Project Information Management for Construction: Organizational Configurations

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Abstract

Project performance could be improved through a more explicit and well-defined ***Project Information Management*** function, particularly in the face of emerging advances in information and communication technologies. This paper summaries a framework for project information management and discussed some of the organizational issues relating to its implementation.

Introduction

Project performance in the architecture, engineering, construction and facilities management industries (collectively referred to simply as "construction" here) could be improved through a more explicit and well-defined ***Project Information Management*** function. This is especially important in the face of current trends in ***information and communication technologies (ICT)*** that are yielding a wide range of new computer-based tools—everything from project collaboration web sites to virtual building environments—which promise great increases in the effectiveness and efficiency of designing and managing construction projects. Yet these systems are often complex and the improvements come at a cost in terms of required changes to skill sets, work practices, and organizational structure.

We are interested in contributing to the development of project information management as a well-defined sub-discipline of project management. To date, this work represents early-phase research in which we are developing conceptual models and approaches (prior to field-based research and implementation of the techniques). Elsewhere (Froese 2004, 2005), we have discussed conceptual models that aid in the understanding of the role and context for ICT in construction, developed a conceptual framework for project information management, discussed some of the organization implications (including the role of a ***Project Information Officer,*** or ***PIO***), and explored the impact on project management as a whole. This paper summarizes our proposed approach to project information management and then further explores alternative organizational configurations that might be appropriate for implementing project information management in various construction contexts.

Information Management as a Sub-Discipline of Project Management

Information and information management have always been recognized as important aspects of project management. But they have not been well-formalized—wide variations exist in the level and techniques used for managing project information. Some perspectives argue against an explicit project information management function: for example, suggestions that project management is inherently *all about* information and communication and cannot be sub-divided into a distinct information function sub-function; that information management is largely a technical support (staff) function rather than a project management (line) function; or that information management is a corporate, rather than a project-centric, function. However, we contend that the necessity, on one hand, for management tasks and technical expertise related

specifically to information and ICT, while on the other hand, for tight integration with the all aspects of project management, demands that project information management be treated as a critical, explicit function within the overall project management process.

This could be considered as very analogous to functions such as safety, risk, or quality, which have also been long recognized as important to project management in the construction industry; yet over time, these areas have evolved from loosely-defined project management objectives to distinct sub-disciplines with well-understood requirements, procedures, bodies of knowledge, and roles within the overall project management process. The same can be said for information management. For example, one chapter of the Project Management Institute's Project Management Body of Knowledge (PMI 2000) defines a communications planning framework, yet this falls well short of a comprehensive approach to project information management. Information management seems far behind the areas of cost, schedule, scope, safety, risk, or quality as a well defined and understood sub-discipline of project management.

We contend that improved project information management could improve performance on any construction project today. Yet it becomes much more significant as projects adopt more advanced, emerging ICT, such as building information models (BIM's). Indeed, we contend that a careful consideration of how information management practices could adopt new ICT provides the essential bridge to move new ICT from development into industrial practice.

A Framework for Project Information Management

A comprehensive list of all of the issues involved in the management of information systems for construction can grow very long indeed. To provide some structure to these issues, we propose that project information management be defined as ***the management of information systems to meet project objectives***. Though simple, this definition suggests a breakdown of project information management into four main topic dimensions: a *management process*, *project elements*, *information system elements*, and *objectives*. The following sections examine each of these topics.

A Management Process for Information Management

The management of information systems should follow general management processes:

- *Plan* all aspects of information system. This includes analyzing the requirements and alternatives, designing a suitable solution taking into account all objectives and constraints, and adequately documenting the plan so that it can be communicated to all.
- *Implement* the plan, including issues such as securing the necessary authority and resources for the plan, implementing communication, training, etc.
- *Monitor* the results, including appropriate data collection relative to established performance measures and taking necessary corrective action.

Other generic management processes such as scope definition, initiating and closing the project, iterating through increasingly detailed cycles of the plan-implementation-monitoring sequence, etc. are all equally applicable.

These generic management processes should be applied in the form of specific management practices tailored to the needs of individual projects. In the field of quality management, as a comparison, generic management and quality principles can be implemented in the form of a specific ISO9001 process, in which a project's quality plan is documented in a quality manual that includes a collection of specific work methods statements. Similarly, a project's information management plan can be documented in an information management manual that includes, among other things, a collection of *information management methods statements*, which describe

how particular pieces of ICT (a software tool, a particular data set, a type of electronic transaction, etc.) will be used for particular functions on the project, thereby acting as the atomic units of the information management practices.

Project Elements

The information management actions of planning, implementing and monitoring an information system should be applied to all parts of a project. This can involve the same project work breakdown structures used for other aspects of project management (e.g., breaking the project down by discipline, work package, etc.). However, there are perspectives on decomposing the work that are of particular relevance to information systems. Adopting the processes view of the project as a basis for structuring information management, the approach should focus on three aspects: project tasks, information transactions, and overall integration issues. The process should define these elements, including identifying participants, project phase, etc. (this should correspond largely to an overall project plan and schedule, and thus it may not need to be done as a distinct activity). Then, for each of these elements, the information management process should analyze information requirements, design information management solutions, and produce specific information management deliverables (this is generally at the level that various work packages must interact with each other, not into the details of how each participant performs their own work packages).

The model considers these elements across all project participants (spanning all participating companies, not just internal to one company), and the information management tasks should be carried out for each of these project elements.

Information System Elements

For each of the project elements to which we are applying our information management processes, there are a number of different elements of an information system that must be considered:

- *Information*: Foremost, we must consider the information involved in each of the project elements. First, the process should assess the significant information input requirements for each element, determining the type of information required for carrying out the tasks, the information communicated in the transactions, or the requirements for integration issues. With traditional information technologies, information requirements generally correspond to specific paper or electronic documents. With building information models and other newer information technologies, however, information requirements can involve access to specific data sources (such as specific application data files or shared databases) that do not correspond to traditional documents. Second, we must assess tool requirements by determining the key software applications used in carrying out tasks, communication technologies used for transactions, or standards used to support integration. Third, we must assess the significant information outputs produced by each task. This typically corresponds to information required as inputs to other tasks. After analysis, these results should be formalized in the information systems plan as the information required as inputs for each task, and the information that each task must commit to producing.
- *Resources:* the information management process should analyze the requirements, investigate alternatives, and design specific solutions for all related resources. These include hardware, software, networking and other infrastructure, human resources, authority, and third party (contracted) resources.

- *Work methods and roles:* the solution must focus not only on technical solutions, but equally on the corresponding work processes, roles and responsibilities to put the information system to proper use.
- *Performance metrics, specified objectives, and quality of service standards:* the information systems plan should include the specification of specific performance metrics that can be assessed during the project and used to specify and monitor information systems objectives and standards of service quality.
- *Knowledge and training:* the information systems require certain levels of expertise of people within the project organization, often requiring training.
- *Communications:* implementing the information systems plan will require various communications relating to the information system itself, such as making people aware of the plan, training opportunities, procedures, etc.
- *Support:* information system solutions often have high support requirements, which should be incorporated as part of the information management plan.
- *Change:* the information management plan should include explicit consideration of change—how to minimize its impact, how to address un-authorized changes by individual parties, etc.

Information Systems Objectives

Solutions should be sought that meet the general project objectives of cost, time, scope, etc. However, there are a number of objectives that are more specific to the information system that should be taken into account:

- *System performance* is of primary concern, including issues such as efficiency, capacity, functionality, scalability, etc.
- *Reliability, security, and risks* form critical objectives for information systems.
- *Satisfaction of external constraints:* we have placed the emphasis on the project perspective, but the information management must also be responsive to a number of external influences. Of particular significance in alignment with organization strategies and information management solutions, including appropriate degrees of centralized vs. decentralized information management. Other external influence include client or regulatory requirements, industry standards
- *Life-cycle* issues should be considered. These include both the life cycle of the information (how to ensure adequate longevity to the project data), and of the information system (e.g., life-cycle cost analysis of hardware and software).
- *Interoperability* is key objective for many aspects of the information system.

Maturity Models

The permutations of all of the issues listed under the previous four dimensions leaves a monumental range of issues to be addressed in a project information management program. Not all projects will be able to do a thorough job of addressing all of these. Indeed, an organization could be assessed in terms of the degree to which it addresses each issue. For example, Mourshed (2005) uses a maturity model scale for assessing organizations' performance on information management tasks, ranging from non-existent to optimized.

The Technical Body of Knowledge: Project Systems and Areas of Expertise

The previous section outlines a very generic framework for information management. While this focus on the conceptual frameworks and management processes provides one leg to the practice of project information management, the other leg consists of the technical body of knowledge that underpins the information systems used throughout the construction industry. Ideally, there would be a well developed and widely understood body of knowledge for this discipline—but this does not seem to exist. At present, technical expertise is built up mainly through extensive industry experience with little in the way of unifying underlying theory or frameworks. Recent developments such as Master degree programs focusing on construction ICT (e.g., the European Masters program in Construction ICT, Rebolj and Menzel, 2004) are helping to contribute to a more formalize body of knowledge for both traditional and emerging construction ICT. A further consideration of the technical body of knowledge is outside the scope of this paper.

Organizational Roles: The Project Information Officer

Organizational Issues for Information Management

The following challenging criteria must be considered in defining the organizational responsibility for information management:

- *Project focus:* information management should be project-focused and organized as a project management function, as opposed to centralized within a corporate ICT department. The information management process, as described above, is tightly coupled to the project processes and, inversely, the project processes should be strongly influenced by the ICT perspective. Furthermore, the information management must be responsive to project objectives and the needs of all project participants, rather than being driven by the corporate objectives and the needs of one company alone. This does not imply that a centralized ICT group is not needed: the depth of ICT expertise and resources required may be well-served through some centralized resources. Thus, a matrix organizational structure may be suitable, with primary organizational responsibility for information management residing in a project position supported by a centralized information management group (although matrix organizational structures are generally not ideal, their use here would be similar to other common applications in the construction industry such as estimating or field engineering services).
- *High level:* since information management is central to the overall project management, it should not be relegated to a low level within the project organizational structure (e.g., as might be found with typical ICT support personnel), but should be the primary responsibility of someone within the senior project management team.
- *Separate function:* Although the responsibility for information management should lie within the senior project management team, it would often be a poor fit with other project management functions and current senior project management staff. It requires a depth of specialized knowledge in areas of technology that are rapidly evolving. It may also be overshadowed by traditional practices if it is added as a new, additional responsibility to someone that already handles other aspects of the project management, such as a contracts manager, a project controls engineer, or the overall project manager. Therefore, project information management should be clearly defined as a distinct project management function and, where possible, assigned to personnel dedicated specifically to that role.

Information Management Functions and Roles: Organizational Configurations

The above criteria suggest that, where possible, information management requires a new, senior-level position with the project management team. We call such a position the ***Project Information Officer (PIO).*** The overall responsibility of the PIO is to implement the information management as described previously. However, no single solution for implementing project information management will be ideal for all projects. Rather, ideal organizational solutions will depend on a number of factors, not the least of which are the size of the project and the relative complexity of the information systems to be used. A number of factors contribute to the level of ICT complexity—a project may be considered to have low ICT complexity only if all of the information management process and key ICT software systems are mature implementations that have previously been successfully used by the key project participants (i.e., no innovation), and there is nothing extraordinary in the information requirements or organization makeup of the project. The following suggest some possible organizational configurations that may be appropriate:

- *Small projects/low ICT complexity:* For small, simple projects, it may be sufficient for the project manager(s) to include information management as one of the responsibilities that they must carry out on the project. It may be treated quite informally, but it must still be considered as an explicit responsibility. In this configuration, the project manager(s) must have some expertise in project information management appropriate to the systems being used. There would be no formal PIO position.
- *Medium-sized projects/low ICT complexity:* For larger projects with no unusual ICT requirements (e.g., no major innovations), it may be appropriate to formally define a project information management function and to assign the position of PIO as one of the duties of someone on the project management team. For example, a project controls manager may responsible for scheduling and cost control in addition to being the PIO. This person should have good expertise in project information management.
- *Large projects/high ICT complexity:* For large projects, or any projects with challenging ICT requirements (e.g., the introduction of innovative, advanced ICT systems), project information management should be a well-defined, distinct project management function assigned to a full-time PIO individual or group. Here, the PIO would have a high level of expertise in the practice of project information management and in the specific technologies to be used.

The Project Information Officer

There are also various alternatives for staffing the PIO position. The PIO may be an employee of the project owner, lead designer, or lead contractor organizations, or may work as an independent consultant/contractor. Regardless of employer, the PIO should be considered to be a resource to the project as a whole, not to an individual project participant organization. The PIO should be a senior management-level position within the project organization (i.e., not a junior technology support position). The PIO should report to the owner's project representative and work with an information management committee consisting of project managers and information specialists from key project participants. Depending upon the size of the project, the PIO may have an independent staff. In addition to the information management committee, liaison positions should be assigned within each project participant organization. As in the medium-size project example above, the PIO could be combined with other areas of expertise, such as project controls or quality management. The PIO position could also be supplemented with a specialist consultant to add specific expertise and/or to assist with certain information

management tasks (although the overall information management function should not be "outsourced" to someone that is not a part of the project management team.

Skills and Qualifications

Candidates for the position of PIO must have a thorough understanding of the AEC/FM industry, information management and organizational issues, data interoperability issues, and best practices for software tools and procedures for all of the major project systems described previously. Preference would be for candidates with a master's degree relating to construction ICT and experience with information management on at least one similar project.

Compensation and Evaluation

Advanced construction ICT offers great promise for improving the project effectiveness and efficiency while reducing risk. Not all of these benefits directly reduce costs, yet the overall assumption is that the costs of the PIO position will be fully realized through project cost savings. This will not be a direct measure, but will be assessed on an overall qualitative basis through an information management review processes that examines the following questions of the information management and technology for the project:

- To what degree was waste (any non-value-adding activity) reduced?
- What new functionality was available?
- How efficient and problem-free was the information management and technology relative to projects with similar levels of ICT in the past?
- What was the level of service and management effectiveness offered by the PIO?
- What is the potential for future improvements gained by the information management practices on this project (i.e., recognizing the long learning curve that may be associated with new ICT)?

There is a need for the development of good metrics and data about industry norms related to these issues.

Conclusion

In summary, emerging ICT offer great potential to improve project outcomes, but they come at a cost. They involve complex systems with high technical and organizational requirements. Current practices for managing project information and ICT need to evolve and current skills need to improve. This paper gave a framework for project information management as a distinct sub-discipline of project management and defined the role of the project information officer as the central organizational focal point for information management. It explored some of the organizational configurations and considerations for project information management.

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