# INTERFACE MANAGEMENT PRACTICES IN TAIWAN CONSTRUCTION PROJECT

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**ABSTRACT:** The interfaces during the construction phase usually cause reworks and conflicts among different project participants. In order to improve construction management, it is necessary to track and solved interfaces when these interfaces will influence the construction works. In practice, the interface information is usually available in related participants and few interfaces sharing and tracking are supported among participants. In order to improve the interface management in construction projects, this study proposes the approaches to enhance interface management effectively in the construction phase of a project. The proposed approaches have been applied in selected case study of a construction building project in Taiwan to verify our proposed approaches and demonstrate the effectiveness of interface management in the construction phase. Based on cast study, results indicate that construction interface management can be improved effectively. Furthermore, benefits of implementation and facing problems during the test have been discussed in this study.

***Keywords:*** *Interface Management, Construction Management, Coordination*

## 1. INTRODUCTION

Construction projects, which typically involve participants from different fields, often have numerous interface problems. Interface information regarding the needs and progress status of each project participant is generally not exchanged effectively among project participants. Moreover, participants frequently execute their own work and rarely share related interface information. Face-to-face meetings and telephone communication are common and practical methods for project participants sharing interface information during the construction phase. Construction projects, which are characterized by extreme complexity and non-standardized production, differ in that they are designed and executed to meet individual owner needs. Thus, effectively managing project interfaces is essential to successful construction management. Effectively tracking and managing interfaces can improve interface management (IM) in construction, thereby eliminating unnecessary mistakes. Effective interface information sharing allows project participants to identify existing interfaces and solve interface problems. Without IM, poorly coordinated and controlled boundary conditions among project participants can cause such interface problems as design errors, part mismatch, system performance failures, coordination difficulties, and construction conflicts. Conventional interface communication methods include face-to-face meetings, telephone communication, regular interface meeting, and virtual design and construction (VDC). However, a typical problem encountered during conventional communication is that discussions may not be effectively tracked and shared with others.

Despite the many studies and discussions in academic and practical literature, there are few case studies to explore what the real facing problems and solutions for IM during the construction phase. The study is to explore the application of IM in practice. Furthermore, this study proposes the approaches to enhance IM effectively in the construction phase of a project. The proposed approaches have been applied in selected case study of a construction building project in Taiwan to verify our proposed approaches and demonstrate the effectiveness of IM in the construction phase. Based on cast study, the results indicate that construction IM can be improved effectively.

Furthermore, the benefits of implementation and facing problems during the test also have been discussed in this study. The main purpose of this study is to propose the approaches for involved participants to improve IM performance efficiency. With the evaluation of the case study in the Taiwan building project, the results show that the approaches of IM is effective in practice for building projects.

## 2. LITERATURE REVIEW

Numerous interfaces are generated and problems are occurred in the construction due to the current project tends to be extremely complex and lots of participants are joined to do works. The manager always wants to control and manage them to reduce the negative effects, while IM is a good concept to get this target. IM is just to do the communication works [1]. Through the communication process, the common construction condition can be addressed using IM concept [2]. The IM can also be defined as "the management of the boundaries between such project entities as people/participants, processes/phases, resources, contracts, costs, schedules, systems/functions, and safety/risks" to enable a dynamic and well-coordinated construction system in current built environment.

Many various categories of interfaces are proposed about product and project interfaces, time, geographic, technical, social interfaces, personal, and system interfaces, static and dynamic interfaces [1,3,4,5]. These interfaces must be managed, and the category of the interfaces also needs to be identified and to determine how to solve them [6].

In practice, the management process is started when the problem is occurred. In order to improve IM, the approaches must be developed for managing and control these diverse interfaces.

## 3. METHODOLOGY

Before the architecture engineering and mechanical and electronic engineering starts, the integrations of interfaces must be implemented. Through integrating interfaces, many interface problems can be found early to avoid the unnecessary problems during the construction. Thereby, the interface engineers who are responsible for integration works must be the experienced workers about the integration of interfaces, to enable problems between the architecture engineering and mechanical and electronic engineering to be identified as far as possible. Through such integration process, the available information can be generated for the construction phase, such as the impact between structure and mechanical and electronic pipes is found and eliminated. And during the construction, interfaces also need to be managed effectively by the information exchange.

In order to support IM, fifteen documents are applied in this study and Table 1 describes the functions of these documents. In addition, numerous communication platforms are built as the communication environments for the integration of interfaces and the management of interface problems, these platforms are as follows: (1) the construction interface collaboration meeting, (2) the meeting for the integration of drawings and the management of problems, (3) the weekly collaboration meeting, (4) the labor-safety and health-environment protection meeting, (5) the safety-health-environment protection meeting, and (6) the joint site investigation. The information interaction among these communication platforms as depicts in Fig. 1. The labor-safety and health-environment protection meeting and the safety-health-environment protection meeting are different even through these two meetings deal with the same problems, which include the identification of the responsibility for the management of the labor-safety and health-environment and the use of the safety-related equipments. The supervisors and contractors are joined in the labor-safety and health-environment protection meeting, and the condition of safety and health for a project will be presented for them. In another meeting, only the contractors and sub-contractors are joined to make main contractors understand the implementation of the labor-safety and health-environment during the sub-contractors' works. Thus, the related meeting minutes and information can be exchanged between these two meetings. The construction interface collaboration meeting is mainly to deal with interface problems, which include problems of

Table 1 Interface management documents description

| Interface management documents | Description |
|---|---|
| Structural Electrical Mechanical (SEM) drawing | To be basic information for the contractors constructed their activities. |
| Combined Service Drawing (CSD) | To provide the information related to pipes assembling, and then to integrate with architecture and structure drawings to complete SEM drawing. |
| Interface Control Document | To provide the information for tracking and management of interface issues. |
| Schedule Report for a year, month, or triple weeks | To handle the construction schedule of contractors by using such reports for project participants. |
| Pre-notice Sheet | To notify the succeeding contractors that their works will start. |
| Control sheet for the integration of diagrams and construction procedure | To manage and control the condition of interface integration between drawings. |
| Interface Issue Sheet | To record the occurred problem content and solutions. |
| Schedule Control Sheet for changes | To provide the information about any change, such as some design items are changed, and the condition of dealing with these changes. |
| Problems and Efforts Report | To present the found problems and solved efforts for the integration of interfaces between drawings. |
| Schedule Control Sheet for materials, machines, and equipments inside the construction site | To provide the information about which resources can be inside the construction site in which time. |
| Rechecked List for SEM/CSD | To assist that the interface engineers recheck the preliminary integration efforts, ensuring the accuracy. |
| Checked Sheet for contractors inside the site | To support the contractors review and check the construction space before the construction starts. |
| Coordinated Installation Program (CIP) plan proposal | To plan the interface integration contents and rules during IM, including which problems should be solved in which communication platforms, which documents should be used, IM organization members etc. |

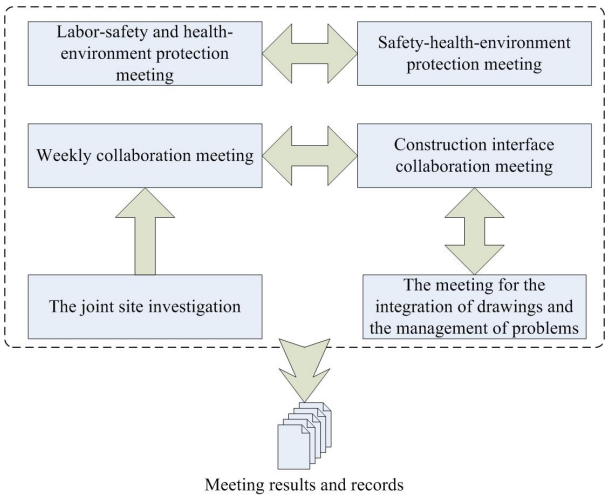


Fig. 1 Information exchange and communication

site construction, construction sequence, schedule, and transportation route etc. If the problems can not be solved in the construction interface meeting and these problems concern errors of the design or construction drawings, the problems can be further discussed and solved in the meeting for the integration of drawings and the management of problems. The weekly collaboration meeting is to manage and track the schedule of activities implemented, the conditions of the construction, and the conditions of implementing solutions for interface problems. Therefore, for the construction interface collaboration meeting, the meeting for the integration of drawings and the management of problems, and the weekly collaboration meeting, the information can be exchanged among these three meetings through the related meetings minutes and documents. The frequency of the above-mentioned meetings held is once-time per-week. Of course, the temporary meeting can be held to solve the emergency problems if it is necessary. Moreover, the results of the discussions in any meeting must be recorded as references of the project implementation. Finally, the joint site investigation can be implemented when it is necessary. Such investigation is mainly to review and understand the whole condition of the construction by the invited project participants, which these participants may include the supervisor, owner, and related contractor. It is not like the above-mentioned meetings which must be held per-week, and the implementation of the joint site investigation is no fix he implementation of the joint site investigation is no fixed frequency. The efforts of the joint site investigation

are feedbacks to the weekly collaboration meeting. Overall, interfaces can be managed and controlled fully through the information interaction among these communication platforms, and avoiding the redundant discussions for the same problem.

## 4. CASE STUDY

In order to understand the effectiveness of the methodology, the proposed approaches have been applied in a real building project. The implementation results have been illustrated and discussed in the follow-up section.

### 4.1 THE DESCRIPTION OF THE CASE STUDY

This case is the new building project in Taiwan for the use of the dormitory and office, and which includes two buildings. There are eight floors on the ground and underground two floors in one building, and there are five floors on the ground and underground two floors in another building, while the total floor area of this building project is 345,621 square meters and moreover this project is still implementing from the January in 2004. Three systems are included in this case, including architecture engineering, mechanical and electronic engineering, and air-conditioning system engineering. All buildings are built by using the construction approach of steel structure; and nine systems in the mechanical and electronic engineering are as follows: fire control, water supply and drainage, information, telecommunication, electric power, centre control, reclaimed water system, park control, and audio-visual system; finally, the air-conditioning system will be completed by using the ice-storage air-conditioning system. Overall, this project includes the complex systems that require the careful integration of interfaces among sub-systems involving the diverse engineering disciplines and manage the interface problems effectively.

In this section, two distinct phases are used to illustrate the application of the methodology. The fist phase is to identify and eliminate the impacts among systems. The second phase is to deal with problems. First, before the construction starts, the professional contractors must propose the interface problems they may find based on their construction schedule and construction requirements, which the problems include the material quantity, construction works route, construction drawings and documents, and the schedule of setting materials and construction. In this phase, the integration of the engineering drawings is most important. In the case, three main contractors are responsible for three engineering system and they assign the engineers to be responsible for the integration of interfaces. The activity of this phase is to integrate the drawings of the mechanical and electronic system and air-conditioning system with the drawings of architecture and structure. Interface engineers must integrate the interfaces among systems (indicates the identification and elimination of impacts among three engineering systems), and finally the SEM drawings will be completed for the use of the construction.

In the integration of drawings process, the CSD drawings must be first completed, which the CSD drawings are generated by integrating diagrams of the mechanical and electronic system and air-conditioning system by interface engineers of these two systems. If any problem is found, the problem must be proposed and discussed in the meeting for the integration of drawings and the management of problems. Then the drawings have to be updated using the efforts of the meeting. The efforts need to be then delivered to construction contractors. The construction contractor integrates the architecture and structure drawings with the CSD drawings to generate the SEM drawings, and the space use, safety, and constructability are considered and the impacts between the structure and pipes also are identified. Of course, if any problem is found, the problem still must be solved in the meeting for the integration of drawings and the management of problems.

Second, during the construction, when any interface problem is found, this problem must be proposed using the interface issue sheet. The project manager acquires this issue and the manager has to know the detailed contents of this issue, and then this problem will be discussed in the construction interface collaboration meeting. Of course, the manager also can determine that the temporary meeting is held if this is the urgent problem. After the problem-solutions are made, the information such as solution-descriptions and agreed-participants must be recorded in the interface issue sheet. If then there is any additional problem about this issue after the solution is conducted, the interface issue sheet will be a tool for identifying the responsibility. In addition, if the problem concerns the

engineering-related drawings to lead to no solutions are made in the construction interface collaboration meeting, this problem has to be discussed and solved in the meeting for the integration of drawings and the management of problems. Noteworthily, the engineers have no authority for determining the decisions which concern cost.

The remaining items in the proposed managed meetings are the weekly collaboration meeting, the labor-safety and health-environment protection meeting, the safety-health-environment protection meeting and the joint site investigation. A lot of contractors are joined to this project. The main contractors must acquire the information related to labor safety and construction environment protection to handle the conditions of the construction. Such information can be retrieved by the main contractors and subcontractors are joined in the safety-health-environment protection meeting. In this meeting, the main contractors must severely request the labors' safety, such as the accurate use of related safety-tools. And the apportioned cost, which includes the cost of environment protection and safety-tools maintenance, also is discussed in this meeting. Then, the supervisors also can know the overview of managed labors-safety and environment in the construction site through the labor-safety and environment protection meeting. Finally, the top management mainly concerns the whole status of construction, such as cost, schedule, and quality. Such information is presented in the weekly collaboration meeting. Nevertheless, after the top management or supervisors know the construction conditions based on the discussions in the weekly collaboration meeting, they still consider identifying the construction is necessary, and the joist site investigation can be implemented. After investigating, the results must be recorded and feed back to the weekly collaboration meeting.

### 4.2 DISCUSSIONS

During the implementation of the approaches in the project, lots of interface problems still are occurred. Based on examining afterward, in order to solve those occurred interface problem, the extra cost is increased on large scale. An example problem of this building project is presented herein, including the lightweight partition engineering, the water supply and sewage piping, and the chilled water piping. The lightweight partition wall is destroyed to re-assemble the related pipes, such as the elevation of the water supply and sewage pipes must be re-set, due to the errors of the constructed sequence and schedule control and the incomplete integration of construction drawings (the elevation of the water supply and sewage pipes is lower than ceiling). Such results of the construction are to lead to the project cost is increased and all of the related activities are delayed. Based on this example problem of this project, the efforts indicate that incomplete integration of interfaces will impact the project implementation and performance. Through utilizing the proposed approaches in this building project, the interface problems occurred is less than before. Table 2 presents the discussion of the encountered problems follows with some solutions provided.

## 5. CONCLUSIONS

The construction project is completed by the project participants collaborate and coordinate with each other. And in practice, the implementation of IM in the construction phase is no standard of management procedure and approaches. Therefore, the mechanisms and approaches are proposed for IM in this study. Through utilizing the systematic management procedure, the IM should be able to be improved. Furthermore, the proposed methodology has been applied in a new building project in Taiwan. According to the applications in case study, the results are as follows: (1) based on the good integration of interfaces, there are positive benefits for the use of the resource, the constructability, and the construction schedule etc., and further to affect the project cost, (2) the integration of interfaces plans are made to implement the integration of interfaces and communication before the construction starts, and although the interface problems occurred is still not avoided, the chance of interface problems occurred can be reduced, (3) the interfaces can be managed and controlled by the communication meetings but the interfaces between the diverse meetings will be arose if the communication meetings are built too much. Moreover, the member of the management can be joined in the meetings, and the schedule of administrative procedure can be compressed to assist the construction related works, (4) the results of the case study indicate that although the

Table 2 The description of the encountered problems and strategies in case study

| Title | Encountered problems | Strategy descriptions |
|---|---|---|
| Much communication platforms | Results of the problem discussions do not be delivered to other meetings to cause that the chance of re-discussing the same problems will be enhanced. | The use of the interface issue sheet and ICD document is suggested. Thereby, managers can handle the interface problems via these data, and avoiding the solved interface problems are re-discussed in other meetings. |
| Fast turnover | When an organization which is responsible for the integration of interfaces has a fast turnover, the gaps may be generated for the deliveries of dealing with interfaces. | The use of the interface issue sheet, which records the detail contents for each issue, can assist the works connections. The followed-engineer can understand the whole conditions about the integration of interfaces. |
| Poor integration of the CSD and SEM drawings | The incomplete integration of drawings is created due to the lack of the engineers experience for the integration of interfaces, and further to cause the errors of the construction. | The use of rechecked List for SEM/CSD needs to be implemented fully. Through such rechecked process, the errors will be decreased as far as possible. |
| Low performance of administrative procedure for identifying data | The administrative process usually takes long time for examining data, and then the time of the integration of interfaces is compressed, resulting in the produced SEM drawings is incomplete. | The member of the management is joined in related meetings is suggested, and the efforts indicate the administrative process progressing can be improved effectively. |
| Diverse values of participants for the integration of interfaces | Administrators know the importance for the integration of interfaces but the engineers can not consider that, resulting in the implementation of IM is not very well. | The guidance and training should be conducted for IM, enabling related participants to understand how to affect the project implementation by the successful and unsuccessful integration of interfaces. |

budget for the integration of interfaces has been considered in the contract and the numbers and qualifications of the engineers for the integration of interfaces are also stipulated, the integration of interfaces is still attended insufficiently. Hence, the engineering management should be incorporated with the concept of IM.

The feedbacks and suggestions are made as follows: (1) although IM can be improved by the use of the interface issue sheets and the development of communication meetings, the lack of the authority for the joined engineers of each communication meeting will be able to retrieve no expected objectives of managing interfaces, (2) in the IM process, it is very important for the interface problems are recorded fully. The recorded-detail information will be one of the references for identifying the responsibility when the dispute and conflict are arose during implementing solutions, (3) in Taiwan, both the quality management and labor-safety and health environment have a system of rewards and penalties to assist the works implementation, and therefore considering such system in IM is suggested for supporting the improvement of IM.

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