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A Conceptual Information Management Model for SOC Projects

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Abstract

This paper presents a conceptual information management model for the efficient management of social overhead capital (SOC) projects. Case studies were conducted on SOC projects currently under construction to investigate information infrastructure, operational processes and programs, and project management information system (PMIS) operation and maintenance aspects. On the basis of the case studies, improvements to the current PMISs were suggested and reflected in the model developed in this paper. The suggested model can integrate and manage the enormous amount of information generated in the different construction project phases and project management functions during an SOC project.

Keywords: social overhead capital project (SOC project); project management information system (PMIS); information management model; PMIS evaluation

1. Introduction

The Oxford Dictionary of Business defines Social Overhead Capital (SOC) as goods and services that constitute essential elements of a national infrastructure, such as roads, railways, sewerage and electricity supply. Because SOC is expected to keep growing to support national economic development as well as to enhance quality of life, investment in SOC has been increasing worldwide. However, an SOC project places heavy demands on the national budget and on private capital. It is a long-term project involving many participants from various organizations. As the amount of data and information can increase without limit in such large-scale projects involving advanced technology and skills, the importance of Information Technology (IT) in the Architecture/Engineering/Construction (A/E/C) industry has grown exponentially in recent years. Computer-aided design packages, scheduling and contract management software, document management systems, and internet applications have demonstrated their ability to improve operations, increasing both service quality and productivity (Peña-Mora et al. 1996). On the other hand, as building technology and material science become more complicated, the risk of error in the design, selection, installation and Operation and Maintenance (O&M) of buildings and other facilities increases. Decisions become increasingly critical, but practitioners find it more difficult to keep abreast of change and so become less likely to recognize gaps in their understanding. Progress by trial and error is common on many such projects. Cost overruns and schedule delays are typical problems. Considering these particular characteristics and problems of SOC projects, a Project Management Information System (PMIS) is recognized as an enabler of effective project management. However, as determined by an evaluation of current PMISs, the operational process and program are limited to several functions and are not applied to all the phases of a project life cycle. To solve this problem, it is necessary to standardize the process of all the construction project phases and the required project management functions.

Thus, taking a process-based approach, this paper evaluates current PMISs for SOC projects to determine whether they support the project management functions required for each process and suggests an information management model that can integrate and manage the enormous amount of the information generated during an SOC project.

2. Related research

2.1 The need for a process-based approach

IT offers an A/E/C firm the opportunity to create strategic competitive advantages in a number of dimensions (Callon 1996). However, IT alone will not achieve these advantages; a firm has to change its procedures and organization as well. This requires a continual rethinking of the way information is generated and handled in a firm and on a project (Breuer and Fischer, 1994). Information management is concerned with communication, and covers its acquisition, generation, preparation, organization, dissemination and analysis of information, and the design, implementation, evaluation and management of information resources. Much research has focused on examining the

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construction process and information flow from the viewpoint that construction is a process-based industry. The research shows that 'process' means not only the production process, which provides tangible outputs such as manufactured units, but also business or service processes, which are often associated with organizational tasks that either support production or sustain business operations (Soares and Anderson, 1997). The construction process can be divided into two highly integrated sub-processes: the information sub-process and the material sub-process. The information sub-process activities always result in information, whereas the material sub-process activities produce services or physical objects. The information and material sub-processes are integrated by information flows in two directions. First, the information process produces information, which indirectly or directly controls the material activities taking place. Second, the information processing activities constantly require feedback information about what is actually happening in the material process (Björk 1999). Generic information flow and required functions have been described throughout the project life cycle for project procedure improvement (Sanvido and Medeiros, 1990). Functional models of the process have been produced to show information flows, participants, organization and IT use, using a generic model of the process (Callon 1996). In this paper, therefore, a process-based approach can be applied to analysis of both the information and the processes that are controlled by the information, to develop an information management model through standardizing the process and content of information management.

2.2 Measures of IT/IS performance

The methodologies employed to measure the performance of IT/IS are basically classified by objective and subjective evaluation. In addition, they can be classified by evaluation items or evaluation scope. Each methodology is applied according to its own characteristics. Through the systematic study of large quantities of IT performance, DeLone and McLean (DeLone and McLean, 1992) suggested an IS success model by categorizing IT performance into: 1) systems quality; 2) information quality; 3) use; 4) user satisfaction; 5) individual impact; and 6) organizational impact. Based on this categorization, research has suggested measures of IT performance through experimental study. First, measures of system quality typically focus on performance characteristics of the information system itself. Second, the quality of the IS output, namely, the quality of the information that the system produces, is primarily found in the form of reports. Third, information use is measured by recipient consumption of the output of an information system, namely, the use of information system reports. Fourth, user satisfaction is measured by recipient response to the use of the output of an information system. At the influence level, the interaction of the information product with its recipients, the users and/or decision makers, is analyzed by measuring use or user satisfaction. Fifth, individual impact is the influence that the information product has on management decisions. Finally, the effects of the information product on organizational performance have been concerned with such issues as operation cost reductions, overall productivity and gains, and returns on investments. The above IS success model has been criticized for including only the measures of IS itself, IS use and IS impact regardless of IT investment cost. In this paper, however, the PMIS evaluation is conducted while focusing on effective implementation and application of a PMIS regardless of the investment in the PMIS. Therefore, measures of investment cost are not used in this paper.

3. Evaluation of current PMISs

3.1 A framework of evaluation

PMISs for a large-sized project such as an SOC project are implemented for the particular project by the project execution organization. Therefore, PMIS for an SOC project can be defined as the system for owners to support the execution of an SOC project by integrating and managing all information generated in the different construction project phases and project management functions of the project. By implementing PMISs, the required information for project planning and control will be able to be used to collect, transfer, and manage effectively. Simultaneously, knowledge for a future project will be accumulated through developing a database for feedback information. As described above, one of the main purposes of the use of computing in construction, in addition to automating tedious information processing work, is to facilitate the use and reuse of information. Therefore, information flows between the different programs need to be analyzed. Also, integration of design and construction information, which is recognized as one of the most significant barriers to implementing PMISs, needs to be analyzed. In implementing PMISs, it is necessary to consider information infrastructure such as tangible material, people and applications, and intangible factors such as organization, methods and policy, all of which are required to form a system (Markus 1984). As effective PMIS implementation is important, operating and maintaining it efficiently is also important. Therefore, the operation and maintenance of the system need to be analyzed. Thus, a framework of PMIS evaluation comprises three parts, as shown in Fig. 1: 1) information infrastructure; 2) operational processes and programs; and 3) PMIS operation and maintenance. The units of analysis are developed as questionnaire items based on the measures of the IS success model suggested by DeLone and McLean (DeLone and McLean, 1992). The questionnaire for the case studies is shown in Table 1. This paper uses a subjective methodology based on subjective measures. Ideally, to evaluate IS performance, objective measures such as increased profits and return on investment should be used. However, subjective measures have been preferred because it is difficult to distinguish the IT performance itself from the project performance and to identify the intangible IS benefit and cost. For a wide range of organizational requirements on IS, most measures may be qualitative and subjective (Martin 1983).

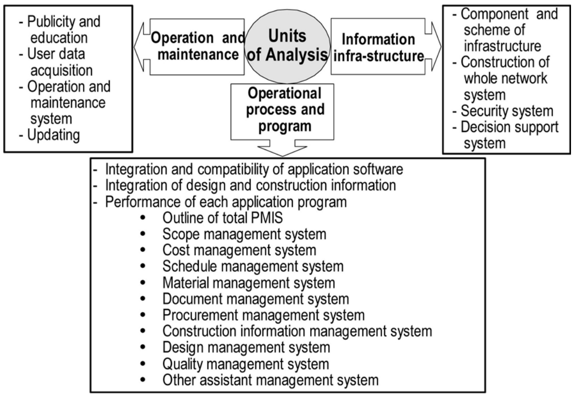

Fig.1. Units of Analysis

3.2 Data collection

Data concerning the present state of PMISs, in terms of the units of analysis shown in Fig. 1, were collected through five on-the-spot surveys currently and by documents and interviews. The interviews were done on the basis of the questionnaire, shown in Table 1, which had been prepared previously. In addition, the PMISs were demonstrated and observed in practice, and further data and problems were revealed through telephone conversations, e-mails, unofficial contacts, and consultation. The Inchon International Airport (IIA) and the Korea High Speed Railroad (KHRC) were selected as the cases for study. Types of these projects are transportation facilities. The IIA project construction began in 1992 and is scheduled for completion in 2020. Its execution is divided into three phases. The first phase was completed and started fully fledged operations in 2001. The KHRC project construction started in 1992 and completed its test operation in 1999.

3.3 Results of evaluation

As a result of the evaluation, the current PMISs for SOC projects were able to enhance the efficiency of project management. However, some problems were observed which can be considered barriers to applying PMISs effectively. The evaluation results are summarized by the units of analysis as follows:

(1) Information infrastructure

In current SOC projects, information infrastructure is isolated physically for security and other reasons. In these SOC projects, material suppliers, equipment suppliers, designers, contractors, supervisors, sub-contractors, and others participate extensively. Any interruption of the PMIS or network will disrupt communication between them.

(2) Operational process and program

In SOC projects, the developed procedures enable the systems and support to manage the appropriate field's procedures systematically. These systems are essential to manage SOC projects efficiently. However, the systems overemphasize the bidding, procurement and construction phases in a project's life cycle. It is thus impossible for the schedule or cost plans, which are established in the planning phase, to be consistent throughout a project's life cycle.

(3) PMIS operation and maintenance

PMISs have been updated since the beginning of their development. To operate a PMIS efficiently, as many participants as possible must use it. However, the efficiency of the systems has decreased, because coordinated use of the systems by the project execution organizations (owners) and outside project participants is limited.

4. Improvements to current PMISs

On the basis of the results of evaluation, improvements to current PMISs are suggested by the units of analysis as follows:

(1) Information infrastructure

Considering that most current SOC projects suffer delays, the interruption of communication between project owners and outside project participants may be an obstacle to shortening schedules. Therefore, the infrastructure of the current SOC projects must be supplemented to promote real-time communication among designers, supervisors, contractors, sub-contractors and suppliers, who are distributed throughout the country. The facilitation of real-time communication and sharing of information have always been considered critical to achieving efficiency (Jaafari 2000). Also, exchanges between project participants must be carried out regardless of operating systems (O/S), software applications, network systems and hardware types. To do this, the existing client server systems should be improved. Internet-based technologies, which lead to more effective information transfer regardless of physical distance constraints and hardware systems, should be applied to implementing PMIS. However, there are very complex supply chains between a contractor and suppliers because of lack of standards and interoperability (Froese 1999). Therefore, a communication infrastructure to enable data transfer between the contractor and suppliers should be applied. Data storage and identification mediums, such as central database and RFID (Radio Frequency Identification) could be used for this purpose.

(2) Operational process and program

To maximize cost savings in the SOC project, in practical terms, the operational process and program must be extended from the bidding, procurement and construction phases backwards to the earlier phases of a project life cycle, such as the planning and design phases. Therefore, as stated above, operational processes and

Table 1. Questionnaire Framework

(A) Information Infrastructure

Unit of analysis	Questions	Related IS variable: Measures	Related IS variable: Criteria
Component and scheme of infrastructure	•What are the components of the infrastructure? •What is the relationship between the components? •How can the CEO be assured of the validity of expenditure? •What are the criteria for cost estimation? •How can the cost be allocated to each section?	IS sophistication (use of new technology) Investment utilization Resource utilization	System Quality
Construction of whole network System	•What kind of network architecture is used to connect between all sites and the home office? •What is the capacity of the server? •Is it possible to reflect prompt decision making, in terms of speed? •Does the operating system have flexibility? •Do all departments use the same kind of hardware?	IS sophistication Response time System flexibility	
System security	•Can access to information be restricted by rank? •Should the remote control of a system be possible through external access? •Is it possible to contact external information organizations for continuous data acquisition?	IS sophistication System accessibility	
Decision support system	•What is the procedure of approval? •Is the liability for problems established in the event of accident? •Is each department empowered appropriately?	Effectiveness and efficiency of decisions influence and power of IS department	Individual Impact

(B) Operational Processes And Programs

Unit of analysis	Questions	Related IS variable: Measures	Related IS variable: Criteria
Integration and compatibility of application software (S/W)	•Is the S/W suitable for the network system? •What does it cost to develop a piece of S/W? •Can the S/W be developed by the organization itself? •Is the S/W compatible with others? •What is the scheme of the S/W? •Is it difficult or impossible to compare or consolidate data from two different sources because the data is defined differently?	Integration of system Process control Reliability System flexibility Usefulness of specific functions	System Quality
Integration of design and construction information	•Is it possible to extract design information from construction information? •Can information generated in each section be exchanged? •Is 3D drawing used to examine interaction between each process or to simulate the progress of work? •Is enough information on cost and schedule being provided? •Can all of the design information be computerized? •Is design information managed systematically? •Is output information sufficiently complete? •Is the system easy to use?	Process control (the degree to which the system exerts constraints and checks on the input, change and deletion of all information in the system) Completeness Ease of use	
	•Do data that you receive from the system require correction? •Is the system troublesome for you when you seek information to accomplish your task? •Is the output presented in a useful format? •Does the system provide sufficient information? •Does the system provide the precise information you need? •Does the information content meet your needs? •Does the system provide up-to-date information? •Does the system provide the information on time? •Is the report from the system useful?	Accuracy Conciseness Format Relevance Understandability Timeliness Usefulness	Quality of IS Output

(C) PMIS operation and maintenance

Unit of analysis	Questions	Related IS variable: Measures	Related IS variable: Criteria
Publicity and Education	•Does the senior manager know the importance of a PMIS? •Can the senior manager use the PMIS? •Do the users reject the system itself? •Is the system publicised well to all employees? •Is there feedback reflecting the opinion of users? •Do you think there is not enough training for you or your staff on how to find, understand, access, or use the project computer systems? •Do you think you are getting the training you need to be able to use systems, procedures and data effectively? •Is there an intensive education program for key members of management in the department? •What is the cost and time required for education? •What kind of education is selected? (Site education, in-house intensive education, or commission education)	Leadership User participation Training	User Satis-faction
User data Acquisition	•What is the quantity of the data needed to input into the system? •What is the method of collecting data according to the participants? (contractors, subcontractors) •How long does it take to acquire data? •Can data external to the system be acquired?	User participation	
Operation and maintenance System	•Is the system user-friendly? •Is the organization wholly charged for operation and maintenance? •Can the organization deal with operation and maintenance problems by itself? •Is there any system related to facility management?	User-friendliness Upkeep (the degree to which the system is maintained, enhanced and generally kept up to date)	System Quality
Updating	•What is the updating period? •How is the updating data input into the system? •How is the updating report developed? •How is the updating report distributed and reflected?		

programs in the current SOC projects must be improved to support all phases of a project life cycle. To save time and avoid human error during the exchange of information or data, the exchange must be standardized and automated (Jaafari 2000).

(3) PMIS operation and maintenance

The efficiency of PMISs has decreased because coordinated use of the systems by the project execution organizations and outside project participants is limited. It has been reasonably observed that IT investment fails because of inadequate staffing and/or funding, large project size, poor system performance (Callon 1996). Therefore, improvements to PMIS operation and maintenance are suggested as follows: First, information should be considered and managed as a strategic asset. Extract the maximum value by reusing that information within a project and other projects. Second, a life cycle approach to construction project management should be implemented. Every stage must consider its impact on future stage and future projects. Finally, operation islands are reduced. Provide a work environment that supports collaboration and information sharing.

5. A conceptual information management model for SOC projects

5.1 A framework for an information management model

The development of a conceptual information management model for SOC projects is suggested to improve the problems of operational process and program among the above problems. To improve the operational process and program, operational processes and programs must be improved to support all phases of the project life cycle and standardized processes used to increase integration of information. Thus, a conceptual information management model is defined standardizing the processes and functions, and identifying their contents of information in order to integrate and manage the enormous amount of information generated during an SOC project. This model is developed base upon the case study results and expert's interviews.

The information management model for SOC projects presented in this paper comprises two sub-models, as shown in Fig. 2: a model of construction project phases, and a model of project management functions. Using a process-based approach described in the related research, the sub-models are presented using IDEF0, an information process language, by standardizing the activities of information management. The processes of phases and functions are partitioned as activities in the notation of IDEF0, as shown in Fig. 2. IDEF0 provides a simple model in which processes are the central concept and inputs, outputs, controls and mechanisms are flows between processes. An input is an entity, such as information or raw material, that is processed by a function. A control is a guideline or constraint for a process. A mechanism is a human resource to perform the process. Finally, an output is a product generated by a process. Outputs can be used as inputs or controls for other functions (Atkin 1998; Björk 1999; Sanvido and Medeiros, 1990). Among the outputs, information considered to be closely interacted with each other and have an impact on other phases or functions is defined as core information. The processes of each phase and function are decomposed until core information is generated. However, the identified improvements in information infrastructure and PMIS operation and maintenance were not applied to this research. They must be considered when the information management model is converted to a physical system.

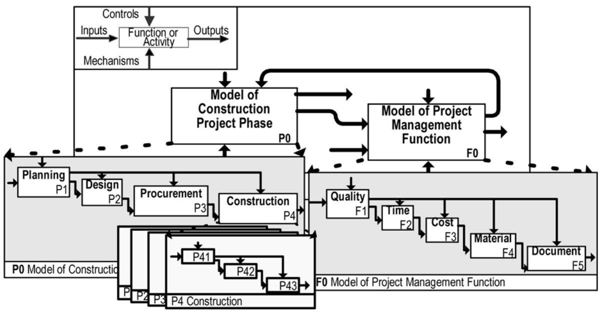

Fig.2. Information Management Model

5.2 An information management sub-model of construction project phases

An information management sub-model of construction project phases is shown in Fig. 3. The model of the phases is divided into four sub-processes that interact strongly with each other: planning, design, procurement, and construction.

Planning management (P1): In the planning management phase, the owners develop conceptual plans by setting up project strategies and objectives. If there is some possibility that the project could be implemented, then a preliminary Feasibility Study (FS) would be performed. In the FS, economic and technical aspects of the project are evaluated, and a feasibility report is prepared. Based on the report, a master plan and an annual investment plan are developed, and a construction project management organization is set up. With reference to all of the above reports, a Project Execution Plan (PEP) is finally developed in this phase.

Design management (P2): In the design management phase, the owners establish contracting strategies for design services, select designers according to defined strategies, and validate design documents as output of the design contract. Based on the PEP developed during the planning phase, contract briefs are prepared for a design contract. The contract briefs include such details as the final products of the work, the period of the work, criteria for estimating construction cost, method of payment, documents for submission, and the due date of each document. According to the briefs, the design contract is made and the progress and the results of the design contract are administered using design interface management and constructability skills. Finally, during execution of the project, if changes to design documents are required, such as in drawings and specifications already approved, then suppliers can issue a Supplier Deviation Disposition Request (SDDR). The technical appropriateness of the SDDR is reviewed and, if the SDDR is approved, contract changes are made.

Procurement management (P3): A purchase order is prepared first. According to the purchase ordering plans already established, execution plans are reported. These plans must include such fundamental components as the project scope, a budgetary measure, bid participation qualification and the contract type. Based on the plans, procurement documents are prepared and reviewed. After reviews, contracts are requested. Finally, contract policy is established and suppliers are selected. After contracting, the contract is administered. Through this process, the contract is substantially controlled. As the objectives of the contract are completed and the contract is closed out, as-built documents are developed. Defects are inspected and repaired during a warranty period. The results are recorded in maintenance management books. Finally, the contractor's performance is evaluated.

Construction management (P4): During construction contract administration, the following processes are performed. Construction progress meetings are held to resolve the existing and expected problems in their early stages by considering and coordinating the different opinions of the related organizations. Field design change orders are classified as Field Change Notices (FCNs), Field Change Requests (FCRs) or Design Change Notices (DCNs). These differ in their applicable scopes and effects. An FCN is a minor design change to improve the field conditions and constructability of the design documents issued by contractors. The owner's approval is not required for each FCN, but they are reported to the owner. An FCR requires a major change to the design documents issued by contractors, and the owner's approval for each FCR is required. A DCN issued by owners is a minor design change caused by errors or omissions in the design documents, or a change in the owner's requirements after the design documents are distributed to contractors. A DCN has the same effect as the original design documents, which do not need to be revised. After supervisors receive a request for progress payment, they verify and evaluate it, and the owners approve the results. Before turning a project over to the owners, supervisors perform a preliminary turnover inspection according to the ownerís turnover plans. Various progress status reports are made, including daily reports, weekly schedule reports, and monthly schedule reports. Results of the reports are managed in compliance with a consistent reporting system to keep track of the overall project progress. Finally, an operating system is established and operated to manage information generated through this mechanism according to quantified construction standards. The system allows the analysis of problems and progress measurements by keeping track of progress on each construction work and the overall construction project.

5.3 An information management sub-model of project management functions

An information management sub-model of project management functions is shown in Fig. 4. The model of functions is divided into five sub-processes that interact closely with each other: quality, time, cost, material, and document management.

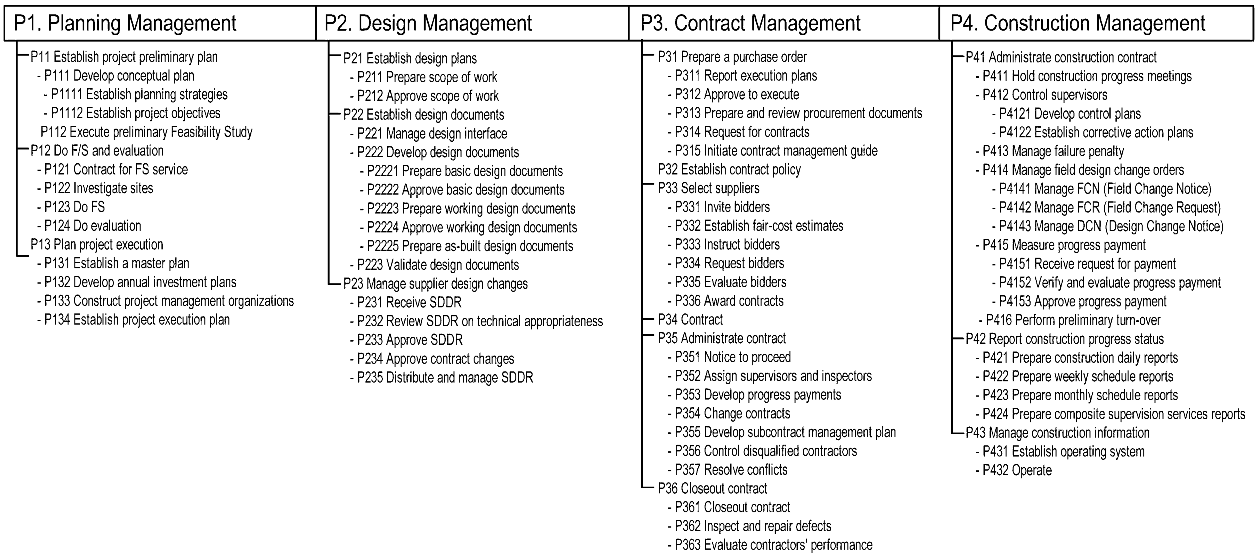

Fig.3. Information Management Model of Construction Project Phases

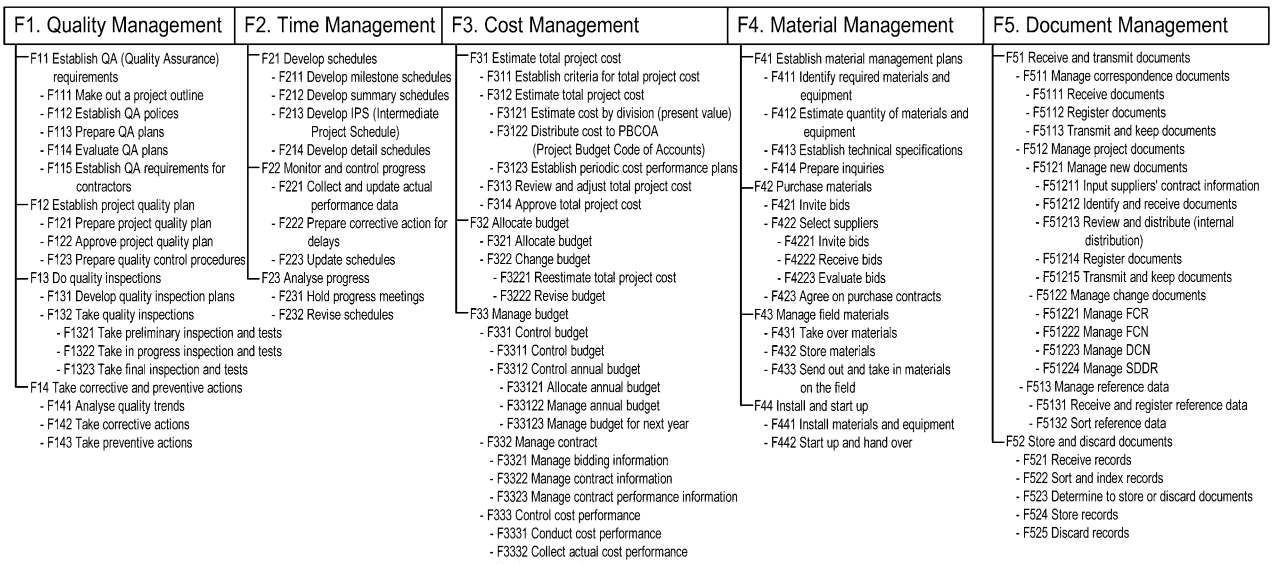

Fig.4. Information Management Model of Project Management Functions

Quality management (F1): After the project outline is prepared, a Quality Assurance (QA) plan is prepared and evaluated. QA requirements for the contractor are then established, and the project quality plan is prepared and approved in accordance with them. Finally, a quality control procedure is prepared according to the owner's requirements. Based on these, a quality inspection plan is developed that also reflects customer requirements. After quality inspection is done according to the plans, non-conformances are identified through analysis of quality trends. If non-conformances are identified, corrective and preventive actions would be taken.

Time management (F2): In the process of developing schedules, milestone schedules showing the major project plan and schedule for the whole project are developed first. Then summary schedules are developed on the basis of the milestone schedules. In the summary schedules, project execution plans are described as contract packages and serve as the basis for the Intermediate Project Schedules (IPSs). The IPSs show schedules by work packages and the interactions between them for junior managers. Finally, based on the IPSs, detailed schedules are developed. The hierarchies of schedules such as milestone, summary, IPS and detail schedules differ according to the characteristics of projects. To monitor and control progress, actual performance data from daily, weekly and monthly construction schedule reports should be collected and updated. Finally, schedule progress meetings are held to compare actual progress with the plan and to initiate any corrective actions as suggested by the analysis.

Cost management (F3): To estimate total project cost, criteria for total project cost should be established first. Based on these criteria, cost by divisions is estimated and distributed according to the Project Budget Code of Account (PBCOA). Periodic cost performance plans are then established. Finally, cost estimation data are reviewed and approved. After the total project cost is approved, the budget is allocated. Total cost reports are developed by divisions or from the PBCOA. During the project, if there is a big difference between the allocated budget and re-estimated total project cost, then the budget must be revised and the total project cost changed. Finally, the budget is controlled, the contract is managed, cost performance is controlled, and cash flow is controlled to manage the budget.

Material management (F4): In establishing material management plans, the required materials and equipment are identified, quantities of materials and equipment are estimated, technical specifications are written, and inquiries are prepared. Material is purchased according to the procedures of inviting bidders, selecting a supplier, and making a purchase contract. When the purchased materials arrive in the field, they are accepted and stored until requested by a contractor. Finally, the materials and equipment are installed according to the installation schedule described in the IPS. After installation is completed, supervisors provide material installation status reports for a field scheduling department to analyse construction progress and hand the installation over to a startup department.

Document management (F5): All documents issued by project participants are managed as they are reviewed, registered, transmitted and revised. Methods of management differ according to the types and uses of documents, such as correspondence, supplier documents, design documents, change order documents and reference data. In deciding whether to store or discard documents, all the documents are classified and indexed. Once the decision is made, they are finally stored or discarded.

5.4 Integrated information flow of construction project phases and project management functions

In the suggested information management model, the process of construction project phases and project management functions are integrated through information flows. Integrated information flows between construction project phases and project management functions are derived as shown in Fig. 5.

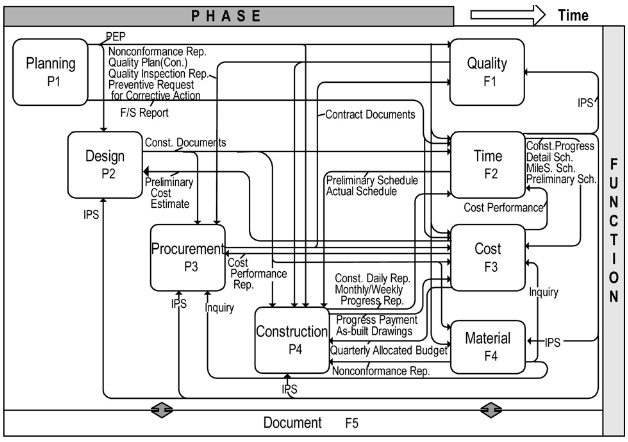

Fig.5. Integrated Information Flows of Phases and Functions

These information relations are analyzed in detail from the viewpoint of each sub-model to find out core information. Fig. 6 shows an example of the planning phase to analyze information flows, which impact the following phases and functions. For example, the PEP, established during the planning phase (P134), is the basis for establishing design plans (P21) and referred during construction progress meetings (P411), which control the construction management. Also, based on the PEP, QA requirements are established (F11), schedules are developed (F21), criteria for total project cost are established (F311) and material management plans are established (F41). Therefore, the PEP is core information, which is used for inputs of P21, F11, F21, F311, F41, a control of P411, and an output of P134. In the same way, the other related information and sub-models are analyzed and a common information matrix between phases and functions is drawn up, as shown in Table 2. Thus, the information management model is confirmed as being able to integrate and manage all of the information generated in the different construction project phases and project management functions throughout a project life cycle.

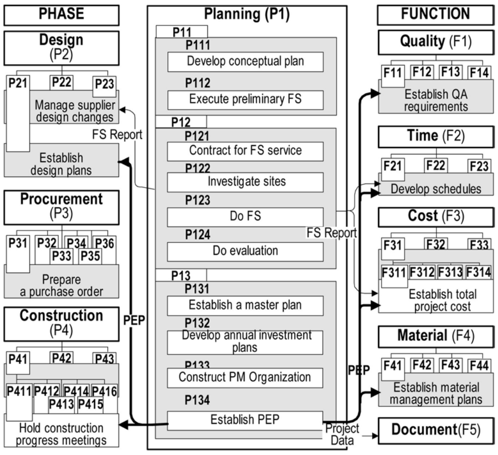

Fig.6. Information Relations from the View of the Planning

Table 2. Common Information Matrixes

Common information	Input	Control	Output
Actual Schedule	P431		F221
As-Built Drawings	F3332		P36, P416
Construction Daily Report	F221		P421
Construction Documents	P341, P414, F3121, F41	F21	P22
Construction Progress	F3331		F221
Contracts Documents	F51211	F12, F332	P34
Cost Performance	F221		F33
Cost Performance Report		P31, P32, P33, P35	F321
Detail Schedule		F331	F214
FS Report	F211	F311, P23	P12
Inquiry	F3331, P313		F414
IPS	F12, F41, P41	F13, F32, P22, P31	F213
Milestone Schedule		F31	F211
Monthly Progress Report	F221	P424	P423
Non-conformance Report	P313, P4141	P41	F13, F43
PEP	F11, F21, F311, P21, F41	P411	P134
Preliminary Cost Estimate		P211	F3222
Preliminary Schedule	F332, P431		F214
Preventive Request For Corrective Action	P416		F132
Progress Payment	F3331		P4153
Project Data	F5		F1~4, P1~4
Project Quality Plan (Contractor)	P32, P41		F12
Project Quality Plan (Owner)	P211	F311	F114
Project Quality Policy (Owner)		P41	F112
Quality Inspection & Testing Plan	P353		F131
Quality Inspection Report	P313, P416		F132
Quality Inspection Status Report	P313, P416		F132
Quarterly Allocated Budget		P41	F33121
Requests For Proposal	F3321		F421
Weekly Progress Report	F221		P422

6. Conclusions

The case studies are applied to evaluate current PMISs based on the framework comprising information infrastructure, operational processes and programs, and PMIS operation and maintenance aspects. As a result of the evaluation, some problems are identified as follows: First, the information infrastructure is isolated physically for security and other reasons. This disrupts communication between the project execution organizations and outside project participants. Second, the operational process and program are limited to several functions and are not applied to all the phase of a project life cycle. Finally, the efficiency of the PMIS operation and maintenance has decreased, because coordinated use of the systems by the project execution organizations and outside project participants is limited. Among the problems, this paper focuses on the problem of the operational process and program. To solve this problem, this paper suggests an information management model. The information management model is composed of construction phase sub-models and project management function sub-models. The sub-model of the construction project phase is presented by standardizing the processes and contents of information management and analyzing the processes by which the information generated in the beginning of the project phase is related to that of other phases. The sub-model of the project management functions is presented by analyzing functions through a project life cycle. The process of the construction project phases and project management functions are integrated through information flow. This research initiated from the case study of only transportation facilities, considering future demand and the similarity of the projects, while acknowledging the wide variety of SOC projects. However, the processes and contents of information management are general in comparison with those of other construction projects and were standardized with reference to related literature and the expert consultation. Therefore, the model presented in this research could be applied as a conceptual information model to other general construction projects if the information were slightly modified for a specific project considering types of each facility, such as transportation, energy, and telecommunication facilities.

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