INTERNATIONAL JOURNAL OF SUSTAINABLE CONSTRUCTION ENGINEERING AND TECHNOLOGY
VOL. 14 NO. 1 (2023) 21-31

IJSCET

http://publisher.uthm.edu.my/ojs/index.php/ijscet

ISSN : 2180-3242 e-ISSN : 2600-7959

International Journal of Sustainable Construction Engineering and Technology

Why Are the Frequently Reported Delay Factors in Construction Projects Recurring?: A Qualitative Study

Jeonghyun Kim[1*], Pilar Bilbao[2]

[1]Faculty of Civil Engineering,
Wrocław University of Science and Technology, Wybrzeże Wyspiańskiego 27, Wrocław, 50-370, POLAND

[2]Faculty of Architecture and Urbanism,
National University of La Plata, 7 Avenue 776, La Plata B1900, ARGENTINA

*Corresponding Author

DOI: https://doi.org/10.30880/ijscet.2023.14.01.003
Received 12 July 2022; Accepted 07 February 2023; Available online 14 February 2023

Abstract: Since a construction project involves a huge amount of resources, delays in construction have an unfavorable impact on all stakeholders. Due to the large-scale, specialization, and complexity of construction projects, construction delays are reported globally. Previous quantitative studies mainly through questionnaires have focused on identifying delay factors. However, the identified delay factors show little difference regardless of time and region, thus, a more fundamental study on the root causes of the delay is needed. Therefore, this study intends to discuss in depth the causes of delay factors identified in previous studies from professionals' point of view. According to the interview with the experts, schedule delays are caused by factors such as short initial construction periods, errors in design documents, and rework. The effect of construction delays includes not only work quality degradation and increased risk of workplace accidents, but also the professional ethical dilemma of managers. The experts mention that the construction delay can be alleviated with basic measures such as estimating spare construction period, reviewing design documents before work, and thorough quality control. This paper helps in understanding of the identified construction delays and can provide valuable insights in formulating effective strategies to avoid delays in construction projects.

Keywords: Construction delays, delay causes, construction management, construction project

1. Introduction

The construction industry is the foundation of the national economy and is one of the main strategies for national economic revitalization and development. Therefore, large-scale construction projects are often discussed as a breakthrough for economic activation and job creation plans. The construction industry in Korea accounts for about 15% of the gross domestic product (GDP), and the amount of construction project orders has gradually increased every year, exceeding 190 trillion Korean Won (approximately 160 billion USD) in 2020. Due to the nature of the construction projects, which take an enormous amount of time and expenses, the success of the construction projects is crucial. The success of the construction project can be defined as when the project goals and expectations are met. Key factors that measure whether goals and expectations of the construction projects are achieved include budget, schedule, and quality [1]. However, today's construction work is becoming larger, specialized, and complex, and the decision-making process is complex and the stakeholder is intertwined, which increases in uncertainty, resulting in potential risks that could impede successful construction management [2].

*Corresponding author: jeonghyun.kim@pwr.edu.pl

Delay in construction can be defined as the failure to complete construction by a designated date and is caused by certain factors that occurred during the early to final stages of a construction project. Delays are responsible for the increase in total construction cost due to changes of the work order and scope to compensate for the delay, and the decrease in labor productivity due to overtime, as well as the increase in low work quality and workplace accidents. Furthermore, it may cause litigation and disputes between stakeholders, and civil complaints by citizens (Figure.1). In fact, the number of construction disputes in Korea is increasing every year, and about 30% of the cases and about 60% of the total arbitration amount filed with the Korea Commercial Arbitration Board over the past 10 years occurred in the construction sector [3].

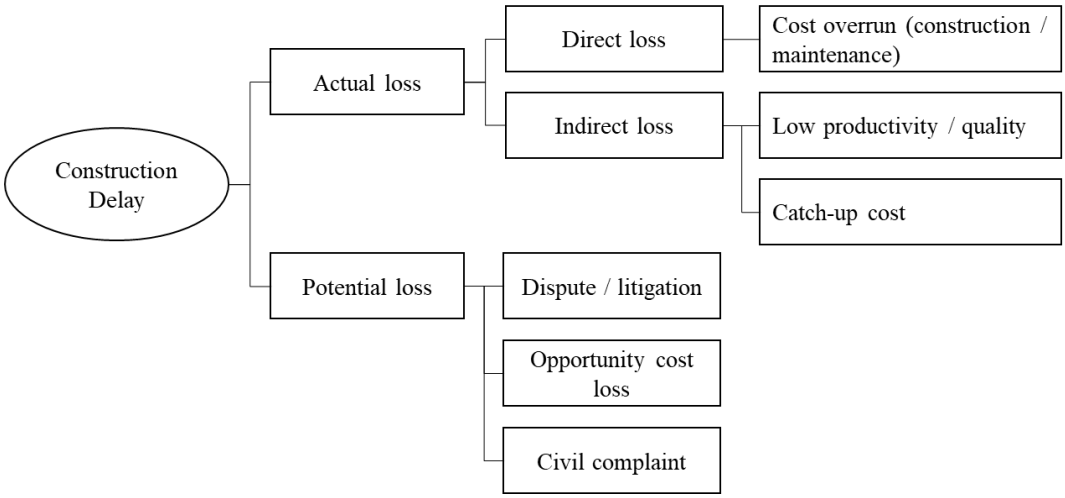

Fig. 1 - Losses in a construction project by delay

As for the status of construction delays, one out of three public construction sites in 2013 extended the construction period, and from 2010 to 2014, 180 out of a total of 550 construction sites (32.7%) extended the construction period [4]. These delays have been reported worldwide and thus delay factors have been identified by several researchers from different countries in the form of quantitative studies such as survey research. In those studies, respondents were given to choose a frequency of occurrence of delay factors selected by each researcher. From a macro perspective, delay factors of construction projects carried out within the similar cultural and political sphere may be analogous to each other. For example, in developing countries, financial problems are often reported as a major cause of delays in construction [5], but in developed countries, financial problems are not often identified as a major cause of construction delays [6,7]. Nevertheless, comprehensively, the main delay factors frequently reported in the previous literature consist of financial problems, design errors, order changes, short construction periods, and so on, regardless of when or where the research was conducted. Therefore, a more fundamental question must be posed. 'Why do construction delay factors, which have already been frequently reported in the past, remain as delay factors to this day?' Therefore, it can be more helpful to understand the underlying practical problems by listening to the thoughts of practitioners on the causes of delays investigated in previous literature, rather than overlapping studies on the factors of delays in construction. However, few studies have been conducted on the causes of the delay from the perspective of practitioners. This study explores the root causes of construction delays in Korea through interviews with experts on delay factors identified in previous literature.

This study can provide scholars and industry practitioners with an in-depth understanding of the fundamental causes of construction project delays, as well as help create effective strategies to avoid construction delays. Except for the introduction, the rest of this paper consists of four sections. The following section provides a literature review of the main delay factors in construction projects reported in several countries. Next, the research method (interview) adopted in this study is elaborated. After that, the results obtained through interviews with experts are presented and discussed. In the last section, the conclusions of this study are presented.

2. Literature Survey

A literature review was conducted on the causes of delays in construction projects. Table 1 presents the main factors observed in the literature. Although the period when the survey was conducted varied from 2006 to 2017, there was no significant difference between the studies in the delay factors of construction projects identified in each study. The top delay factors reported mainly in Korean construction projects are owner interference, discrepancy between design documents and construction site, design errors, and order changes. For comparison, a literature review of delay factors for global construction projects was also conducted (Table 1). Kog [8] investigated the delay causes of construction projects over 50 countries and Table 2 shows the top 10 causes. These include financial problems, changes

to work during construction, lack of materials and inadequate planning. While all the studies have helped to better understand the issues associated with delay factors in construction projects, but have some limitations: in other words, it can be seen that there is a difference in ranking between the frequently reported delay factors at the global level and the Korean domestic level, but there are few new delay factors. Shahsavand et al. [9] mentioned that some existing studies mainly focused on finding the cause of the delay, identifying very limited factors or ignoring some important factors. This may be a limitation of the method used in some previous studies. In the studies in Table 1, surveys were the dominant approach used to identify the delay causes. The selection of the delay factor for the questionnaire design was based on existing published literature, and the respondents were asked to select the frequency of occurrence of the selected factor within a 4 or 5-point scale. After that, the frequency of delay factors was ranked based on the survey results. However, Agyekum-Mensah and Knight [10] have pointed out that surveys may not provide a new understanding or verification of the problem as only existing factors in literature can be repeatedly rotated.

Table 1 - Major factors of construction delay from literature

Reference	Country	Type	Major causes of delay
[11]	Korea	General construction	• Public interruption • Changed site condition • Failure to provide required construction site • Unrealistic contract durations • Design error
[12]	Korea	Building construction	• Shortage of manpower/productivity • Delay in construction of subcontractors • Design error
[13]	Korea	Building construction	• Discrepancy between drawings and actual site conditions • Construction delay by subcontractors • Design error
[14]	Korea	Building construction	• Design changes • Construction delay by subcontractors • Natural disaster • Design error • Interruption by owner
[15]	Korea	General construction	• Project size and complexity • Designer's incompetence • Discrepancy between contract terms and actual site conditions • Inflation, rising material and labor costs
[16]	Korea	Structure in apartment building	• Inaccurate master schedule prepared by owner • Work accident • Claim / dispute • Inaccurate work plan / design error
[17]	Korea	Building construction	• Discrepancy between contract terms and actual site conditions • Interruption by owner • Designer's incompetence • Weather condition
[18]	Korea	Building construction	• Lack of workforce planning • Prevention and handling of civil complaints • Inappropriate construction method • Improper construction and procedures
[19]	Malaysia	High-rise construction	• Design changes • Poor labor productivity • Material shortage • Inadequate planning
[20]	Kuwait	Housing	• Frequent order changes by owner

			• Financial constraints • Owner's lack of experience • Materials • Weather condition
[6]	UAE	General construction	• Delay in preparation and approval of drawings • Unrealistic contract durations • Slow decision-making by owner • Shortage of manpower/productivity • Poor supervision and poor site management
[21]	Iran	Gas pipeline	• Unrealistic contract durations • Material shortage • Slow land expropriation due to resistance from occupants • Frequent order changes by owner
[22]	China	Building construction	• Delay in payments • Frequent order changes by owner • Delay by subcontractors • Interruption by owner
[23]	China	Grain bin construction	• Shortage of adequate equipment • Poor communication among contracting parties • Problems with subcontractors • Designer's incompetence • Frequent order changes by owner

Table 2 - Top 10 construction delay factors on a global scale [8]

Rank	Delay Factor	Proportion (%)
1	Financial and payments of completed work by owner	72.9
2	Variation orders/changes of scope by owner during construction	62.7
3	Late delivery/shortage of materials	62.7
4	Ineffective planning and scheduling	54.2
5	Financing by contractor	49.2
6	Poor site management and supervision by contractor	45.8
7	Inadequate contractor experience/incompetence contractor	42.4
8	Equipment (or operator) availability and failure	39.0
9	Slow decisions by owner	39.0
10	Late issuance of instructions, information or drawings/incomplete drawings/ inadequate information/delay in revising and approving design documents/ delays in design work	37.3

3. Research Method

Due to the limitations of quantitative surveys using questionnaires, there is a lack of realistic and fundamental discussion on the reasons for delays in construction projects. Therefore, in order to understand the causes of construction delays from a professional perspective, a qualitative study was conducted in this study. For the discussion of the delay factors identified in literature reviewed in the previous section, experts who met both of the following criteria were intentionally selected: (i) at least two years of industry experience; (ii) experience in managing two or more construction projects. The reason for setting the minimum experience to be at least 2 years is because the perception of delays is different depending on the length of service [14]. In the interview, 2 owners, 2 supervisors, 7 builders, and 4 designers participated. Participants' experience consists of 2-3 years (27%), 3-6 years (53%), and 6-11 years (20%). This distribution of years of service indicates that the interviewees are primarily practitioners rather than decision-makers in the organization. As for the survey method, the purpose of the study was explained to the interviewees, and data on factors of delay in construction collected from the literature were delivered. The following three questions were asked to all interviewees, and additionally, the interviewees were allowed to make a free statement about the delay.

• Have you ever experienced delays on a construction project?

• What do you think is the root cause of construction delays?
• What do you think is the solution to the construction delay?

4. Result and Discussion

4.1 Structure

With the exception of one practitioner with two years of work experience, 14 interviewees responded that they experienced delays in more than one construction project.

4.1.1 Short Duration of Construction Project

The unrealistic duration of construction projects, which were initially estimated to be short, is the major cause of construction delays mentioned by many interviewees, which results in other delay factors. According to the design VE guidelines for public works, the designer should calculate the optimal construction period and present it in the basic and detailed design documents, but Lee and Yun [24] noted that the construction period calculation by the designer is affected by the building use planning presented by clients. Due to the economic logic that time is money, most clients want their construction work to be completed in the shortest possible time. The interviewees said they seldom felt that the construction period was sufficient for the projects they were working on.

Interviewees who have worked for a state-owned enterprise over 7 years and who are primarily clients of construction projects agreed with the above statements. An interviewee, who is in charge of design, ordering, construction management, and supervision, mentioned that the construction project is highly subdivided and specialized, hence, it is important to calculate the construction period from a holistic perspective. According to the construction period calculation standards for public construction works, the construction period is specified as the sum of the preparation days, non-working days (e.g. due to holidays, weather conditions), working days, and clean-up days. The interviewee pointed out that even the appropriate construction period is calculated based on past project data and various bases, the decision-makers within the same organization reduce the construction period based on their experience, considering often merely the working days. Although based on the rationale that increasing resources, such as manpower and equipment, can shorten project duration, it needs to be clarified that the lack of skilled manpower and materials is one of the most frequently reported delay factors. Olawale and Sun [25] stated that professionals should have the courage to refuse unrealistic project schedules. However, in the Korean corporate culture of a vertical hierarchy, especially in construction companies represented by the conservative corporate culture, it is not easy for subordinate personnel to express their opinions against the decisions of the superiors. Therefore, construction projects with shorter durations in this way are called for bids. The effect of organizational culture with construction delays has been investigated in previous studies [26]. Moreover, the interviewee said that even if the construction period is shortened, there are companies participating in the bidding. This is because construction companies that have not achieved a certain amount of construction performance may have some restrictions on bidding for public construction works, thus, in some cases, several construction companies apply for bidding even if the financial profit from winning the contract of the project is not great [27].

A construction manager who worked for a multinational construction company recounted an experience in which short construction periods were set due to insufficient on-site surveys of cross-national cultures and lifestyles. The company that the interviewee worked for mainly carried out construction projects in Asia, including Korea, China, and Vietnam, and then expanded its business to Europe. Since the character of the construction projects, such as design documents, layouts, materials, was similar irrespective of region, similar durations and amounts were allocated for the construction project in Europe. However, about 30% of construction site workers in Korea are foreigners from China and developing countries, and the working hours of these workers are relatively longer compared to those from other developed countries. In 2020, the annual working hours in Korea is 1908 hours, which is 15-25% longer than the OECD average of 1687 hours and the EU-27 average of 1513 hours. Furthermore, conventionally, there are no closed days at Korean construction sites. Without taking into account the details of these differences, the construction durations were estimated based on high work intensity including shift work and weekend work. According to his statement, delays began to occur from the very beginning of the project (i.e, from concrete foundation work). Although weekend work and night shifts were performed to compensate for the delay, the number of workers who came to work was only about 10, which was less than 5% of the number of daytime workers on weekdays.

Completing construction projects in a short period of time can be a key performance indicator for individuals and companies, and in fact, some construction companies reward their employees for shortening the construction period. However, under the guise of an optimized schedule, an overly short construction period makes it difficult to cope with future risks. As there are always uncertainties and multiple contractors and sub-contractors involve, construction projects rarely proceed as originally planned. In particular, if the preceding construction work is delayed, the companies in charge of the subsequent works have to start working on a different day than scheduled, raising the possibility of additional risks. Thus, some interviewees mentioned that having float time may be better in terms of suppressing additional delay risks.

4.1.2 Design Error and Change

Issues related to design documents have been identified in previous studies as the top factor inhibiting effective project cost management and time management [25]. Construction delays due to changes in design and work plan of construction projects in Korea account for 28.3% of the total construction delays [28]. Moreover, design errors are a leading cause of accidents, and it has been shown that 80-90% of failures in buildings, bridges and other civil structures are caused by serious design errors [29].

The reasons for design change can be divided into two main categories: changes due to human errors; and unexpected variables that occur during construction. The difference is that the former is sufficiently preventable and the latter is nearly impossible to predict. Moreover, the former is responsible for the poor quality of the design documents, the root causes of which include: insufficient construction experience of designers; uncertain guidelines for drawing documents; lack of consultation among the persons involved; lack of understanding of construction materials and methods; insufficient review of design documents; frequent order of design change; short time and low cost assigned for design work [30]. Previous studies have proven that low design documents quality has a significant relationship with a cost increase, delay, quality degradation, and occurrence of rework in construction projects [31,32]. Therefore, it is necessary to make an effort to minimize design errors in advance through double-checking and cross-checking among each part of the work.

In the latter case, on the other hand, design changes occur for unexpected reasons unless the construction is physically performed. For example, as shown in Figure. 2, construction was delayed due to the presence of unexpected obstacles or underground structures during excavation work. Although the design documents included the results of underground exploration, physical underground exploration was rarely carried out for the entire area of the construction site, thus, underground obstacles and underground facilities that were not recognized in a specific spot may be found during construction. One interviewee recounted his experience with the discrepancy between the drawings and the actual construction site. The tasks he managed were to demolish the masonry bricks covered on concrete walls and finish the concrete wall with paint. During the masonry demolition work, it was found that the space between the concrete wall and the masonry was filled with cement mortar. In general, in the combination of concrete wall and brick finish, the mortar is not applied to concrete vertically, thus, only the removal of bricks was reflected in the scope of work. Consequently, unscheduled time was taken for removing the cement mortar from the wall, and additional costs such as waste disposal costs were incurred. As can be seen in these cases, the discrepancy between the site and the design document was selected as a major delay factor in the following literature [13,15,17].

Fig. 2 - Underground obstructions found during excavation work

4.1.3 Shortage of Labor

Lack of workers and workforce planning was identified as a major delay factor in the following case study conducted by Lee and Yun [18]. According to this interview, respondents agreed that mobilizing workers on a 'planned schedule' is not the matter. Conversely, there may be problems in mobilizing manpower on the 'changed schedule' due to reasons such as changes in construction order and construction methods caused by delays. In particular, if the construction process is managed without any clear plans, the order of work sometimes changed on a daily basis, and in this case, it is difficult to mobilize manpower immediately, resulting in a labor shortage. This is related to the affiliation of workers. Workers performing physical work on site are mainly composed of individuals and small independent teams who are not affiliated with the construction company that won the construction contract. That is, if the preceding

process is delayed, workers and equipment operators in the subsequent process work at other construction sites for a living rather than waiting.

4.1.4 Unqualified Workers and Poor Management

A construction project consists of several subcontractors and re-subcontractors, the more subcontracting, the lower the profit for the subcontractor. Therefore, some subcontractors tend to hire illegal immigrants with low labor costs to maximize profits. According to the press release of the Construction Association of Korea [33], about 70% of foreign construction workers working in Korea were illegal immigrants. In order to hide their identity, these unqualified foreign workers often skip safety and quality training and aim to somehow complete the project within the construction period given regardless of quality or safety. Hence, on the surface, the construction seems to be progressing quickly, but in reality, the quality and safety-related risks are very high, which can lead to rework and safety accidents, which can be a major impediment to the success of the project. To prevent such low-level speed warfare, construction managers and supervisors are included in the construction project, but professionals say that the number of managers is insufficient. One interviewee once alone managed 6 residential buildings with more than 20 stories, and another respondent mentioned that only two people managed a factory building with a total floor area of 40,000m^2. Surprisingly, it is a long-standing practice in the construction industry to assign only a few construction managers to such large sites. When a problem occurs in one area of the site, the construction manager tries to solve it on the spot, but all construction except that area proceeds without a supervisor. As in the case above, it is practically impossible for the manager to check all the construction processes.

4.1.5 Rework

Rework is an action with no added value and may occur due to design documents errors, human errors, material defects, damaged material during construction, work change by clients and poor management, etc. Furthermore, rework can lead to the following adverse consequences: loss of motivation and increased fatigue of workers; quality degradation; loss of profit; inter-organizational conflict; additional material and resource consumption; bad corporate reputation [34].

The extent of delay due to rework depends on the scope of the work and when the defect is discovered. As shown in Figure 3(a), if the reinforcing bar directly touches the formwork or the appropriate cover thickness is not secured, immediate correction is possible on site, and although it may take some time, there is no critical delay in most cases, while reworks combined with the demolition of concrete due to incorrect construction and re-ordering of damaged ready-made materials prolong the period of activity, resulting in resource over-allocation (Figure3(b)). In this case, external factors such as weather conditions, curing duration, supplier schedules, and material transport should be taken into consideration and these factors can cause significant delays in projects. In extreme cases, structural instability or illegal design and construction may require complete demolition and reconstruction, resulting in widespread delays for years. In 2014, the 28-day compressive strength of the concrete wall of an apartment under construction in Korea did not meet the design standards, hence, the building was completely demolished and reconstructed.

(a) (b)

Fig. 3 - Examples of rework (a) inappropriate cover depth; (b) damaged precast concrete during construction

4.1.6 The One-Off Nature of Construction Projects

The construction team consists of designers, clients, supervisors, contractors, and subcontractors to construct a uniquely designed structure within a set time frame. Construction projects are usually of a one-time nature, where one construction project ends and the next one begins. This characteristic can make construction managers insensitive to

construction delays. Construction managers are assigned to a new construction project once the previous project with or without the delay has somehow been completed. However, a newly-started project actually has no delay, thus, no action is taken related to the delay. Then, when the delay in construction of the new project is discovered, necessary countermeasures begin to be established, but this is just a repetition of the past, and there is no proactive approach.

4.2 Effects of Construction Delay

4.2.1 Low-Quality Construction Work

If the completion date of a construction project is exceeded, compensation for delay is imposed on the contractor. Hence, the contractor is often forced to work excessively to shorten the construction period, which leads to poor construction. Interviewees shared their experiences with quality degradation caused by delays. During the interview, it has also been observed that construction managers encountered professional ethical dilemmas.

When an interviewee was an entry-level engineer, he found that only one rebar was missing from a slab with an area of about 3000m2 while inspecting before concrete pouring. In concrete work, on-site inspection before pouring is the last chance to correct errors, but, in general, finding faulty work causes delays, and missing or ignoring it creates potential quality issues. However, many construction engineers know empirically that the omission of single rebar does not significantly affect the deterioration or collapse of the structure. Due to strong pressure from the clients and superiors for rapid construction and ready-mixed concrete cars waiting to be poured at the construction site, the interviewee confessed that he was a bit hesitant to give correct instructions for rebar reinforcement.

Another interviewee provided pictures of concrete (Figure 4), along with recounting experiences of pouring concrete in sub-zero weather. Due to the delay in the preceding work, the concrete work, which should have started in July, could be started at the end of November. In order for concrete to function properly, curing at the beginning of casting is highly crucial, thus, it is not recommended to pour concrete in cold weather. However, if the concrete work was not carried out, it was impossible to proceed with the subsequent works, so a serious delay was unavoidable. After much consideration, the person in charge of the construction site managed by the interviewee decided to push ahead with concrete work in winter to make up for the delay. Thermal insulation was carried out using a hot air blower and bubble sheet, but damage from freezing as in Figure 4 was observed in various spots. The interviewee also said that the site manager's decision to do concrete work in the winter was unacceptable as an engineer, but understandable as the head of a family and an employee under pressure from superiors.

(a) (b)

Fig. 4 - Damage to concrete poured in sub-zero temperatures (a) concrete surface freezing; (b) damaged concrete surface by freezing

4.2.2 Workplace Accident

Schedule delay is closely related to the increase in the accident rate [35,36], and reckless construction to shorten the construction period is frequently cited as the cause of various serious accidents occurring at construction sites. As examples, one of the causes of 38 deaths in a fire at a logistics center construction site in 2008 was the unreasonable demands of the client for shortening the construction period [37]. In addition, in the collapse accident of the exterior wall of an apartment (from 38th to 23rd floor) under construction in 2022, a construction participant said that the cause of the collapse was the concrete work in winter due to the client's time pressure, followed by the poor concrete curing [38]. Whenever such serious disasters including worker deaths occur, a tight construction period is attributed to the root, and there are many opinions that the construction culture that indiscriminately presses hasty construction should be eradicated. According to the coverage of an article [39], an anonymous site manager at a construction company said, “In winter, we, the construction company, do not want to do certain work that has a risk of accidents, such as concrete

work, if possible. However, delays in construction and site management costs are non-compensable by clients. There are also calls every day asking about the progress of the construction. We are in a work environment where we are forced to take risks and reluctantly push our work".

4.3 Prevention and Resolution of Construction Delay

According to the study conducted by Kim and Kim [14], extended working hours accounted for 46% of measures to offset schedule overrun, followed by an increase in the number of workers (22%), an increase in input resources (17%), an increase in equipment (10%), and Others (6%). However, it is worth emphasizing that these are not measures to alleviate construction delays, but merely a means to meet the deadline of project through resource mobilization.

The interviewees could not confidently respond to the question about how to resolve construction delays. Some interviewees argue that construction projects should not be in tight timeframes and that spare construction periods should be calculated for the following reasons: (i) construction methods and materials are specialized, so that the clients and designers cannot determine the appropriate construction period based on the details of all these construction methods; (ii) given decreasing legal maximum working hours and adverse weather conditions due to climate change, estimates of construction schedule based on past construction history may not adequately reflect today's reality. Experiencing recurring construction delays, some other respondents expressed their skepticism of the prospects of remedial measures for construction delays. Despite numerous accidents and controversies caused by the lack of construction period as discussed in the previous sections, clients still tend to calculate the construction period tight due to opportunity cost. In the design stage, clients and designers sometimes try to shorten the construction period by applying a specific construction method. However, the interviewees emphasize that if construction methods that shorten the construction period are applied, the contract period will be shortened accordingly. For example, if the modular construction method, which has the advantage of shortening the construction period compared to the traditional construction method, is applied, the amount of time saved by the modular construction is reduced in the first place. In other words, there is an effect of reducing the total construction duration compared to the traditional construction, but this has nothing to do with mitigating the risk of delay. As with the past and present situations, the respondents predicted that there would be many delays in future construction projects, and the causes of the delay would not differ significantly. Nevertheless, respondents recommended that the following basics be devoted to in order to curb the risk of delays:

• A realistic contract period calculation for the construction project should be a prerequisite.

• Prior to the start of construction, an intensive final review of design documents is required. In particular, all parties involved (clients, designers, contractors) should participate in the check.

• Unnecessary rework should be prevented in advance through training and supervision of work quality.

• If a delay is recognized, a realistic countermeasure should be established promptly in consultation with each person concerned.

5. Conclusion

In this study, a detailed discussion was conducted on the reasons for delays in construction projects from a professional point of view. The causes of delays in Korean construction projects identified in existing literature were explored and the effects of delays were described. Strategies to mitigate construction delays were then briefly discussed.

This qualitative study showed the 'real' causes of construction delays such as short initial construction contract period, lack of site managers, rework and design error. The construction delays had an impact on the work quality, safety of workers, as well as the professional ethics of managers. While it is ideal to complete construction without delay, it is not realistically feasible, hence it is important to proactively prevent the risk factors that can cause delays. Professionals remarked that a commitment to the basics, such as estimating the appropriate construction period, a thorough review of design documents, and quality control, can mitigate delays in construction projects.

This study provides an understanding of the root causes of construction delay factors from a practical perspective and raises important issues. Practitioners can establish construction management strategies and delay control strategies based on the underlying causes of construction delays identified in this study. However, since the interviews were mainly based on the empirical evidence of the respondents, the results of this study do not represent the causes of delays in all construction projects. Further research on delay is needed to build a more diverse knowledge base for the achievement of successful construction projects.

References

Sohn T., Park H-D.: *Direction and factors for estimating construction period for ensuring Adequacy of construction period in public construction projects*. Seoul, Korea; 2018.

Kim KH., Kim KH., Lee YS., Kim JJ.: A study about influence of risk factors in relation to construction cost increase and schedule delay on the reinforced concrete construction. *Journal of the architectural institute of Korea (structure & construction)*, *24* (2008) 5, pp. 165–172.

KCAB.: *Casebook of domestic arbitration*. Seoul, Korea; 2019.

Kim D.: A study on the legal issues due to time extension of public construction work. 2016.

Alaghbari W., Razali A. Kadir M., Salim A., Ernawati.: The significant factors causing delay of building construction projects in Malaysia. *Engineering, Construction and Architectural Management*, *14* (2007) 2, . doi:10.1108/09699980710731308.

Faridi AS., El- Sayegh SM.: Significant factors causing delay in the UAE construction industry. *Construction Management and Economics*, *24* (2006) 11, . doi:10.1080/01446190600827033.

Assaf SA., Al-Hejji S.: Causes of delay in large construction projects. *International Journal of Project Management*, *24* (2006) 4, pp. 349–357. doi:10.1016/j.ijproman.2005.11.010.

Kog YC.: A global survey of top construction delay factors. *International Journal of Construction Project Management*, *13* (2021) 1, pp. 63–87.https://www.proquest.com/scholarly-journals/global-survey-top-construction-delay-factors/docview/2568752258/se-2?accountid=46407Accessed.

Shahsavand P., Marefat A., Parchamijalal M.: Causes of delays in construction industry and comparative delay analysis techniques with SCL protocol. *Engineering, Construction and Architectural Management*, *25* (2018) 4, pp. 497–533. doi:10.1108/ECAM-10-2016-0220.

Agyekum-Mensah G., Knight AD.: The professionals' perspective on the causes of project delay in the construction industry. *Engineering, Construction and Architectural Management*, *24* (2017) 5, pp. 828–841. doi:10.1108/ECAM-03-2016-0085.

Acharya NK., Im H-M., Lee Y-D.: Investigating delay factors in construction industry: A Korean perspective. *Korean Journal of Construction Engineering and Management*, *7* (2006) 5, pp. 177–190.

Ahn S-H., Yu J-H., Kim C-D.: An Analysis on Work Delay Factors in Apartment House Construction. *Korean Journal of Construction Engineering and Management*, *8* (2007) 6, pp. 159–166.

Lee S-H., Lee S-H., Kim J-H., Kim J-J.: Delay Factors Based on the Importance of Finish Work in Apartment Construction Project. In: *Proceedings of the Korean Institute of Building Construction Conference*. The Korean Institute of Building Construction; 2010:125–129.

Kim J-Y., Kim E-S.: The State of Schedule Management and the Recognition of Duration Shortening. *Journal of the Korea Institute of Building Construction*, *10* (2010) 5, pp. 87–94. doi:10.5345/JKIC.2010.10.5.087.

Jung JH., Kim DY., Lee HK.: The computer-based contingency estimation through analysis cost overrun risk of public construction project. *KSCE Journal of Civil Engineering*, *20* (2016) 4, pp. 1119–1130. doi:10.1007/s12205-015-0184-8.

Kim EJ., Kim JH., Lee JH., Huh YK.: Analysis of Different Perception on the Importance of Construction Schedule Delay Factors by Participants in Apartment Construction Projects. *Journal of the Architectural Institute of Korea*, *18* (2016) 3, pp. 165–172.

Lim K-J.: An analysis on the delay influence factors in apartment construction site and its improvement measures. 2017.

Lee S-M., Yun S-H.: A Study on Delay Factors in Apartment Housing Project Through Case Study. *Journal of Next-generation Convergence Technology Association*, *2* (2018) 1, pp. 6–14.

Kaming PF., Olomolaiye PO., Holt GD., Harris FC.: Factors influencing construction time and cost overruns on high-rise projects in Indonesia. *Construction Management and Economics*, *15* (1997) 1, . doi:10.1080/014461997373132.

Koushki PA., Al- Rashid K., Kartam N.: Delays and cost increases in the construction of private residential projects in Kuwait. *Construction Management and Economics*, *23* (2005) 3, . doi:10.1080/0144619042000326710.

Fallahnejad MH.: Delay causes in Iran gas pipeline projects. *International Journal of Project Management*, *31* (2013) 1, pp. 136–146. doi:10.1016/J.IJPROMAN.2012.06.003.

Wang T-K., Ford DN., Chong H-Y., Zhang W.: Causes of delays in the construction phase of Chinese building projects. *Engineering, Construction and Architectural Management*, *25* (2018) 11, pp. 1534–1551. doi:10.1108/ECAM-10-2016-0227.

Chen G-X., Shan M., Chan APC., Liu X., Zhao Y-Q.: Investigating the causes of delay in grain bin construction projects: the case of China. *International Journal of Construction Management*, *19* (2019) 1, . doi:10.1080/15623599.2017.1354514.

Lee J-T., Yun H-D.: Improvement Plan Through Analysis of the Current Status of Construction Period Calculation of Public Construction Projects. *Korean Journal of Construction Engineering and Management*, *22* (2021) 3, pp. 12–20.

Olawale YA., Sun M.: Cost and time control of construction projects: inhibiting factors and mitigating measures in practice. *Construction Management and Economics*, *28* (2010) 5, pp. 509–526. doi:10.1080/01446191003674519.

Arditi D., Nayak S., Damci A.: Effect of organizational culture on delay in construction. *International Journal of Project Management*, *35* (2017) 2, pp. 136–147. doi:10.1016/J.IJPROMAN.2016.10.018.

Ahn T., Seo H., Choi G., Kang L.: A study of process model for estimating optimal bidding rate in the lowest bidding system. *Journal of The Korean Society of Civil Engineers*, *31* (2011) 5D, pp. 719–726.

Kim Y-K.: A study on the indirect costs caused by the time extension in construction projects. 2016.

Love PED., Lopez R., Edwards DJ., Goh YM.: Error begat error: Design error analysis and prevention in social infrastructure projects. *Accident Analysis & Prevention*, *48* (2012)pp. 100–110. doi:10.1016/J.AAP.2011.02.027.

Kwak C., Kim YS.: An analysis for the causes of design quality declining from the perspective of a contractor in the apartment construction projects. *Journal of Architectural Institute of Korea (Structure & Construction)*, *26* (2010) 12, pp. 193–200.

Won J-S., Kim J-Y.: Analysis of the Relations between Design Errors Detected during BIM-based Design Validation and their Impacts Using Logistic Regression. *Journal of the Korea Institute of Building Construction*, *17* (2017) 6, pp. 535–544.

Love PED., Edwards DJ., Smith J., Walker DHT.: Divergence or Congruence? A Path Model of Rework for Building and Civil Engineering Projects. *Journal of Performance of Constructed Facilities*, *23* (2009) 6, pp. 480–488. doi:10.1061/(ASCE)CF.1943-5509.0000054.

CAK.: 226,000 foreign workers estimated in construction sites nationwide. *Construction Association of Korea*, (2018).http://www.cak.or.kr/board/ajax/fileDownload.do?boardId=news_report&fileId=15851AccessedJanuary 27, 2022.

Asadi R., Wilkinson S., Rotimi JOB.: Towards contracting strategy usage for rework in construction projects: a comprehensive review. *Construction Management and Economics*, *39* (2021) 12, pp. 953–971. doi:10.1080/01446193.2021.2004609.

Han S., Saba F., Lee S., Mohamed Y., Peña-Mora F.: Toward an understanding of the impact of production pressure on safety performance in construction operations. *Accident Analysis & Prevention*, *68* (2014)pp. 106–116. doi:10.1016/J.AAP.2013.10.007.

Lee S-I., Kang K-S.: A study on effects of the prevention of rush work of construction sites on human accidents. *Journal of the Korea Safety Management and Science*, *19* (2017) 1, pp. 27–37. doi:10.12812/ksms.2017.19.1.27.

Jo J-Y.: Ensuring 'appropriate construction cost and time' is the way to prevent major disasters. Korea Specialty Contractors Association June 1, 2020. https://www.koscaj.com/news/articleView.html?idxno=210234. Accessed January 27, 2022.

Park Y.: An order from above to shorten the construction period. News1 January 12, 2022. https://news.v.daum.net/v/20220112134856170. Accessed January 27, 2022.

Yoo U.: Even the 9th place in the construction rankings... "Gwangju collapse accident" could happen to every construction industry. Moneytoday January 14, 2022. https://n.news.naver.com/article/008/0004695907. Accessed January 27, 2022.