prices, and currency fluctuations, due to the instability of the domestic industry and use of outdated technologies. Further, although the construction industry is exposed to considerable risk, investment and management of risk are insufficient and lower than those of other high-risk industries [32].

Companies with appropriate risk management strategies share a number of traits, including the derivation and management of the main risk management factors, establishment of a systematic risk management process, active communication among employees and risk managers, and sufficient attention and investment by the CEO. By contrast, the risk management practices of CM firms currently large room for improvements because of the lack of (1) defined risk factors in the field of operation management, (2) a standard task system for each risk factor, (3) responsible departments and managers, (4) risk management training, and (v) attention paid by senior management [33].

Nevertheless, since private construction companies first introduced the CM service in 1996 and CM firms' laws were first enforced in public construction companies in 2001, the sector has been growing. Hence, the findings of this study should play an important role in the future growth of CM firms in Korea. Furthermore, this study not only provides an approach for the systematic risk management of CM companies, but also reiterates the need for Korean CM firms to adopt suitable risk management practices.

4.3 Limitations and Future Research

This study focused on the derivation of risk factors of CM firms in Korea, and there are some limitations. First, the ultimate purpose of this study is to lay the foundation for systemic risk management by developing and applying risk management systems for the site operation management of CM firms, and to contribute to successful project implementation through efficient management. An analysis of CM performance data for the past 4 years published by the MOLIT showed $434 million in 2012, $287 million in 2013, $532 million in 2014, and $622 million in 2015. As shown in the data, the CM market has witnessed growth for 4 consecutive years, except in 2013, which had the lowest growth rate. The reduction in order volume in CM firms was followed by a decline in operating profit, and this highlighted the importance of cost reduction and risk management. For this, changes in the CM market were researched and analyzed. Based on these results, the status was checked to ascertain if CM firms had systemic risk management practices in place after 2013, when the significance of risk management in CM firms emerged. As part of these efforts, the risk management status of CM firms was analyzed every year from 2013 to 2015 by targeting the top 15 firms in the CM records published by the MOLIT. In addition, interviews and surveys were conducted with experts on risk factor changes. As a result, it was found that there is no change in the risk factors and RPN of CM firms, as concluded in this study.

The reasons are as follows. (1) The continuous slowdown in the construction industry since the global economic crisis has led to a reduction in sales orders, which has driven down corporate revenues. Accordingly, many companies have implemented various policies to save costs and increase profits, including reducing investment in research and development and the development of management techniques. Accordingly, systemic risk management has not received sufficient attention and investment, causing the same risk factors and RPN results to persist. (2) Understanding the importance and necessity of risk management is not sufficient. To date, construction firms and CM firms in Korea have classified cost, time, and quality as the major elements in project management; however, they have not prioritized risk management. Therefore, our study analyzed the issue of CM firms' failure to consider the impact of risk on project success and revenue and failure to make sufficient investments and efforts regarding systemic management, thus allowing the risk factors presented in this study to affect the CM firms continuously. Research and analyses of CM firms from 2013 to 2015 indicate no changes in the risk factors and RPN. As the years 2014 and 2015, but not 2013, showed

an increase in CM performance, our study determined that using 2013, the year in which the importance of risk management emerged, as a baseline in the analysis is efficient.

Second, because all interviews and surveys were conducted with experts in CM firms in Korea to derive risk factors during the management of field operations, this study lacks an understanding of the risk factors in the management of field operations of overseas CM firms. In future works, therefore, we need to derive the risk factors during the management of field operations of overseas CM firms and analyze their risk management status to compare them with those in Korea. Accordingly, causes of risk occurrence and differences were analyzed, thereby conducting a study of risk factors, occurrence frequency, and impact according to differences in construction environments.

Third, this study focused on the derivation of risk factors and the importance of analysis of those factors. Therefore, we need to conduct studies to develop a standard task system for task process analysis and efficient management of each risk factor. To do this, a management process for each risk factor of CM firms is analyzed to identify problems, and a standard work process is proposed for business process design and active communication among hands-on workers using the standard representation method called BPMN.

Fourth, overseas examples include Risk Management Plan (RMP) and Risk-Based Estimate System (RBES) in the Washington Department of Transportation (DOT), the US, which is relatively active in risk-related research, and The Simple Risk Management Process (TSRMP) designed with the support of the Royal Society, the U.K., and the Fully Integrated Risk Management System (FIRMS) of International Contractors Association of Korea (ICAK). With continuous research and practical applications, risk management capabilities have been improved further. However, systems to manage risk for CM companies are far from sufficient. We think that it is necessary to develop a risk management system for CM firms, and the derivation of the risk factors and risk analyses suggested in this paper can be used as basic data for the development of such a system.

Finally, the development and introduction of a risk management system using Building Information Modeling (BIM) is critical for the systematic risk management of CM firms in the future. In 2016, the MOLIT actively examined the introduction of CM at Risk and bidder's proposal bidding system, which is a contracting method used in advanced countries, and decided to introduce them in the public construction market after amendment of the construction law, if the efficiency of CM at Risk and bidder's proposal bidding system is proven [45]. To that end, the importance of project management and risk management using BIM is on the rise. For example, in the UK construction industry, the use of BIM has been steadily increasing in large construction firms and innovators, yet the introduction of BIM among small- and medium-sized enterprises is slow. Thus, the importance of systematic management through the introduction of BIM is recognized [46]. Furthermore, architectural, engineering, and construction (AEC) firms in the construction industries of China and other developing countries have reported the value of using BIM in the profitability and risk analysis of investment projects and the development of green building projects, refurbishment and demolition projects, and procurement systems [47, 48]. In short, risk management based on the various functions of BIM (such as 3D visualization, clash detection, construction simulation, and facilitating identification) can play a critical role in the development of an effective risk management system and the decision-making process in a project [49–51]. Therefore, continuous investments and efforts toward BIM is important for systematic risk management and successful project performance in the construction industry.

5 Conclusions

The separation between design firms and general contractors in the Korean construction industry was made only after the initial establishment of the construction law in 1958, and subcontractors emerged with the introduction of the licensing system for specialty contractors in 1975. The 1990s was a decade in which the Korean construction industry had become large and complex, and, along with the advancement and diversification of the industry, numerous safety accidents had occurred. Accordingly, legislation on construction supervision focusing on the quality management tasks in the construction phase was enacted in 1994. Later, amid the increasing importance of management tasks recognized in the construction life cycle and the early phase of the construction industry, the introduction and legislation of CM in 1997 led to a full-scale implementation of CM in the Korean construction industry. For the past 20 years since the introduction of CM, the Korean CM industry has enjoyed consistent growth, about which various studies have been conducted. However, a few studies have focused on the risk management of Korean CM firms.

The analysis results on the research and development of CM technologies in Korea and abroad [52] showed that 33% of the studies were on general CM, 18% on time management, 17% on cost management, 13% on construction information technology (IT), 9% on safety management, 8% on construction policy, and 2% on quality management. Although the largest percentage of the current research targeted general CM, most of the studies were about construction management, CM business practice, and the present condition of construction, and few were about CM risks.

Particularly, little research on CM risk management in Korea had been conducted, because Korean CM firms lacked

an understanding of the importance of risk management and because the effects of risks were often delayed, affecting the field and the head office after the passage of time. Furthermore, it is usually easier to determine risks based on intuition and experience than on systematic methodologies or logic. Another reason for the paucity of research was the Korean construction industry's peculiarities that still primarily stressed time management, cost management, and quality management. Accordingly, CM firms invest less in personnel and technologies for risk management, and due to the burden of going public with CM risks, which CM firms would have to do during construction site management, CM risk-related research and development continues to lag. Despite the abundance of studies that have identified risk factors associated with the construction industry, little is known about the specific project risk factors of CM firms. Because of the lack of effective risk management practices in this sector, a project owner can quickly oppose an expectation of improved project performance from using a CM service. To bridge this knowledge gap, the present study investigated the risk factors critical to project execution in CM firms and ranked them using the AHP and FMEA methods. Data were derived from interviews with executives in the top 15 Korean CM firms, and a survey was employed to develop a priority ranking. An in-depth analysis of existing business processes for the two highest ranked risk factors followed.

The results of this study revealed that payment delays, project delays, and legal disputes with clients are the three most prominent risk factors in the construction industry. It was further found that the risk factors of high detection indicate high severity, while those of low severity also possess low importance. Hence, payment delays, project delays, legal disputes, customer dissatisfaction with field services, and contract revocation are the risk factors that demand attention from both headquarters and field offices. These factors could have a significant impact on a company's financial performance; however, forecasting them is challenging, because they are difficult to detect in advance. By contrast, the lack of available workers and customer dissatisfaction with headquarters' technical assistance has a lower priority. In terms of the former, the increased availability of workers in the construction industry due to the persistent recession since 2008 has improved the supply of workers needed for projects. For the latter, the increase in the accumulation of project data and the rising capability of CM firms mean that technical assistance for clients can be provided locally, without damaging client satisfaction.

Finally, we found that the two highest ranked factors—payment delay and project delay—are currently not being managed systematically in CM firms because of (1) lack of communication between headquarters and field offices, (2) shift of responsibility from headquarters to field offices, (3) absence of regular monitoring of project progress, and (4) ex-post management practices.

Because CM practices in Korea have their roots in the structure and contractual arrangements of CM for fee practices in the US, the findings of this study should be suitable for global generalization. Hence, this research can greatly assist industry practitioners and decision-makers in establishing robust risk management practices and for making more informed decisions. Developing and applying robust risk management strategies can maximize firms' profitability and project performance while minimizing client dissatisfaction.

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Compliance with ethical standards

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