A Practical Guide to Construction Project Organizational Structuring

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This paper presents a practical step-by-step guide about how construction project teams can be better organizationally structured. Step 1: Devising the groupings. Step 2: Determining the unit size. Step 3: Providing liaison devices. Step 4: Adding planning and control systems. Step 5: Defining the decision-making system. Step 6: Designing the positions. The procedural guide, based upon Mintzberg's design parameters and Lucas' IT-enabled variables, was developed from a study conducted using Yin's multiple case holistic design approach with qualitative data from major successful building construction projects.

Key Words: Construction Organizational Structure, Project Organization, Organizational Design, Organizational Structuring.

Introduction

The design parameters of positions, superstructure, linkages and decision-making (Mintzberg, 1979) are the basic components of organizational structure and IT-enabled variables such as virtual components, technological leveling, electronic linking and communications (Lucas, 1997) are extensions of these components. This extended framework using design parameters and IT-enabled variables were used as a reference against which descriptive in-person interview, questionnaire results and observations were interpreted to draw prescriptive lessons about how building construction project teams can be better organized. These lessons, derived from this author's Ph.D. dissertation (Salgado, 2005) are summarized in this paper, which presents a step-by-step procedural guide and practical advice for making organizational decisions in construction project organizations.

Research Methodology

The type of research methodology used for the case studies was a multiple-case holistic approach. Holistic case studies allow an investigation to retain the meaningful characteristics of real-life events such as organizational and managerial processes. Their unique strength is the ability to deal with a full variety of evidence –documents, interviews and observations. The components of this methodology lead from theoretical framework, to research questions and propositions, to the logic linking the data to the propositions and finally interpretation. In multiple case holistic research methodology we look for replication logic, if all cases turn out as predicted, these cases in the aggregate, would provide compelling support for the propositions. When using a multiple-case design, one of the main questions had to do with the number of cases necessary for the study. Because a sampling logic is not used, the typical criteria regarding sample size applied to quantitative cases is not applicable. The decision is in terms of case replications. The number of replications depends upon the certainty required to have about multiple-case results. According to Yin's multiple-case holistic study research design and methodology (Yin, 2003), when the issue at hand does not require an excessive degree of certainty, two or three cases would be sufficient or if a high degree of certainty is required, he suggest five cases. Following Yin's guidelines, this author settled with five cases.

The case study construction firms were selected on the basis of knowledge of the firms, their reputation and the likelihood that their experiences will shed some light on how project organization is integrated. Interviews, documentary information and direct observations were undertaken for the purpose of gaining insight into the practice. The units of analyses for the multiple-case study were the project organizations rather than the firms. The background features of each participating firm and project sizes were important elements in the case analyses, but more as a contextual backdrop to circumstances and events on each project rather than the objects of analysis in their own right.

Four quality tests are commonly used in multiple case holistic studies: construct validity, internal validity, external validity and reliability. Construct validity has to do with establishing correct procedural methods for the concepts being studied. In our cases we use interviews, documentary evidence and observations. Internal validity deals with establishing causal relationships. We used patterns identified across cases. External validity deals with generalized findings. We used multiple cases investigated using replication logic. Finally, reliability deals with consistency. We used the same procedures and demonstrated that the operations of the study, such as the information and collection procedures were repeated with the same results. (Salgado, 2005)

Building construction projects with similar characteristics are more likely to have similar organizations. Five major building construction project cases were selected. The project selection criteria included (see Table 1): cost (> $20 million), duration (>12 months), owner (public), type (building), location (Maryland/DC Metro Area) and delivery method (CM. GC/CM, PM). Each of the projects provided information on their organization; project type descriptions, schedules, general cost data and organization descriptions. The project analyses were developed, in part, from this information.

Project managers from each of the projects received the study questions, the measures of organization structure and IT questionnaires. The questionnaires and information gathering were described to the project managers as a way of obtaining and sharing insight on the project’s organization and management. After gathering the information, an interview was held with the project manager of each of the projects. The interviews were held for the purpose of looking into the different aspects of the project organization structure, the unit grouping, its size, liaison devices, planning and control systems, decision-making system, design of positions, as well as, IT and its impact on the project organization structure. The information was key in formulating conclusions about each project. Each project site was observed during a site tour. Issues such as general organization of the work site and site offices were noted. Table 1 displays abbreviated information on the projects used in the case studies.

The organizational structures in each of the five building construction project cases studied share a number of similarities. These five major successful building construction project cases were studied using the multiple case holistic design approach explained. In this context, a successful building construction project is defined as a project built/completed according to quality standards, on time and within budget.

Construction managers involved in the five cases studied, used principally past experience and were very adaptive in making organizational structuring decisions. Like most building construction managers, those in the study cases lacked formal training in or even exposure to formal organizational design theory, and thus make their decisions based on what has seemed to have worked in the past, and on intuition. The hope here is that a step-by-step procedural design process considering this extended framework may provide construction project managers with some level of rational guidance for use in designing project organizations. The following sections present a procedure for using this extended framework to design construction project organization structures.

Table 1.

Project Information

Criteria	Project A	Project B	Project C	Project D	Project E
$Million Cost	$21	$29	$38	$128	$100
Duration	18 months	24 months	12 months	32 months	36 months
Owner	Government Agency	University	University	University	Quasi-Government Agency
Type	Building	Building	Building	Building	Building
Location	Baltimore	Princess Anne	College Park	Washington, DC	Arlington, VA
Delivery Method	CM/GC	CM	CM/GC	CM/GC	PM

Procedure

The procedure, proposes six steps based on the extended framework, with lessons learned from the case studies results. One important consideration in this extended design process is the applicability of information technology (IT) and IT-enabled variables simultaneously at each step in the structuring process of the project organization.

Step 1: Devising the Groupings

Among the first things to be done in the design of a construction project organization is the breakdown to key tasks required to meet the project goal and performance objectives, and to allocate these tasks to individuals or groups (line and staff organization).

It is through the process of grouping into units that the hierarchy of the organization is built (Daft, 2001). Our research findings on the cases studied are that they all used a combination of work process and business functions as a means for setting levels and devising groupings.

Anecdotal evidence from discussions with managers on the five case studies suggests that work and business function groupings are chosen primarily because this combination provides a good balance of business administrative function requirements (estimating, planning, scheduling, accounting, etc.), in concert with construction operations and work processes requirements at the project level (superintending, project methods, fabrication, assembly, etc.). These grouping attributes seem to be the hallmark of the successful project cases studied.

A parallel consideration is the impact of virtual (i.e., information technology created) organizational components in the case studies, and correspondingly, what opportunities are suggested by the case studies for leveraging virtual components. A virtual component occurs when an organization uses information technology to create an organizational unit that does not exist in conventional form. For example, a group of workers may appear like a physical department on an organization chart, and they seem to be co-located, but each member is actually in a different location and work is accomplished virtually.

The case studies suggest that construction organizations are aggressively including virtual organizational units within project structures. Project A used information technology to create organizational unit components and collaborative team groupings as virtual components. Those included the mechanical-electrical unit, the scheduling unit and a museum specialist unit. These units were enabled by a web-based collaboration. In Project E, the Program Manager in Arlington, Virginia, used an Internet-based video-conferencing system to create collaborative groupings with the Architect-Engineer and the Construction Manager located in Nashville, Tennessee. Both of these were highly complex projects compared to Projects B, C, and D. In Project B, a design-build contractor wanted part suppliers to "substitute" for on-site inventory; the supplier was linked through an electronic data interchange system with the design-builder using overnight delivery. This provided parts to the builder as they were needed for installation. The builder had a virtual raw materials inventory, which was owned by the supplier until it arrived on site for installation. This allowed conventional organizational components to be substituted by virtual grouping components. This seemed to be especially true for logistical operations such as material supply chain activities as has been suggested in the literature (Galliers & Baets, 1998).

Step 2: Determining the Unit Size

After selecting a grouping for the units, determining unit size is next. What should be the unit size of construction project personnel assigned to the project? How many sub-units should a manager be heading (span of control)? How many levels should there be in the hierarchy? There is no precise formula for determining ideal unit size. Unit size variations depend largely on the mechanisms used to coordinate work across units. In general, the greater the use of standardization, the larger the size of the work unit; the greater the reliance on mutual adjustment, the smaller the size of the work unit. This is one parameter that requires experience with similar projects. In the case studies, unit sizes varied from seven in Projects A, B and C to fourteen in Project D. The Project Manager span of control ranged from three sub-units in Projects A, B, C and E to four sub-units in Project D. The levels in the hierarchy went from two levels in projects A, B and C to four levels.

One consideration at this step is electronic linking. Electronic linking provides a technological leveling that substitutes information technology for layers of management and for a number of management tasks. In some organizations, layers of management exist to look at, edit and approve messages that flow from the level below to the level above. Through electronic linking/communications, some of these layers can be eliminated and the overall unit size decreased.

Step 3: Providing Liaison Devices

Liaison devices facilitate coordination by mutual adjustment, and refer to the means of communication used between units of the project organization. These devices form a continuum from staff liaison positions, to coordinating meetings, to integrating managers and matrix structures (involving dual reporting). Examples of liaison positions from the case studies included: expediters, field office engineers and area superintendents. All the projects investigated used a combination of liaison devices. In all cases, the project manager was the key integrating manager and coordinating face-to-face meetings were the conventional liaison devices used. Simultaneously, all the projects used a combination of interaction technologies, including fax, e-mail, web-based linking and conferencing, and collaboration systems.

Faxing is the oldest of these interaction technologies still in use today. Fax devices were used extensively by all of the firms in the projects studied as an electronic linking/communication tool.

E-mailing was the most widely used interaction technology application for transmitting project messages among the project teams to complement conventional liaison devices in all the projects studied.

Web-based linking and conferencing and collaborative systems allowed synchronous discussion with ability to interchange project information, as well as, real-time data manipulation exchange. These systems were used to a larger degree in projects D and E. These projects were the more costly projects, in the range of 100 million dollars each and had longer durations. The usage of these systems was more limited in projects A, B, and C which were in the range of 20 to 40 million dollars each and had shorter durations.

On these systems, project managers cautioned that it takes a lot more time and resources to set up jobs, establishing collaborative routines and training using the more sophisticated systems. Therefore, the recommendation here is to use the more sophisticated web-based collaborative systems only on higher value and longer duration jobs.

Step 4: Adding Planning and Control Systems

Selecting the size of the unit responsible for the planning and control system is influenced by: project objectives, coordination needs of the work, reporting requirements and the system used. Planning and control systems regulate the outputs of the project organization unit and relate to coordination by standardization of outputs. The projects studied used both action planning and performance control systems for coordination. Through the action planning system they developed action programs, expenditures guidelines, detailed CPM scheduling, and operating performance specifications. Through the performance control system, they established control budgets, scheduled milestones and performance standards.

All the case study projects used internet systems and a combination of computer software tools for planning and control. All the projects used Primavera Project Planner® as the planning and scheduling system in combination with Prolog® internet-based collaborative system for project control.

The planning and scheduling system used Critical Path Method network logic and durations. In addition, to activity duration, resources such as manpower, costs, equipment and so on were attached to activities. The system allowed management to compare planned vs. actual work activities, it also provided for work breakdown structure’s multiple summary levels, methods of searching, selecting and sorting. As resources are loaded, planning project curves can be produced, then as activities are completed performance plots are used to compare scheduled, actual and earned projections.

Prolog system for project control was implemented starting the first day of the projects on all the case studies. The project page displayed general and miscellaneous information to characterize the project for multiple reporting and query. The system used a web browser with all the information stored and managed in one central database. The five main features of this control system included collaboration, purchasing management, cost control, document management and field administration features.

All five construction companies used web-based collaborative features in setting up planning and control systems. Advantages cited by case study management included: real time communication, more efficient document processing, reduced printing and overnight delivery charges, and last but not least, that salaried staff spends less time finding and distributing information and more focus on higher end tasks.

Step 5: Defining the Decision-Making System

Defining the decision-making system has to do with decentralization. We decentralize for two main reasons: (1) all decisions cannot be made by one person in any organization, and (2) decentralization allows the organization to respond quickly to new situations. Two main delegations of decisions need to be made: (1) delegation of operational decisions down the chain of authority (vertical decentralization), and (2) delegation of decisions to staff personnel and assign authority for these decisions (horizontal decentralization).

All the case study projects used selective/limited vertical and horizontal decentralization, because this provided flexibility. In the vertical dimension, formal authorities were delegated to work units at various levels of the hierarchy. Financial, budget and personnel decisions were taken by the project manager selectively and within certain limits. In the horizontal dimension, managers made selective use of staff unit expertise and experience. A conclusion taken from these experiences is that selective/limited vertical and horizontal decentralization appears to offer needed flexibility on major projects.

Simultaneously, information technology appears to have better enabled the decentralization of information and of decision-making. Information that was previously available only to the top manager can be quickly shared throughout the organization.

These IT systems, in addition to enable project personnel to coordinate on-line, have also facilitated decision-making. These programs have decision support capabilities to perform project tracking and forecasts, what-if analyses, web-enabled document management, query facilities, etc.; thereby, facilitating the decentralization process and enabling personnel to make decisions at their level. The recommendation concerning this step is that in designing the decision-making system for the project organization; use the features of these IT systems that allow for selective/limited vertical and horizontal decentralization which was identified earlier as providing the selectivity and flexibility required for the decision-making of large construction projects.

Step 6: Designing the Positions

All of the above considerations affect and influence the specifications for filling key positions. Grouping initially defined the division of labor. Designing the positions involves (1) specialization, (2) formalization and (3) training and experience requirements.

How specialized should the jobs be? In all the case studies, project management personnel were engaged in a wide variety of managerial tasks, their jobs were more enlarged both horizontally and vertically than is typically found in other professional jobs at the company level. This is consistent with managerial jobs, which are typically the least specialized in an organization. Flexibility and adaptability were key qualities required when considering specialization of personnel.

Next, the positions need to be formalized. In all cases studied, all rules and procedures were in writing and project management personnel followed them when making decisions. The jobs were formalized by written job descriptions specified in the employee handbook. Project personnel had on-line access to job descriptions, career paths, rules and regulations. Some of the formalization techniques used started with an effective hiring selection process designed to determine if job candidates “fitted” into the organization. The hiring selection process included role requirements, policies and expectations.

Finally, people need training. In designing positions, clear explanation of training, skills, knowledge, abilities, experience and other characteristics needed to perform the jobs have to be specified. In all cases studied, the firms offered extensive construction project management training through on-the-job-training, mentoring programs, off-the-job through extensive workshops and seminars, as well as on-line delivery of training. Actual qualifications of available personnel may require iterative processes of changes in the project organizational design. They may alter the groupings, unit sizes, liaison devices, planning and control systems, and decision-making systems. These processes conclude when reasonable balances between qualification requirements and the personnel assigned are obtained.

Conclusions

This paper has presented and explained a practical step-by-step guide about how construction project teams can be better organizationally structured. Step 1: Devising the Groupings. Step 2: Determining the Unit Size. Step 3: Providing Liaison Devices. Step 4: Adding Planning and Control Systems. Step 5: Defining the Decision-Making System. Step 6: Designing the Positions. The research methodology and extended theoretical framework based upon Mintzberg's design parameters and Lucas' IT-enabled variables were useful tools when applied to construction project organizations. We can use these tools to provide insights into project organizations and information technology-enabled capabilities to make relative comparisons among different construction management organizations. The main lesson is to consider design parameters and information technology enabled variables simultaneously in structuring project organizations. Information technology must be an integral part of project organization design.

The literature on construction project organizations does not explain the processes of organizational structuring considering design parameters and IT-enabled variables of organization. It is primarily limited to construction project organization charts. Construction project managers, for the most part, use subjective seat of the pants methods for project organizational structuring. They rely on experience and copy past project organization structures. IT is something that is haphazardly added on to make improvements in evolving makeshifts of construction project organizations. In order to approach construction organizational structuring in a rational way, a practical guide, integrating design parameters and IT-enabled variables, can help design a better organization for the project situation to better achieve project goals and objectives.

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