Effective Change Management Process for Mega Program Projects

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Abstract
Mega program projects include several sub-projects, require extended periods of time, and incur heavy costs to finish. Because of their project scope, complexity, and size of construction durations and budgets, they may undergo extensive deviations and changes. Therefore, effective change management for a mega program project is critical for the successful completion of the project. Although there are some studies on the development of change management systems and processes, they are mostly limited to a single project and lack practical applicatory analysis. In contrast, this study strives to develop mega program project management systems and processes. Moreover, this study developed a change management process model, and applies the model to real case studies. In addition, this study affirms its validity through surveys about applicability of the developed model. Finally, this study suggests that the process model can cope with changes rapidly. This process model has not only systemized the change management process, but has also used it to improve the efficiency of business processes.

Keywords: change management; mega program; management process; management system

1. Introduction
Recent construction projects have become mega program projects that are more complicated and require heavy construction expenses for a single project. Each mega program project is a combination of various projects, including the necessary infrastructure. Therefore, it is essential that a detailed change management plan, including the initial plan for the construction schedule and expenses, be established. If a long-term construction project is executed without establishing a plan that is sufficiently detailed, it will be difficult to analyze the plan and adjust it according to changes in the business environment. This necessitates the reworking of the plan, the occurrence of interference, and an increase in expenses. Because of the characteristics of a construction project, several change factors such as the budget and contract for the year, design changes, contract change, and plan changes affect the initial plan. To address these change factors, the plan should be reestablished by adjusting the initial plan and through a review and analysis of alternative strategies to achieve the phased goals in the adjusted plan. The reestablished plan that addresses the change factors allows an estimation of the following year's budget according to the level of changes. Securing the budget for the following year in advance is imperative in construction business management.
To avoid the risk of an increase in the costs of a mega program project and an extension of its construction duration, it is necessary to establish a more systematic initial plan as well as a flexible process to deal with various changes during the execution of the construction project. Therefore, the purpose of this study is to develop the processes and systems for efficient change management in the program management of the mega program project, which is executed over a long period of time and on a large budget.
In this study, the concept of change management, based on program management, and domestic and international research trends concerning change management processes are examined and analyzed to manage changes in projects such as construction projects that are typically executed over a long period of time. Based on the findings of this study, change management standards are established, change factors are selected and the necessary management plan is devised, and a process model is developed for each
change factor. Finally, the developed process model is applied to a mega program project and verified through a survey.

2. Literature Review

Change management is a generic term for a series of continuous tasks including the estimation of change factors, analysis of change factors, establishment of countermeasures, support of decision making, and feedback after monitoring, to respond to change factors systematically and promptly and achieve the project purpose effectively. According to a literature survey (Table 1.), change management in construction industry is defined as follows.

In research literatures, change management is treated as a project management process to minimize changes and execute the project successfully. Also, research on change management in construction has been conducted to provide guidance for project management and systematic process as shown in Table 2. However, this study examines a method of performing change management on a program basis instead of a project basis.

Research trends reveal that extensive research on change management factors and process proposal have been conducted since 2000. Further, studies on change factors have been conducted actively abroad, but there were limitations concerning the verification of validity through result analysis, for case application. Specifically, research regarding change factors and systems in complex urban development projects have been conducted actively in the country but the components of changes have not been quantified; therefore, there are difficulties in determining the effects of change factors on the whole project.

This study examines the program management–based change management model for plan management in mega program projects. For this purpose, the management operation measure through the selection of change management factors is presented first; next, the measure for establishing the change management data and plan is presented for efficient management operation. Finally, the process model to manage project plans continuously is presented by reflecting the components of change, based on the previously established project plan and reestablishing the project plan according to the updated conditions.

3. Develop a Change Management Process Model

For the systematic management of the project plan, change management factors are selected first; next, the identification and operation plan for the selected change factors and the database (DB) establishment method for change management are presented, to suggest

Table 1. Definition of Change Management

| Study             | Definition of Change Management                                                                 |
|-------------------|--------------------------------------------------------------------------------------------------|
| Kim et al. (2010) | Managing change factors involves re-performance of business                                       |
| Shin (2011)       | Total management to reflect demands for change and to overcome all forms of resistance in construction environments. |
| Son et al. (2012) | Systematic management technology to deal with changes in the construction environment, from the project planning stage to goal achievement, including the identification of various change factors that could collectively occur in advance, to achieve the initial project goal or the changed goal and minimize risk. |
| Cha (2013)        | Management and adjustment procedure to achieve the goals in the early stages by predicting any change that could occur or that has occurred already during the entire duration of the construction project and by analyzing the influence of change. |
| Ibbs et al. (2001)| Adding or deleting the project goal or range due to change of project cost, schedule, or quality. |
| EPSRC (2004)      | Forecasting any change that could occur, identifying any change that has already occurred, planning to prevent its impact, and coordinating changes that have occurred during the project execution. |
| Zaho et al. (2009)| It is a project management tool that can solve problems and minimize any changes that could occur or cause problems during the project execution, when changes occur in the project. |
| Oracle (2009)     | Understanding the differences between initial contract requirements and requirements arising after the conclusion of the contract. |
| Hwang et al. (2012)| Systematically handling and managing any hindrances during the execution of projects.             |
| Moghaddam (2012)  | A combination of procedures and tools to anticipate, recognize, and coordinate any changes that could occur. |
3.1 Selection of Change Factors

In this study, new contract, contract suspension, budget change, and performance management including design change and plan change are selected as the change factors that influence the schedule and cost expenses of a project plan. A new contract is selected as a change factor since changes in schedule and cost expenses occur due to the contract progress and bid-dropping rate. Further, changes in the schedule and cost expenses occur due to a change in the cost expense for each year according to the contractual characteristics of domestic national projects. Therefore, the change in the budget for the relevant year is selected as a change factor.

3.2 Identification of Change Factors

Considering the program management for a mega program project in which a new contract is ordered according to the initially prepared plan schedule, at this time, the program management business personnel requests the contract information from the contractor and registers the preliminary data for the new contract. Changes are identified from the registered contract information through the review of schedules and cost expenses in comparison to the initial plan.

Because of the characteristics of a mega program project, design changes and contract suspension occur frequently in most cases and, accordingly, any change in the initially prepared contract details should be identified. To identify any design change and changes associated with the contract suspension, the program management business personnel request the design change and contract suspension information from the contractor and identify changes when design change and contract suspension occur during the execution of the construction project, when the approval of the owner is available.

Mega program projects are conducted mostly in national projects, and various changes such as the addition and deletion of new projects, adjustment of project schedules and cost expenses occur according to the changes in domestic and international environments. Further, the mega program project is executed over a long period of time because of its characteristics; therefore, modifying the initial plan during the period of project execution is unavoidable because of budget and schedule changes.

Especially in the case of long-term continuous contracts among contract methods for domestic national projects, budget security remains uncertain. Therefore, the project contract is concluded on the basis of the whole project expense, but the project is executed on an annual basis according to the amount of budget secured and, therefore, changes in cost expenses occur every year. At this time, the project management business personnel receive information on annual budget and plan changes. In case these changes affect the whole project period and cost expenses, the project management business personnel consult with the owner and register these changes.
The plan change occurs and disappears due to various reasons such as verification of the validity of the project, change of plans, and budget shortage during the period of execution of the construction project. Various changes in the initial project plan occur accordingly, and the flow of changes due to the addition and deletion of new projects, adjustment of project schedules, and business expenses is identified as shown in Fig.3.

For the identification of changes due to these plan changes, cost expenses are modified in case of deletion, and changes in the additional items of the schedule and cost expenses are identified in case of new project addition. For the plan changes, the schedule should be reviewed through an analysis of the relations between projects and the entire cost expenses should be examined again through an analysis of variations in cost expenses.

3.3 Change Management Plan

For the identified change factors attributed to changes in schedules and cost expenses during the execution of the program management business, the level of their influence should be aggregated and analyzed through the change management operation. Therefore, the data establishment measures for identifying change factors and analyzing their effects, and the management measures for each change factor are presented.

For successful large-scale urban development projects, a detailed project management system should be established. The management standard progress schedule developed during the establishment of the system is used as the basic data for the plan establishment. There are two types of plans established in large-scale urban development program projects, which are: (1) the plan of cost expenses during the planned construction period for efficient budget allocation and (2) the plan of progress of facility work except for land cost among the total project expenses, and services including design and construction supervision on an annual basis.

In this study, three steps are suggested as measures to establish the plans of project expenses and progress. 3.3.1 Application of Project Progress to the Plan

It is possible to improve the reliability of the models of plan establishment by applying the previous project result data to the plan and establishing the plan again.

When establishing the plan, the previous project results are applied for each project. The previous project results can be separated into the result of cost expenses and the result of progress, which are then applied to each project.

When these two results for each project are applied and collected, the program-level results can be arranged. (Fig.4.)

3.3.2 Establishment of Plan for the Year

After the project results are applied, the budget for the relevant year is applied, and the budget plan is established separately according to the existence of contract. The budget application according to the existence of a contract can be classified into four case types. Fig.5. below shows the cases of budget application according to the existence of a contract.

Cases 1 and 2 are the projects for which contracts exist, and cases 3 and 4 are the projects for which contracts do not exist. The method of establishing the detailed budget plan according to the concluded contracts is as shown in Fig.6.

For a project for which a contract exists, the budget plan for the relevant year is established based on the prearranged project progress schedule. At this time, the prearranged project progress schedule is prepared based on the construction expenses (earned value) only;
therefore, the plan for government-furnished material should be applied separately. For facility construction work of a project for which a contract does not exist, the standard progress curve (S-Curve) is applied to establish the budget plan for the relevant year; for field application, the linear graph is used to establish the budget plan. In this way, to establish the budget plan, the budget information for the relevant year, prearranged project progress schedule, standard progress curve, and linear graph should be utilized. Data collected for each project and each month of the relevant year can be used for program-level progress management in the relevant year.

3.3.3 Establishment of a Future Plan

After the previous project results and the budget for the relevant year are applied, the future plan is established. The future plan is an important element for the establishment of the budget for the next year and the medium and long-term plans; in the case of large-scale urban construction projects, these are long-term projects and, therefore, a more thorough examination for the establishment of future plans is necessary. The established future plans can be classified into three cases according to the existence of a contract. Fig.7. below shows the cases of expense application in future according to the existence of a contract.

Fig.7. Case of Contract Funding Application

Case 1 is the project for which a contract exists, and cases 2 and 3 are the projects for which contracts do not exist. The detailed future plans established according to the existence of contracts are as shown in Fig.9. For Case 1, the previous business result and the budget for the relevant year are applied and, then, the rest can be treated as future expenses. For the government-supplied material expense, it can also be treated as a future expense according to the business result and the budget for the relevant year. In case the contract exists, the plan is established based on the prearranged project progress table prepared in the actual construction field as mentioned in the budget plan for the relevant year. The projects with no contracts can be classified into two types according to the existence of a budget for the relevant year as shown in Cases 2 and 3. In case the budget exists but a contract does not, as in Case 2, the plan is established as future expenses, except for the budget for the relevant year. In case the budget does not exist as in Case 3, the plan is established with an S-Curve or linear graph for the whole amount of project expenses.

To establish the plan at the program level, it is essential to provide accurate data regarding the schedule and cost expenses of projects managed by business entities.

The monthly and annual planning data for each project aggregated through this may be used by each business entity. Further, it is possible to present the base date for securing the budget by predicting the budget to be secured for the next year in detail.

To establish the plan effectively based on the plan establishment measure in three steps including the arrangement of business results, establishment of the plan for the relevant year, and the establishment of the future plan, as presented above, it is necessary to modify the plan every year, after the budget is finalized at the beginning of the year.

3.4 Change Management Process and System Model

The change management process model for each change factor is as shown in Fig.8.

The change management process flow is established in three steps. Step 1 for the identification of change is established to collect, check, and review the information from new contracts, design changes, and plan changes. Step 2 for change management is the step to modify DB according to the change information for each detected change factor including schedule, project expenses, and progress table, to accumulate change data. Step 3 is concerned with re-establishing and storing the plan in a temporary plan DB through the change DB and plan establishment module, and deciding whether or not to revise the plan through an analysis and comparison of the re-established plan with the previous plan.

Change management in a mega program project is more complicated than change management in an individual project, and is less efficient and difficult to perform without Information Technology (IT) involvement. Specifically, problems in the offline execution of change management are as follows.

Fig.8. Change Management Process Model
First, it is less efficient to manage the data volume offline due to the existence of numerous sub-projects in the mega program project.

Second, the mega program project is executed over a long period of time as well as by various business entities. A lot of information generated from each business entity should be managed systematically and confirmed frequently through summing up and analysis of accumulated information. Without database management through the system, it is difficult to maintain the credibility and timeliness of information.

Finally, offline change management cannot provide the convenience and information regarding prompt detection and analysis of change factors to program management control personnel.

Therefore, the change management system model is developed to secure work efficiency and reliability.

The change management system model is established as shown in Fig.9, to improve the system efficiency and perform the change management business in connection with the program management system.

The same common code system established in the program management is applied and used for the change management system model, and changes precipitated every month by change factors are registered and updated in the Project Budget Cost of Accounts (PBCOA) - Activity-Contract (P-A-C) table, which constitutes the fundamental data for determining the level of influence of the changes. The change data is also accumulated in the change management DB. Further, the plan establishment module is developed from the programmed measure to establish the plan presented in this study, and the change data is accumulated in the plan establishment DB.

4. Case Study

For case applications, common code extracted from the Program Management Information System (PgMIS) of the urban development project was registered in the change management system to unify the code and initial data; the changed data extracted from PgMIS were registered in the change management system to accumulate data in the change management DB. The plan is re-established using the change management DB and the plan establishment module in the change management system; the re-established plan is compared and analyzed with the previous plan. The cases are applied according to the system work flow as shown in Fig.10.

The initial activity list and PBCOA list are arranged, and the initial business plan is established in connection with P-A. The contents of changes occurring until the year "n-1" are arranged and applied to the P-A-C list, and the plan for year "n-1" is established based on the findings. The established plan for year "n-1" is compared with the initial plan to determine the amount of change. The contents of change occurring for each change factor and P-A-C changes during the operation of program management are confirmed, and the plan for year "n" is established based on the findings. The amount of changes are confirmed through the comparison between the plan for year "n", initial plan, and plan for year "n-1". Further, the causes for the change are determined through the comprehensive analysis at the time of establishment of the plan for year "n", and the change management system is applied in the flow of estimating the required budget in year "n+1" for each business entity for normal project promotion.

It was confirmed from this case that many changes occurred in the initially established business plan along with changes in business environments. Further, it was confirmed that it was possible to determine the level of influence of changes on the whole project and predict the direction of project progress in the future by managing the contents of change for each change factor systematically.

It was possible to manage the plan based on program management efficiently, and promptly detect and respond to changes that occur based on the program management through the change management process model and change management system model presented in this study. Therefore, it was confirmed, through the application of change management process model to the case, that the change management business could be performed effectively.

5. Questionnaire and Model Validation

The survey was conducted to verify the change management process presented in this study and the research result, to verify its usability in actual business practice, and to affirm the validity of the research
result. Twenty-four out of 25 copies of the survey targeting ordering organizations and construction management (CM)/project management (PM) business personnel were collected through face-to-face interviews and e-mail inquiries for 19 days.

The targets of the survey included CM/PM personnel who have participated in mega program projects and owner agencies.

Seventy-five percent (18 respondents) of those surveyed are in a CM/PM-related business, 13% are on the owner side (three respondents), 8% are in the construction business (two respondents), and 4% are in the consulting business (one respondent). Further, 42% (10 respondents) of those surveyed have less than 10 years of work experience and 58% (14 respondents) have more than 10 years of work experience.

Twenty-one out of 24 respondents answered that they have experienced change including change of project plan or design in a mega program project that could affect the project, and the reasons include change of project plan (30%), change of project duration (39%), and change of cost expenses (32%).

Seventy-three percent of those surveyed answered that five change factors (new contract, design change, contract suspension, budget change, and plan change) selected in this study that affected the plan management were significant. However, those surveyed answered that a new contract was less significant among those change factors. In addition, there were opinions that even if various change factors might exist in mega program projects, the change factors presented in this study were established too broadly so that a consideration of detailed factors was relatively inadequate.

For the survey on the change management process model, regarding three change factors including new contract, design change, and plan change (for the efficient operation of change factors selected in this study), positive answers were obtained for both practical usability and applicability to other projects. However, those surveyed indicated that change management in the operations stage would be important, but the measures to deal with changes in a project that required various changes in its early stage, such as large-scale land development or urban environmental maintenance, were insufficient. Further, there were opinions that actual preparations to internally deal with various changes in system and logic would be necessary for applying it to similar projects in future.

The result of the survey on the practical usability and applicability of the change management system model linked with PgMIS presented in this study for other projects is as shown in Fig.11.

Positive answers were obtained from more than 70% of those surveyed for practical usability including 8% for very high and 63% for high, but there were also negative answers on the applicability to other projects in comparison to the practical usability. Further, those surveyed indicated that PgMIS would be an essential system for handling a large amount of data and information in the case of mega program projects, and operation of data in connection with the change management system would be appropriate in terms of sharing and managing information. However, because the PgMIS system should be implemented to optimize the change management business process from the early stage of development, and the expenses required for the system development also should be considered, there were opinions that careful consideration was required to apply the PgMIS system to other projects.

6. Conclusion
In this study, the contents of previous studies on the management of change were analyzed and a change management process model for managing a plan based on program management was proposed.

Factors influencing the schedule and business expenses of a project plan based on the plan established to achieve goals were selected as the change factors for the change management; the contract, design change, contract suspension, budget change, plan change, and performance were drawn as the change factors in preceding research literature on the characteristics of mega program projects.

A logical model was established to detect and accumulate change factor data automatically according to the program management business performance. The management plan for each change factor is established, and the systematic plan establishment measure was presented by applying changes. The analysis measure to determine the level of change easily by quantifying the effect of change on the plan through a comparison with the previous plan and the analysis measure was presented.

The change management DB was established to accumulate the components of change for each change factor in the P-A-C table and improve the reliability of data. The plan establishment model was developed from the systematic plan establishment measure, and the change management system was established to reduce the plan establishment time; this required a significant amount of time and effort and improved the efficiency of the change management business.

To verify the change management process, a domestic mega program project was selected and the
change management process model was applied. The application result showed that there are changes in initial project plan, and it was possible to determine the effect of the change on the whole project and predict the direction of project progress in the future. Therefore, it was confirmed through the application of the change management process model to the case that the change management business was performed effectively. Further, the usability and validity of the process model developed in this study were verified through the survey targeting people who experienced the program management business.

It is expected that it would be possible to play a significant role in the successful completion of the project by identifying the specific change factors that could affect the schedule and business expenses, and managing the system efficiently based on this study.

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