

ABSTRACT

Title of Dissertation: **CONSTRUCTION PROJECT
ORGANIZATIONAL STRUCTURING**

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This dissertation presents an extended research study of project organizational structuring design, using Mintzberg's design parameters of organization and Lucas' IT-enabled variables on construction building project organizations. To the design parameters of unit grouping, unit size, liaison devices, planning and control systems, decision-making system and design of positions, this dissertation study simultaneously considers virtual components, technological leveling, technological matrixing, electronic linking and communications. This study used Yin's multiple case holistic design approach for this extended research study with data from major successful building construction projects to illustrate the use of this extended view and compare its findings. Based on this extended research study, this dissertation develops a practical methodology for construction project

organizational structuring design. Furthermore, this dissertation applied Robbins' measures of organization structure (complexity, formalization and centralization) for corroboration.

CONSTRUCTION PROJECT ORGANIZATIONAL STRUCTURING

by

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CHAPTER 1

INTRODUCTION

1.1 Introduction

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. Furthermore, IT is something that is haphazardly added on to make improvements in evolving makeshifts of construction project organizations. In order to approach construction project organizational structuring in a rational way, a practical methodology, based on a sound integrated theoretical framework for analysis, needs to be developed.

An integrated theoretical framework based on Mintzberg's design parameters, (Mintzberg, 1979) extended by Lucas' IT-enabled design variables (Lucas, 1997) will be explained and presented. To the design parameters of unit grouping, unit size, liaison devices, planning and control systems, decision-making system and design of positions, this dissertation study simultaneously will consider virtual components, electronic linking/communications, technological leveling and technological matrixing. Furthermore, this dissertation will apply

Robbins' measures of organization (complexity, formalization and centralization) for corroboration. (Robbins, 1987)

The purpose of this dissertation, following Yin's multiple case study holistic approach, is: First, to describe how this integrated theoretical framework is applied to the particular case of construction project organizations. Second, to examine a number of case study questions, using data from major successful building construction projects (follow-on work to the present study should expand the purview to include unsuccessful examples), looking at the similarities (what they all share in common) in the design parameters, IT-enabled variations and dimensions (measures) of organizational structuring. Third, based on this extended theoretical framework application and its specific findings, to develop a rational procedural step-by-step practical methodology, illustrated with supportive practical examples from the case studies, that construction project managers can use as a tool for project organizational structuring.

1.2 Literature Review

There are many publications about construction and project organizations. The most relevant literature deals mostly with different

aspects and types of construction and project organization structures. Barrie and Paulson (1992) address the topic of development and organization of projects and organizational concepts, i.e., functional, line and staff, task force and matrix structures. Bresnen (1990) studied the forms and processes of interaction that occur in the organization and management of projects. The main findings of this study point to a paradox that emerges when one considers the forms and practices of organization and management, and the likelihood of them actually being achieved and maintained, given the prominence of the contractual dimension. Clough and Sears (1994) deal with organizational structure within the context of the company organization. The information presented is simply a narrative of common practice; no attempt is made about explaining organizational management forms from a design viewpoint. Fryer (1989) reviews topics on organizational activities, objectives, characteristics of organizations, types of organization and subcontracting. Harrison (1992) outlines project management and project organization structure and reviews the elements involved in designing project organizations. Hughes's dissertation (1991), undertakes four case studies, and the extent to which their organizational structures match a model is compared to the level of success achieved by each project. The analysis of the case studies shows that they tended to suffer due to inappropriate organizational

structure. The projects tended to be organized as rigid hierarchies, particularly at decision points, when what was required was a more flexible, dynamic and responsive organization. Ivancevich et al. (1994) highlights the importance of organizational structure in developing an effective organization and points out the key choices managers make in determining organizational structure: specialization, delegation, departmentalization and span of control. Kerzner (1995) under selecting the organizational form, outlines seven basic factors (project size, project length, experience with project management organization, philosophy and visibility of upper-level management, project location, available resources and unique aspects of the project) four parameters on implementation (integrating devices, authority structures, influence distribution and information systems) and quotes Galbraith on six additional factors (diversity of product line, rate of change of the product lines, interdependencies among units, level of technology, presence of economies of scale and organizational size). Klitgaard's dissertation (1988), focused upon the relations of work in the residential construction sector of the New Hampshire economy. While changing technology is integrated into the analysis, the primary concentration is upon the organization of work, which includes the development of the technical division of labor, supervision and structures of control, and the degrees of dependence or independence

afforded the worker. Kimmons and Loweree (1989) reference, presents the work of 116 experts, addresses all of the diverse project management responsibilities and tools from the perspective of the project management profession. It covers the elements of project management technology, offers suggestions about the project manager's involvement with several engineering disciplines, treats the management of small and large projects, as well as utility, government, research, pharmaceutical, fast track, and international projects, explores management abilities and effective communication. Oberlender (1993) presents the principles and techniques of managing engineering and construction projects from the original plan, through design and construction, to completion. It emphasizes project management during the early stages of project development and shows various organizational structures. Pilcher (1992) discusses the goals of an organization in the context of what it has to achieve and how it is structured. Organization charts are presented and the principles underlying the design of organization structures are discussed. Smith (1992) examined organization structures that can be used during the construction phase of large public sector construction management project. He examines the advantages and disadvantages of the hierarchical, project and matrix structures, as well as, the applications of each to construction management projects. Tatum (1984) sought to

develop a better understanding of practices in organizational structuring. This research indicated that managers adapt and apply experience as a primary means of organization structuring. Tatum and Fawcett (1986) provide a starting point for organization design through practical application of organizational alternatives and selection of the most beneficial structure. Tatum (1989) describes elements of organization structure and culture that appear to foster construction innovation. Firms maintained flexibility in unit size and grouping to allow attention to innovation and built a diverse technical capability. Tenah (1984) presents step-by-step methods for organizing and routing information in a construction firm. He examined how the information required by the construction personnel is organized into reports, the contents of these reports, the purposes they serve, and the frequency at which they are issued. A typical organization structure is used as an illustration. Thomas et al. (1983) provide a primer on organizational structures and authority structures. The objective was to describe organizational forms that relate project characteristics to the best choice of project management structures. He outlines principles to guide in the selection of a project manager and his/her authority and responsibility within the hierarchy of the organization. Thomas et al. (1986) is a case study of organizational changes of the Susquehanna Steam Electric Station (SSES) project. It was concluded that the

changes were inconsistent with principles of effective organization design. From the viewpoint of project authority structures, the most appropriate structure does not seem to have been instituted until very late in the project. Walker (1989) focuses upon the way in which the people involved in projects are organized. This work presents the different aspects for analyzing and designing organizational structures, including the operating system, the managing system, the relationship of people in the organization and their interdependencies, the roles in the organization, the decision making positions and the relationships in arriving at decisions.

In this dissertation study, the main link to established conventional organization theory will be based on the work of Henry Mintzberg (1979) *The Structuring of Organizations: A Synthesis of the Research*. Mintzberg, ahead of his time, most successfully, integrates the work of all the others in a comprehensive manner, and provides very useful concepts for the analysis of the basic design parameters of organization structure and design.

Concerning IT and organization design, a surprisingly small number of researchers have written about it. Authors deal mostly with the impact of IT on organizations in general. Groth (1999) draws

heavily on the work of Mintzberg. He proposes new forms of organizations because of the advancements in information technology. His work provides new and innovative ideas on IT and organization design. Galliers and Baets (1998) blend empirical studies of the way information technologies are implicated in organizational transformation with theoretical synthesis by leading scholars and lessons learned from practice. The blending of theory, empirical studies and practical experience gives the kind of conceptual breadth that is increasingly required in approaching the complex issues of information technology and organizational transformation. Good and Schultz (2000), in this latest research work, examine the impact of technologies within contemporary businesses. They assess the strategic, organizational, and managerial impacts of technology. They discuss how technologies change organizational teamwork, influence internal and external relations and give insights into the integration within business firms. Targett et al. (1999) present original findings, which are of practical value to general managers and IT managers. They offer case studies for teaching purposes and provide the latest and best works on the management of information technologies and information systems.

Willcocks and Lester (1999) bring together a number of papers from authors whose intent is to explore the issue of IT and its productive use in organizations. The papers in this publication explore the linkage between IT use, productivity and organization performance.

According to Daft (1998) IT is having an impact on organizations. Some of these impacts may include smaller size groupings, reduction of the layers of management, decentralization of decision-making, collaboration improvements and greater employee participation. Some of these impacts will be explored within the context of our study.

Henry Lucas (1997) introduced the concepts of IT-enabled variables. He makes the basic argument of using information technology enabled variables to design new organizations or redesign existing ones. He presents a series of new information technology design variables to be used in creating a technology-based organization.

Conventional methods do not consider IT-enabled design variables. IT becomes something that is added on after the organization has been designed. In this dissertation we will consider design parameters and IT-enabled organization design variables

simultaneously in analyzing the project organization structure. This dissertation will describe this in-depth view with cases from actual construction projects, and will present a methodology for practical applications in the systematic design of construction project organization structures. The conclusions will highlight the benefits of designing and integrating IT-enabled information technology variables rather than evolving makeshifts of project organizations. Having a basic understanding of project organization design processes and practices will provide construction project managers with new tools to make better decisions concerning the organization and the information technology involved. This study is extremely important today, because of the proliferation of IT systems in project management and the need to integrate the technology and the organization in order to better achieve project goal and performance objectives.

Finally, an important methodological issue in the analysis of organizations is the development of valid measures of organization structure. In *Organization Theory: Structure, Design, and Applications*; Robbins (1987) presents a methodology for measuring the dimensions of organization structure.

This author will use Mintzberg's organizational design theory, Lucas's theory on IT-enabled organization design and Robbins' theory on measures of organization structures, to analyze construction project organization structures.

Yin's case study research method (2003) will be used in this dissertation. A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context and describes the real-life context when the boundaries between phenomenon and context are not clearly evident, and multiple sources of evidence are used. Case studies allow an investigation to retain the holistic and meaningful characteristics of real-life events such as organizational and managerial processes and their unique strength is the ability to deal with a full variety of evidence –documents, interviews and observations. The case study research design is an action plan for getting from here to there, where “here” may be defined as the initial set of questions to be answered, and “there” is some set of conclusions about these questions. Each individual case study consists of a “whole” study, in which convergent evidence is sought regarding the facts and conclusions for the case; each case's conclusions are then considered to be the information needing replication by other individual cases. Both the individual cases and the multiple-case results should be the focus of

the findings and conclusions. The components of the research approach in this dissertation leads from theoretical considerations, to research questions and conjectures, to the logic linking the data to the conjectures and finally to the interpretation of the findings and conclusions. Chapter 3, section 3.3 explains in detail the research methodology.

1.3 Summary

This dissertation is divided into six chapters, with appendixes, a glossary and references. Chapter One contains the introduction, which discusses the purpose, focus and objectives for this study. Following the introduction a review of the literature is presented.

Chapter Two, Theoretical Framework, discusses basic concepts of organization, the design parameters, IT-enabled design variables and measures of organization structure.

Chapter Three, Research Objectives and Methodology, presents the statement of research objectives, research methodology and project selection criteria.

Chapter Four, Research Analyses, presents the case study projects and cross-case analyses of conjectures, measures, and the IT documentary information questionnaire.

Chapter Five discusses the findings, conclusions and recommendations for future research.

Chapter Six presents a step-by-step methodology, using the extended framework that construction management professionals can use, as another tool for construction project organizational structuring.

Appendixes A, B, C, D and E contain detailed reports of the five case study projects. Appendix F contains the case study questions, Appendix G the Robbins' measures of organization structure and Appendix H the IT questionnaire. A glossary and references follow the appendixes.

CHAPTER 2

THEORETICAL FRAMEWORK

2.1 Introduction

This chapter will present and describe how the theoretical framework for the application of organizational design parameters, IT-enabled structural variables and measures of organization structure is applied in the analysis of construction project organizations.

2.2 Basic Concepts

Most writers seem to agree on the basic concepts of organization: division of labor (basic and administrative) and coordination. In *The Structuring of Organizations, A Synthesis of the Research*, Mintzberg defines three main coordination concepts (coordinating mechanisms), which explain the fundamental ways in which organizations coordinate their work: The concepts of coordination by mutual adjustment, direct supervision and standardization.

Under mutual adjustment, the coordination of work is accomplished by informal communication. Direct supervision

accomplishes coordination by having one person taking the responsibility for directing the work of others. Work can also be coordinated without mutual adjustment or direct supervision by virtue of standardization, the coordination of parts is incorporated in the work, and the necessity of continuing communication is reduced. The three basic ways of standardizing is by standardization of work contents, standardization of outputs and standardization of skills.

Mintzberg further defines the design parameters of organizational structuring, i.e. unit grouping, unit size, liaison devices, planning and control systems, decision-making system and design of positions. These parameters relate directly to the basic concepts of organization as shown on Table 2.1.

2.3 Design Parameters

Parameters, in the context of organization theory, are components or constituents of a whole. A design parameter is one of the component parts into which a whole may be resolved by analysis. Following are the six design parameters of organization design.

Design Parameters	Related Basic Concepts
Unit Grouping	Administrative division of labor and coordination by direct supervision.
Unit Size	Coordination by direct supervision.
Liaison Devices	Coordination by mutual adjustment
Planning and Control Systems	Coordination by standardization of outputs
Decision-Making Systems (Vertical and Horizontal Decentralization)	Administrative division of labor.
Design of Positions Job specialization Behavior Formalization Training and Experience	Basic division of labor. Standardization of work content. Standardization of skills.

Table 2.1 Design Parameters

The design parameters are the basic components of organization structure that influence how the organization functions.

2.3.1 Unit Grouping

Unit grouping is the process of clustering jobs according to some logical arrangement. Unit grouping relates to the concepts of administrative division of labor and coordination by direct supervision. Unit grouping is the portion of the structure indicated by conventional organization charts. It involves dividing the work activities, arranging

the resulting groups and determining their staffing. Managers may base this on one of several characteristics of the groups: knowledge and skill, work process and function, grouping by time or sequence in the work flow, type of output, grouping by client, grouping by place or location in which the group operates, etc. Different bases for grouping are used at different levels in the organization depending on the interdependencies (work-flow, process, scale or social) that are seen as having the highest priority: work-flow embraces all kinds of interdependencies between separate tasks in functional specialized organizations; process refers to interdependencies within separate stages; scale refers to economies of scale and social interdependencies denote the unit group interaction.

Seven main bases of unit grouping are discussed in the literature of organizational structuring. The main question to be asked concerning unit grouping is: On what basis or combination of bases does the project organization group position into units? Is it grouped by knowledge/skills? Is it by work process? By products? By business function? By shifts at the jobsite? By type of client? By area? Or a combination of groupings?

2.3.2 Unit Size

Unit size refers to how large a unit work group should be. No precise formula exists for determining the ideal unit size. Unit size relates to the concept of coordination by direct supervision, it defines the span of control (number of persons reporting) for individual managers and the shape of the organization. In the literature the term span of control is sometimes used to indicate unit size. The term unit size is preferable to span of control, because span of control (direct supervision) is only one coordinating mechanism, other mechanisms include standardization of work, standardization of outputs and standardization of skills.

Variations in unit size are explained in terms of the mechanisms used to coordinate the work. The greater the use of standardization for coordination, the larger the size of the work unit. The greater the reliance on mutual adjustment, the smaller the size of the work unit. Multiple levels in the hierarchy produce a tall structure; a large span of control produces a wide structure. Unit size is driven up by standardization, similarity in the tasks performed in a given unit, the employee's needs for autonomy and the need to reduce distortion in the flow of information up the hierarchy; and it is driven down by the need

for close direct supervision, the need for mutual adjustment among complex interdependent tasks and the need for members of the unit to have frequent access to the manager for consultation. How do we determine the unit size? What should be the unit size of construction project management personnel assigned to the project? How many sub-units should a manager be heading? How many levels should there be? The answer to these questions should guide the manager in designing the project organization.

2.3.3 Liaison Devices

Liaison devices relate to the concept of coordination by mutual adjustment and refer to the different means of communication methods and techniques used between units of an organization. Liaison devices are the linkages within the organization stemming from the grouping. Liaison devices encourage cooperation between individuals. These devices can be considered to form a continuum from liaison positions, through coordinating meetings to integrating managers and matrix structures (involving dual reporting). The liaison devices are generally used where work is at the same time horizontally specialized, complex and highly interdependent. When there is a high interaction between groups, one individual may be assigned a liaison position, to facilitate

communication and coordination, that is, integration. Standing midway is the matrix structure in which dual authority replaces unity of command. Are there liaison positions for coordination? Are there regular coordinating meetings (staff, client/management, etc.)? Are there integrating area managers? Matrix managers?

2.3.4 Planning and Control Systems

Action planning and performance control systems regulate the outputs of the organization unit and relate to the concept of coordination by standardization of outputs. Planning specifies the standard of desired outputs and control systems assess whether or not that standard has been achieved. Budgets, schedules, specifications, etc. are all plans. Budgets are plans that specify the costs of outputs; schedules are plans that establish time frames for outputs; specifications are plans that establish the quality of materials, workmanship and execution standards; etc. Control systems, which are highly dependent on the use of effective information systems, regulate and measure the overall results. The planning and control systems provide further means of coordination through (a) performance control imposing general performance standards, and (b) action planning, defining specific decisions, actions and schedules. What are the means

of coordination in terms of planning and control systems? Performance control monitoring (i.e. budget standards, milestones, earned value) and/or detailed action planning/scheduling monitoring.

2.3.5 Decision-Making System

The decision-making system (vertical and horizontal decentralization), our fifth design parameter, relates to the concept of administrative division of labor.

2.3.5.1 Vertical Decentralization

Vertical decentralization establishes the location of decision-making authority within the hierarchy of line management. Vertical decentralization is concerned with the delegation of decision-making power down the chain of authority. Key decisions are categorized as financial (budget) decisions; technical (design) decisions; operational and administrative decisions. Three design questions arise in vertical decentralization: 1. What decisions should be delegated down the chain of authority? 2. How far down the chain should they be delegated? 3. How should their use be coordinated (or controlled)? For example, delegating the authority to approve subcontracts or purchase orders

under a specified dollar amount to the superintendent defines the degree of vertical decentralization for this type of decision.

2.3.5.2 Horizontal Decentralization

Horizontal decentralization establishes the location of decision-making authority at the staff personnel level (horizontal level). Horizontal decentralization refers to the extent to which staff personnel control the decision-making authority. Giving authority to the staff personnel creates horizontal decentralization. In horizontal decentralization we move into the realm of informal power, specifically of control over information gathering and advice giving to line managers and the making of their choices. The shift of decision-making from line management to system analysts, experts, or support specialists by virtue of their knowledge. When an organization relies on systems of standardization for coordination, some power must pass out from the line managers to the designers of those systems, typically the analysts. To the extent that the organization has need of specialized knowledge, notably because certain decisions are highly technical ones, some power must pass out from the line managers to the experts. In theory, horizontal decentralization is complete when everyone in the project organization participates equally in decision-

making. To what extent staff personnel control decision-making (horizontal decentralization)?

2.3.6 Design of Positions

Design of positions is the sixth and final design parameter in our scheme. This parameter establishes the requirements for positions. It includes, (a) job specialization, (b) formalization and (c) training and experience.

2.3.6.1 Job Specialization

Job specialization relates to the concept of basic division of labor. Job specialization is one of the conventional variables in the design of positions. It takes place in both the horizontal dimension (breadth) and the vertical dimension (depth). Horizontal job specialization, the predominant form of division of labor, defines how many different tasks and how broad or narrow these tasks are. In horizontal job enlargement, the worker engages in a wide variety of tasks. Vertical job specialization separates the performance of the work from the administration of it. When a job is enlarged vertically or "enriched," not only does the worker carry out more tasks, but he also

gains control over them. For example, low horizontal specialization and high vertical specialization describe the position of Owner's Project Engineer on a large construction project with responsibility for broad overview of design activities by all disciplines in the A/E organization. How specialized (high, low) are the positions in the project organization?

2.3.6.2 Behavior Formalization

Behavior formalization relates to the concept of standardization of work content. It is the second conventional variable in the design of positions. The means of formalization are categorized in three ways: (1) Formalization by job: In this case, the organization attaches the behavioral specifications to the job itself, typically documenting it in the formal job description. (2) Formalization by workflow: In this way, instead of linking the specifications to the job, the organization attaches them to the work itself. (3) Formalization by rules: the organization simply institutes rules for all situations, jobs, workflows, and workers. To what extent (high, moderate or low degree of formalization) is the work content formalized?

2.3.6.3 Training and Experience

Training and experience relates to the concept of standardization of skills. When a body of knowledge and a set of work skills are highly rationalized, the organization factors them into easily learned jobs and then relies on the behavior formalization to achieve coordination. Training is the design variable by which the coordinating mechanism that is called the standardization of skills is affected. What are the training and experience requirements for construction project management personnel?

2.4 IT-enabled Design Variables

IT-enabled variables, within the context of organization structures, are variations or modifications in organization structure, enabled by IT. According to Lucas (1997), conventional organization design literature does not recognize the new design variables enabled by information technology. In the case of linking mechanisms, IT such as e-mail or groupware can be used instead of conventional solutions like task forces or liaison positions. According to Lucas, whatever overall structure the firm takes, one of the important tools available to

managers to assist in coordinating and workflow is communications through electronic linking. Therefore, communication is also an element that must be integrated in the design process. Table 2.2 relates Mintzberg's design parameters and Lucas' extensions. The following sections present brief summaries from Lucas' classification of IT-enabled structural variables.

Theoretical Framework	Extensions
Mintzberg's Design Parameters	Lucas' IT-enabled variables (modifications)
Unit Grouping	Virtual components Technological Matrixing
Unit Size	Technological Leveling
Liaison Devices	Electronic Linking/Communications
Planning & Control Systems	IT Systems & Information Processing/Electronic Workflows/Groupware
Decision Making System	Technological Leveling
Design of Positions	IT systems/Technological Leveling

Table 2.2 Mintzberg's Parameters and Lucas' Extensions.

2.4.1 Virtual Components

A virtual component occurs when an organization uses IT to create a structural component (organizational unit) that does not exist in conventional form. Unlike conventional structural components, a virtual unit component works across space, time and organizational boundaries with links strengthened by webs of communication technologies. A component that appears to exist, but does not exist in reality in the same way; Lucas gives the following example: When manufacturers want part suppliers to substitute for on-site inventory, the supplier is linked through electronic data interchange with the manufacturer; using overnight delivery, it provides parts to the manufacturer just as they are needed for production. The manufacturer now has a virtual raw materials inventory, which is owned by the supplier until it arrives for production. Another 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 through electronic communications. Are there virtual (collaborative team groupings) components in the project organization structure?

2.4.2 Electronic linking/Communications

Through electronic mail systems, electronic bulleting boards, or video conferencing, and fax, it is possible to form communication links within and across all organizational boundaries. New workgroups form quickly and easily. Electronic linking also facilitates monitoring and coordination, especially from remote locations. Has IT, through electronic linking, impacted the unit size (increased/decreased) in the project organization? Are there liaison devices like electronic linking (e-mail, fax, video-conferencing, web-based linking/conferencing) means of coordination?

2.4.3 Technological leveling

IT can substitute for layers of management and for a number of management tasks. Electronic communications can eliminate some of these layers; thereby a manager's span of control can be increased. Has IT, through the IT-enabled variable of technological leveling, caused a reduction on the layers of management (management levels) resulting in a flatter project organization structure? How much of a reduction?

2.4.4 Technological Matrixing

Creating temporary work groups that cut across organizational boundaries using e-mail and groupware. Group members report electronically to their departmental supervisors and to the team leader, thereby creating a matrix organization based on technology. Is technological matrixing used? Are there temporary work groups cutting across organizational boundaries, using dual reporting via e-mail and/or groupware?

2.5 Robbins' Measures of Organization Structure

Measures are established to ascertain quantitative comparisons (Robbins, 1987). Developing measures of organization structure is important for a manager. A practicing manager's interest is not in elaborate precision scores, but rather simple measures that can provide reasonable estimates of whether for example a given organization is high, moderate or low in complexity. How can a manager determine the degree of formalization or gauge its centralization? In this respect Robbins' measures can be used to provide reasonable estimates of dimensions of organization structure. The three measures are:

complexity, formalization and centralization. Table 2.3 relates Robbins' measures of organizational structuring to Mintzberg's design parameters.

Robbins' Measures of Organization Structure	Related Mintzberg's Design Parameters (related basic concepts).
Complexity	Unit Grouping (division of labor and coordination) Unit Size (coordination by direct supervision) Liaison Devices (coordination by mutual adjustment) Design of Positions (basic division of labor)
Formalization	Design of Positions (standardization of work content and skills) Planning and Control Systems (standardization of outputs)
Centralization	Decision-Making Systems (Administrative Division of Labor).

Table 2.3 Robbins' Measures and Mintzberg's Parameters

2.5.1 Complexity

Complexity refers to the degree of horizontal, vertical, and spatial differentiation in an organization. Horizontal differentiation

refers to the degree of differentiation between units based on the orientation of members, the nature of tasks they perform, and their education and training. The larger the number of different job titles, level of training, number of occupational specialties, degrees held, knowledge and skills, the more complex the organization is and the more difficult for management to coordinate activities. Vertical differentiation refers to the depth in the structure, the levels that exist between top management and operatives. Differentiation increases, and hence complexity, as the number of hierarchical levels in the organization increases. Spatial differentiation encompasses the degree to which jobs are dispersed geographically. An organization dispersed geographically is more complex. Even though IT has dramatically improved the ability for separated decision makers to retrieve information and communicate with each other, complexity is higher. The more complex an organization, the greater the need for effective communication, and liaison devices. As complexity increases, so do the demands on management to ensure that differentiated and dispersed activities are working together toward achieving the organization's goals. This is the paradox: Management's decision to increase differentiation is made in the interest of efficiency, but this decision creates the need to add liaison devices to facilitate coordination and communication.

Appendix G presents a sample questionnaire, the answers to which can provide a reasonably accurate estimate of an organization's degree of complexity. The sum of the item scores is the degree of complexity (out of a possible 35). Scores under 15 represent relatively low complexity; scores above 22 indicate relatively high complexity and scores of 15 to 22 make up the moderate range.

2.5.2 Formalization

Formalization refers to the degree to which jobs within the organization are standardized. Work processes are standardized when the contents of the work are specified and programmed. The job incumbent has explicit job descriptions, rules, specifications and procedures covering work processes. Standardization reduces variability, develops consistency and uniformity and promotes coordination. Appendix G presents a sample questionnaire, the answers to which can provide a reasonably accurate estimate of an organization's degree of formalization in the organization unit. The sum of the item scores is the degree of formalization (out of a possible 35). Scores under 18 represent relatively low formalization, scores above 25 indicate relatively high formalization, and scores of 18 to 25

show relative moderate formalization. It taps the major elements in formalization: the degree to which job descriptions and regulations are specified, the degree of supervision, the amount of freedom given to subordinates and managers, the degree of work standardization, and the degree to which regulations exist and are enforced.

Organizations use formalization because of the benefits that accrue from regulating employees' behavior. Standardizing procedure reduces variability, promotes coordination and reduces the cost of training new employees.

2.5.3 Centralization

Centralization refers to the degree to which decision-making is concentrated at a single point in the organization. A high concentration implies high centralization, whereas a low concentration indicates low centralization or what may be called decentralization. Organizations need to respond rapidly to changing conditions at the point at which the change is taking place. Decentralization facilitates speedy action. All organizations process information so that managers can make decisions. Attention must be given to identifying the most effective way in which to organize where those decisions should be made. Appendix G

presents a sample questionnaire, the answers to which can provide a rough appraisal of an organization's degree of centralization. The questionnaire taps the degree of influence that management has over key parts of the decision-making process, and the amount of discretion that the typical first-line supervisor has over the critical elements of his or her job. The sum of the item scores is the degree of centralization (out of possible 50). Approximate guides for translating scores into categories are as follows: 40 points and above represents high centralization, 21 to 39 is moderate, and 20 or less indicates low centralization. Low centralization (decentralization) reduces the probability of information overload, facilitates rapid response to new information and provides more detailed input into decisions. On the other hand, centralization adds a comprehensive perspective to decisions and can provide significant efficiencies.

2.6 Summary

This study will consider the integrated theoretical framework based on Mintzberg's organizational design parameters; Lucas' IT-enabled organizational design variables and Robbins' measures of organization structure in the analysis of the construction project organizational structures.

This chapter has presented the theoretical framework for the study, including fundamental concepts of organization, the design parameters, IT-enabled variables and measures of organization structure. The next chapter presents the research objectives and the design methodology used in the study.

CHAPTER 3

RESEARCH OBJECTIVES AND METHODOLOGY

3.1 Introduction

This chapter will present the statement of research objectives, the research methodology, study questions, conjectures and the project selection criteria used.

3.2 Statement of Research Objectives

In the construction project management literature, the study and analysis of project organization structures is mostly limited to organization charts. Moreover, construction project managers, for the most part, use subjective seat of the pants methods for organizational structuring. They rely on experience, copy past organization structures or evolve makeshifts of organizations. There is a lack of understanding of fundamental organizational design processes. In order to approach organizational structuring rationally, a practical methodology, based on a sound integrated theoretical framework for analysis, needs to be developed. An integrated theoretical framework based on Mintzberg's design parameters, (Mintzberg, 1979) extended by Lucas' IT-enabled

design variables (Lucas, 1997) and Robbins' measures of organizational structure has been presented. (Robbins, 1987)

The purpose of this research, following Yin's multiple case study holistic approach, is: Firstly, to describe how this theoretical framework is applied to the particular case of construction project organizations. Secondly, to examine a number of case study questions, using data from major successful building construction projects, looking at the similarities (what they all share in common) in the design parameters, IT-enabled variations and dimensions of organizational structuring. Thirdly, based on this extended theoretical framework application and its specific findings, to develop a rational procedural step-by-step methodology, illustrated with supportive practical examples from the case studies, that construction managers can use as a new tool for project organizational structuring.

3.3 Research Methodology

The type of research methodology to be selected is a multiple-case holistic approach relying extensively upon our theoretical framework and the use of case study research techniques (Yin, 2003).

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 the research approach leads from theoretical considerations, to research questions and conjectures, to the logic linking the data to the conjectures and finally to the interpretation of the findings and conclusions.

In multiple case holistic research designs we look for replication logic (external validity). If all the cases turn out as predicted, these cases, in the aggregate, would provide compelling support for the set of propositions. (See conjectures section 3.3.2)

When using a multiple-case design, a further question has 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 are not applicable. In case study research, the decision is in terms of case replications. The number of replications depends upon the certainty required to have about the multiple-case results.

According to 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 suggests five cases. Following Yin's guidelines, this author has settled with five cases.

Case study research techniques will be chosen due to several reasons. First, a highly individualized package of information concerning background organizational characteristics will be obtained for each case. Second, a strong emphasis will be put upon obtaining participants' own perceptions and attitudes towards organization structural parameters, IT-enabled variations and dimensions of organization structure. Consequently, a particular concern will be with understanding circumstances and events from the respondents' points of views and with allowing as full a range of responses as possible. Third, an interest in events as they unfold will require a more flexible, and unstructured approach, by which lines of inquiry will be followed as particular issues arise and develop. Fourth, the number of key project management personnel to be interviewed will be comparatively small; consequently, the standardized and structured techniques commonly applied to larger samples will not be appropriate for the

study. Fifth, the influence of situational factors; therefore, a premium will be put on an approach that allows for the full range of conditions to be taken into account. Finally, when taking a holistic approach, case study research methods are the norm.

The research will examine a number of case study practices looking at the similarities and differences in the parameters, IT-enabled variations and dimensions of the project organization structures. The firms will be selected on the basis of knowledge of the firms, their reputation and the likelihood that their experiences will shed some light on how the project organization is integrated. Interviews, documentary information and direct observations will be undertaken for the purpose of gaining insight into the practice. The information involved will be looking at the project covering the organization design parameters, IT-enabled variables and dimensions of organization structure and their impact on construction project organization design.

Since a case study method is to be used, no claim will be made as to the representativeness of the sample. The cases will not be sampled in any way and it will not be possible to generalize the findings from this study to the wider population of similar types of firms and/or projects found within the industry.

The unit of analysis for this study will be the project organization rather than the firm. The background features of each participating firm will be 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.

The four quality tests, according to Yin (2003), commonly used to establish the quality of a case study research are: construct validity, internal validity, external validity and reliability. Table 3.1 summarizes the tests, case study tactics, research phases and actions recommended. Construct validity has to do with establishing correct procedural methods for the concepts being studied. Internal validity (for explanatory or causal studies only and not for descriptive or exploratory studies) deals with establishing causal relationships. External validity has to do with establishing the domain to which a study's findings can be generalized and Reliability deals with demonstrating that the operations of a study, such as the information collection procedures can be repeated, with the same results.

<u>Tests</u>	<u>Tactics</u>	<u>Phases</u>	<u>Actions</u>
Construct validity	Use multiple sources of evidence	Data collection	Use of interviews, documentary evidence and observations
Internal validity	Do pattern matching	Data analysis	Patterns identified across cases
External validity	Replication Logic	Research design	Multiple cases investigated using replication logic
Reliability	Use similar case study procedures questions	Data collection	Same procedures followed for each case; consistent set of questions used

Table 3.1 Case Study Design Tests

3.3.1 Interview Protocol: Study Questions

The study questions have been organized around the design parameters of the structure of an organization: unit grouping, unit size, liaison devices, planning and control systems, decision-making system and design of positions.

1. Unit Grouping

On what basis or combination of bases does the project organization group position into units and units into larger ones? (Project organization chart). Market basis (products, clients, region, area). Functional basis (function, knowledge/skill, work process).

Are there virtual (collaborative team unit groupings) components in the project organization structure? If so, explain.

2. Unit Size

What is the total (unit size) of construction project management personnel assigned to the project?

How many sub-units (span of control) is the project manager heading?

How many levels are there in the hierarchy?

Has IT, through electronic linking, impacted the unit size in the project organization? If so, how? (Increased/decreased)

Has IT, through the IT-enabled variable of technological leveling, caused a reduction on the layers of management (management levels) resulting in a flatter project organization structure? How much of a reduction? Explain.

3. Liaison Devices

Are there liaison positions for coordination? Elaborate.

Are there regular coordinating meetings? (Staff, client/management, etc.)? Elaborate.

Are there integrating area managers? Matrix managers? Elaborate, if there are.

Are there IT liaison devices like electronic linking/communications (e-mail, fax, video-conferencing web-based linking/conferencing) means of coordination?

Is technological matrixing (dual reporting via e-mail and groupware) used?

4. Planning and Control Systems

Explain your planning and control system in terms of:

(a) performance control monitoring (i.e. budget standards, milestones, earned value...)

(b) detailed action planning/scheduling system monitoring.

What IT system (MIS, Project Management or other software/groupware) tools do you use? Elaborate.

What is the extent of IT project management control system on the project?

5. Decision Making System

Key decisions: financial (budget) decisions; technical (design) decisions; operational decisions, administrative decisions.

What decisions are delegated (vertically decentralized) down the chain of authority?

How far down the chain are they delegated?

Has IT enabled to reduce layers of management and vertically decentralize decision-making?

To what extent, staff personnel control decision-making (horizontal decentralization)? Elaborate.

What role does IT play on the horizontal decentralization of decision-making?

6. Design of Positions

In general, how specialized (high, normal, low) are the positions in the project organization?

How has IT impacted job specialization?

To what extent (degree of formalization) is the work content formalized?

How has IT impacted formalization?

What are the training and experience requirements for construction project management personnel?

How has IT impacted training and experience requirements?

3.3.2 Conjectures

The purpose of the conjectures is to put forward an opinion, a tentative judgment, and a supposition from incomplete evidence. Some of the conjectures may seem general or obvious, but the basic idea is

simply to suggest, to guide, to illuminate the direction of the inquiry or to direct attention to something that should be examined within the scope of the study. In our case, these conjectures arise out of theoretical considerations and will be modified or extended by the case study results. Given the theoretical framework and study questions, the following is a summary of the study conjectures. Similarly to the research questions, the conjectures have been organized around the design parameters of unit grouping, unit size, liaison devices, planning and control systems, decision-making system and design of positions.

1. Unit Grouping

Seven main bases for grouping are discussed in the literature of organization structuring: (1) Grouping by knowledge and skills. (2) Grouping by work process or activity. (3) Grouping by business function. (4) Grouping by time shifts, according to when the work is done. (5) Grouping by output, on the basis of the products. (6) Grouping by client. (7) Grouping by place, according to the different areas in which the organization operates. To the question of on what basis does the project organization group position into units, given that in construction project management we deal with operations/work processes requirements, as well as, business function requirements *it*

can be conjectured that the project organization uses primarily a combination of work process and business functions for grouping.

According to Lucas, an organization can use IT to create organizational grouping components in other than conventional form, as virtual components. For example, a group of workers may appear from an organization chart to be co-located in a physical department, but each member may actually be in a different location and work may be accomplished through electronic communications. Considering the question: Are there virtual (collaborative team unit groupings) components in the construction project organization structure? *IT can be conjectured to enable virtual components (collaborative team groupings) in the construction project organization.*

2. Unit Size

According to Lucas, Technological leveling is the action of substituting IT for layers of management and for a number of management tasks, thereby reducing the management levels and unit size of the organization. Considering the question of IT affecting the unit size and causing reduction on the management levels, *IT can be conjectured to affect the unit size in the project organization and*

reduce the management levels in the project organization structure. In other words, to cause a reduction on the line managers and administrative support staff with the result of fewer hierarchical levels and a flatter project organization structure.

3. Liaison Devices

Liaison devices refer to the different means of communication methods and techniques used between units of an organization. These devices can be considered to form a continuum from liaison positions, through coordinating meetings to integrating managers and matrix structures (involving dual reporting). *It can be conjectured that the project organization uses a combination of devices (i.e. liaison positions, meetings, area managers and/or matrix managers).* As an extension, we can use IT (fax, e-mail, web-based linking/conferencing collaboration systems, etc.) to complement/supplement conventional liaison devices in the project organization. Therefore, as an extension, *IT can be conjectured to modify the project liaison devices.*

4. Planning and Control Systems

Planning systems specify (standardize) desired outputs. Cost and programming schedule estimates are plans that establish the estimated costs and programming time frame of outputs. Specifications are planning tools that establish the standards of materials and workmanship required. Controlling systems assess whether or not the planning standards have been achieved. Budgets, milestone schedules and quality control are performance control monitoring measures the organization uses to regulate outputs. Concerning planning and control systems (standardization of outputs), *it could be conjectured that the project organization uses a combination of performance control monitoring and detailed action planning/scheduling system monitoring.*

At the company level, construction organizations use electronic information systems to provide planning and performance controls, system examples include budgeting monitoring systems and management systems. At the project level also, *IT can be conjectured to have extensive usage of project management systems.*

5. Decision-Making system

Theoretically, five distinct types of vertical and horizontal decentralization are classified. (A) Vertical and Horizontal Centralization: Decisional authority is concentrated in the hands of the manager. He/She retains both formal and informal authority, making all the important decisions and coordinating by direct supervision. (B) Limited Horizontal Decentralization (Selective): This type relies primarily on standardization of work processes for coordination. The structure is centralized in the vertical dimension. Non-managers in the horizontal dimension have limited (selective) decentralization. (C) Limited Vertical Decentralization: In this type managers are delegated (in parallel) a good deal of formal authority to make decisions concerning their specific sector or area. (D) Selective Vertical and Horizontal Decentralization: Here selective decentralization comes together. In the vertical dimension, authority for different types of decisions is delegated at the various levels. And in the horizontal dimension, staff make selective decisions according to how technical are the decisions they must make. (E) Vertical and Horizontal Decentralization. Here the decision making is concentrated largely at the operating core level. Given these theoretical considerations, *it*

could be conjectured that the project organization uses selective vertical and horizontal decentralization.

Advanced information technology has enabled organizations to quickly and easily share information throughout the organization. Management in varied positions has the information they need, to make important decisions quickly, rather than waiting for decisions from headquarters. *IT can be conjectured to influence the decision making system (centralization/decentralization) of the project organization.*

6. Design of Positions

Job specialization takes place in both the horizontal dimension and the vertical dimension. Low vertical specialization means more administrative control and low horizontal specialization broader scope. Project management jobs tend to be broader in scope and the worker has more administrative control. Therefore, concerning job specialization, *it could be conjectured that the project management organization uses low vertical and horizontal specializations.*

As an extension, today's IT systems have facilitated more administrative controls (vertical specialization), as well as, broadened

work scopes (horizontal specialization). IT could be conjectured to influence horizontal and vertical specialization levels of the project organization.

Formalization is defined as “the extent to which rules, procedures, instructions are written.” What would be the level of formalization extent in major construction management firms in terms of job descriptions, regulations, etc.? Given the highly regulatory environment in which large construction project organizations operate *it could be conjectured that the degree (extent) of formalization at the project level would tend to be in the range of moderate to high.*

More organizations are using on-line IT systems in formalization. These systems have an impact on accessibility and facilitate the standardization of work processes. *IT can be conjectured to influence the degree (extent) of formalization of the project organization.*

Training and experience relate to the concept of standardization of skills. The body of knowledge of project management personnel relates to multiple construction related disciplines and needs to be broad by the very nature of construction managerial work. *It can be conjectured that training and experience (standardization of skills) in*

construction related disciplines are key requirements in the design of positions of project personnel.

The implementation of IT systems means that organizations need people to be trained and experienced in using these systems. Therefore, *IT can be conjectured to influence training delivery and experience of project personnel.*

3.4 Project Selection Criteria

Suitable case study projects are essential in multiple case studies. GC (General Contracting), CM (Construction Management), PM (Project Management) and CM/GC project delivery methods dominate the building segment of the construction industry.

Project managers of firms and projects with similar characteristics are more likely to have similar organizations. Therefore, projects must meet the following selection criteria:

- The project's value exceeds \$20,000,000.00 in cost. Larger projects will have significant on-site project organizations available to facilitate the study.

- The project is underway during the period of study.
- The project is scheduled for at least twelve months.
- The owner of the project is a state government agency, university or quasi-government agency. (Quasi-government agencies receive funding from the government for non-essential government purposes.)
- The project is building type rather than process plants or civil structures such a roads, bridges or dams.
- The construction managers are organized in similar ways and do similar work in the given regional market area. In this case the region comprising the State of Maryland and the Washington, DC metropolitan area.
- Projects are accessible and in settings other than remote sites in rural areas. (Very remote sites sometimes require a more integrated design and build organization.)
- The project delivery method is by GC, CM, PM or CM/GC.

3.5 Summary

In this chapter on research objectives and methodology, the author has presented the statement of research objectives, research design

methodology, study questions, conjectures and project selection criteria. The next chapter presents the research analyses.

CHAPTER 4

RESEARCH ANALYSES

4.1 Introduction

The ultimate objective of this study, based on the extended theoretical framework application and its research findings, is to develop a rational procedural step-by-step methodology, illustrated with supportive examples from the case studies, that construction managers can use as a tool for project organizational structuring. This chapter will present the case study projects, which includes the information gathering and procedures followed, cross case analyses and a summary of the research findings. The Appendixes present complete project narratives, project reports, measures of organization structures' questionnaires, documentary information (IT questionnaires) and samples.

4.2 Case Study Projects

Five cases were selected. The projects selected comply with the selection criteria established. Each of the projects provided information on the project organization, project type descriptions,

schedules, general cost data and organization descriptions. The project analyses were developed, in part, from this information. Besides the information provided by the project, observation of the project site and interviews were used to develop the case studies. The information provided additional confirmation that the project met the basic selection criteria.

Project managers from each of the projects received the study questions, the Measures of Organization Structure Questionnaire and IT Questionnaire (see Appendixes). The questionnaires and subsequent information gathering were described to the project managers as a way of obtaining and sharing insight on the project organization and management.

After gathering the information through the methods described above, 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, measures of organizations, as well as, IT and its impact on the project organization

structure. The information was key in formulating conclusions about each subject project.

Each project site was observed during a site tour. Issues such as general organization of the work site and site offices were noted. The following table displays abbreviated information on the projects used in the case studies.

Criteria	Project A	Project B	Project C	Project D	Project E
\$M 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

Table 4.1 Subject Project Information

4.3 Cross-Case Analysis: Conjectures

Conjecture 1: It can be conjectured that the organization uses a combination of bases (market and functional) to group positions into units.

In all of the cases the organization used a combination of bases. At the company level they were of a market basis, i.e. regions, areas and projects. At the project level they were mainly functional, i.e. work processes and function bases.

Conjecture 2: IT can be conjectured to enable virtual components (collaborative virtual team groupings) in the project organization.

In project A, the project organization used IT to create organizational unit components/collaborative team groupings in other than conventional form, that is, as virtual components. Those virtual components included the mechanical/electrical unit, the scheduling unit and the museum specialist unit. These units were virtual departmental units enabled by IT.

Through the firm's intranet, project B had virtual collaborative team groupings with the home office, A/E and others associated with the project. In addition to that the intranet contributed to the project effectiveness and enhanced project communication.

In Project C there were no virtual components in the project organization.

In project D, the firm supports each project with a technical staff (virtual collaborative groupings) of highly trained construction professionals and a team of specialists in partnering, estimating, purchasing, scheduling, cost engineering, risk management and community relations.

In Project E, the PM used IT to create virtual collaborative team groupings with the A/E and CM located in Nashville, Tennessee. They communicated via video-conferencing through the Internet.

Conjecture 3: IT can be conjectured to impact the unit size in the project organization and reduce the management levels in the project organization structure.

In Project A, the total construction project management personnel assigned to the project was seven. The span of control of the senior project manager consisted of three sub-units: the site/building sub-unit headed by the project manager; the construction sub-unit headed by the superintendent and the accounts sub-unit headed by the office accountant. There were two levels in the hierarchy: (a) Senior PM-PM-Project Engineers and (b) Senior PM-Senior Superintendent-Superintendent. IT, through electronic linking, has impacted the unit size of the project organization. It decreased the unit size from nine to seven. Technological leveling has had no direct effect on the management layers at the project level. The project organization, with or without IT, is a flat project organization structure.

In Project B, the total construction management personnel assigned to the project was seven. The span of control of the project manager consisted of three sub-units: project engineering superintending and the assistant project management. Formally, there were two levels of hierarchy on this project. IT, through electronic linking, has not impacted the unit size of the project organization; rather, it was a tool for better communication. IT has had no direct effect on the management layers at the project level.

In Project C, the total construction project management personnel assigned to the project was seven. The span of control of the project manager/executive consisted of three subunits. There were two levels in the hierarchy. IT, through electronic linking, has not increased or decreased the unit size in the project organization. IT, through technological leveling, has not caused a reduction on the layers of management; it was a flat project organization structure.

In Project D, the total construction project management personnel assigned to the project was fourteen. The span of control of the senior project manager, in this case the project executive was four sub-units. From the project executive to the field personnel, there were four levels in the hierarchy. IT has not impacted the unit size of the project organization, or the layers of management (management levels) of the project organization structure.

In Project E, the total PM/CM personnel assigned to the project was twelve. They include senior managers, project managers, project engineers, office administrators, superintendents and field engineers. The span of control of the PM consisted of three sub-units: the A/E, Q/C and the CM. There were three levels in the management hierarchy.

Electronic linking has not had a significant impact on the unit size, nor technological leveling caused a reduction on the layers of management.

Conjecture 4: It can be conjectured that the project organization uses a combination of devices for coordination.

In project A, as far as the continuum combination of liaison devices, from liaison positions through coordinating meetings to integrating managers, the senior project manager was the key integrating manager and coordinating meetings were the conventional liaison devices used for coordination. The senior project manager conducts coordinating meetings: (a) on a weekly basis, with field staff for review and clarifications, with subcontractors to review construction operation activities and workflow; (b) on a biweekly basis, with owner representatives and principal A/E for reviews, clarifications and improvements; (c) on a monthly basis, meeting with the home office for updating resources (work force, materials, equipment, financial/cash flow).

In project B, the project manager was the key integrating manager between the home office and the owner's representative. The project engineer was the key liaison position between the A/E and the

CM. Weekly and monthly coordinating meetings were the conventional liaison devices used for coordination. Weekly meetings were held among the project team members on site. These meetings increased the face-to-face interaction with all project members. Weekly meetings with subcontractors and monthly owner/project team meetings were also held.

In project C, the project manager/executive was the key integrating manager and coordinating meetings were the conventional liaison devices used for coordination. The superintendent met with the subcontractors on a weekly basis to update schedules of work performed. The project manager/executive was the key-integrating manager responsible for completing monthly reports, which were forwarded to the vice-president.

In project D, the project manager was the key integrating manager and coordinating meetings the conventional liaison devices used for coordination. There were owner's meetings every two weeks and staff meetings and foreman meetings n a weekly basis.

In project E, the program manager was the key integrating manager and coordinating meeting the conventional liaison devices

used for coordination. Weekly staff meetings, dealing with design and construction issues, such as scheduling, submittals, etc. and subcontractors meetings dealing mainly with coordination of tasks and procurement issues.

Conjecture 5: IT can be conjectured to modify the project liaison devices through electronic linking/communications and/or technological matrixing.

Project A used electronic linking/communications as IT liaison devices. The company had an intranet linked to the job site. The owner had also developed a project website to facilitate communication/coordination of information with the GC/CM, A/E and other agencies. Technological matrixing, using electronic linking/communications to create matrix organizations, was not used.

Project B used electronic linking/communications as coordinating devices. The company had its intranet linked to the job site. Most of the correspondence was through e-mail. Fax and other means were also used. Technological matrixing was not used.

Project C, as far as electronic linking as means of coordination the project used mostly e-mail and fax. Technological matrixing was not used.

Project D used web-based linking conferencing and collaborative systems, e-mail and fax as electronic linking/communicating devices. Technological matrixing was not used.

Project E used web-based linking/conferencing as coordination devices. E-mail was used for coordination of RFIs (requests for information) and submittal documentation. The program manager used video/teleconferencing with companies out of Nashville. Technological matrixing was not used.

Conjecture 6: It could be conjectured that the project used a combination of performance control monitoring and detailed action planning/scheduling system monitoring (standardization of outputs).

All of the projects used both performance control, as well as, detailed action planning systems for coordination. Through the performance control system they established cost control budgets, milestones and performance standards. Through the detailed action

planning system they developed action programs, expenditure guidelines, and detailed CPM scheduling and operating specifications.

Conjecture 7: IT project management systems can be conjectured to impact the management control on the project organization coordination.

In Project A, as far as IT, the company had an Intranet and it used Prolog ® for Scheduling and Project Management.

In Project B, the CM firm used a construction accounting software system, as well as, Excel ® to set up subcontracting project budget controls. Suretrack® and Primavera® were used for planning, scheduling, monitoring and control. Each element was cost loaded to help track costs. The payout was based on the percentage complete of work done using the loaded schedule. The project team was connected to the company's intranet, which facilitated information and communication.

Project C used Primavera ® and Prolog ®, as well as, Microsoft ® software extensively for project administration (RFIs, transmittals, submittals, etc.).

In project D, Primavera ® was the main IT system software used for project management.

In project E, the company had an intranet, at the project level it used Prolog ® in combination with Excel ® to control budgets and Suretrack ® and Primavera ® for scheduling and project management. Budget controls were linked to the accounting software. The company used JD Edwards's AS400 ®. It tracked salaries, trade contract payments, reimbursables, etc.

Conjecture 8: It could be conjectured that the project organization uses selective vertical and horizontal decentralization.

All projects used selective/limited vertical and horizontal decentralization. In Project A, on the vertical dimension managers made selective use of staff unit experts, according to how technical the decisions they had to make were. Concerning financial (budget) decisions, these were taken by the senior project manager. He had an accountant/clerk under him. Progress payment requests were sent to the home office for collection. Technical decisions were delegated (to some extent) to the junior project management level and they were

usually decided in consultation with the appropriate party having the expertise. Operational/administrative decisions were delegated to the appropriate level, as far down as the junior construction superintendent and field engineers.

In Project B, concerning financial (budget) decisions, the project manager had exclusive responsibility. All other decisions were selectively delegated within the project team. For example technical (design) decisions were divided between the project engineer and the assistant project manager. In general project team members had decision-making ability based on their responsibility and scope of work.

In project C, the project manager/executive had limited control over the budget and personnel. Technical decisions were delegated to the appropriate personnel at the project level. Staff personnel on this project had very limited control over decision making.

In project D, on the vertical dimension, different types of decisions were delegated at various levels. For example Change Orders of less than \$10,000 were handled by the Project Manager. Change Orders higher than \$10,000 but less than \$250,000 were handled by the

Vice President. Change Orders of over \$250,000 must go through the main office. In the horizontal dimension managers made selective use of staff unit experience and expertise in decentralization of decision-making.

In project E, on the vertical dimension, administrative decisions were delegated at various levels. In the horizontal dimensions technical decisions were delegated depending upon the level of expertise required.

Conjecture 9: IT can be conjectured to play a role on the decision-making system (centralization-decentralization) of the project organization.

In Project A, IT has not had any significant impact as far as vertical/horizontal decentralization.

In Project B, IT has not had any significant impact as far as vertical decentralization. As far as horizontal decentralization, IT has played a role, by allowing team members instant on-line communication; thereby enabling and facilitating horizontal decentralization.

In Project C, IT has not had any direct impact as far as vertical or horizontal decentralization.

In project D, IT has not had any significant impact as far as vertical/horizontal decentralization.

In project E, IT has provided employees with easier access to information, enabling to make decisions at their level. In this sense, IT has had an impact on the decentralization of decision-making.

Conjecture 10: It could be conjectured that the project personnel has low (vertical and horizontal) specializations.

In all the projects, the specialization of jobs of the project personnel tended to be low. In project A, flexibility and adaptability are key qualities. In project B, the assistant project manager can do RFIs (Requests for Information), which happens to be the project engineer's responsibility. The roles of team members can intermix somewhat, but come decision-making time, each team member has to make their decisions based on their scope of responsibilities. In project

E, the project personnel deal with a broader scope of issues and have more administrative control.

Conjecture 11: IT can be conjectured to impact horizontal and vertical specialization levels.

In all the projects, IT has had a relative impact on both horizontal and vertical job enlargement. In horizontal job enlargement, the worker engages in a wide variety of the tasks associated with the work. When a job is enlarged vertically, or “enriched”, not only does the worker carry out more tasks, but he also gains more control over them.

Conjecture 12: It can be conjectured that the degree of formalization would tend to be high.

In all the projects the degree of formalization tended to be high. In all projects jobs were formalized by job descriptions specified in the employee handbook. The handbook also had information on career paths and the company in general.

Conjecture 13: IT can be conjectured to impact the degree of formalization (standardization of work content).

In project A, IT had impacted job formalization information through on-line links. Employees have on-line accessibility to the employee handbook where they can look into job descriptions, career paths, company programs, incentives, etc. Similar results were replicated in the other projects.

Conjecture 14: It can be conjectured that training and experience (standardization of skills) in construction related disciplines are key requirements in the design of positions of project personnel.

This proposition was replicated in all the cases. In project A, the company hires project management personnel based on their professional background. New hires come from backgrounds in the engineering, architecture and/or construction sciences. The company provides formal training, as well as, on-the-job training. In project B, the firm hires project personnel with construction management, engineering or related backgrounds. Training is informal and usually on-the-job training. In project C, training and experience requirements for new hires are primarily a background in construction management

or related field, as well as, field experience. In project D, new hires come from diverse backgrounds in the business, architecture and engineering fields. In project E, background and training in the areas of CM, civil engineering and related fields were standard requirements.

Conjecture 15: IT can be conjectured to impact the training and experience requirements of project personnel.

In all the cases IT had an impact on training and experience requirements of project personnel. In project A, IT has had an impact on the delivery of training. The company uses IT to deliver on-line training programs. Project B used on-line training. Training involved primarily managerial, computer software and safety training. In Project C, IT is playing an increasing role in training through the company's intranet site and on-line education courses. In project D, the company provided formal training and on-line training for new hires. In job E, IT has had an impact on jobs with the accessibility and availability of on-line training.

4.4 Cross-Case Analysis: Robbins' Measures

This section presents the cross-case analysis of our five projects. How they compare in terms of the three measures of organization structure: Complexity, Formalization and Centralization. Formalization defines the degree of horizontal, vertical and spatial differentiation. Formalization indicates the degree to which jobs are standardized and Centralization indicates the degree to which formal authority to make discretionary choices is concentrated in an individual, unit or level.

4.4.1 Cross-Case Analysis: Complexity

Complexity has been defined by the degree of horizontal, vertical and spatial differentiation. Total scores under 15 represent relatively low complexity; total scores above 22 indicate relatively high complexity and total scores of 15 to 22 make up the moderate range.

1. How many different job titles are there? Projects A, B, C and E had a score of 3 (moderate number) and project D had a score of 4 (large number).

2. What proportion of employees hold advanced degrees or have many years of specialized training? Project A had a score of 2 (11-20%), projects B and E had a score of 4 (51-75%) and projects C and D had a score of 5 (76-100%).

3. How many vertical levels separate the chief executive from those employees working on output in the deepest single division? Project A had a score of 2 (3 to 5), projects B and E had a score of 3 (6 to 8) and projects C and D had a score of 4 (9 to 12).

4. What is the mean number of levels for the organization as a whole? Projects A, C and D had a score of 2 (3 to 5), project B had a score of 3 (6 to 8) and project E had a score of 4 (9 to 12).

5. What is the number of separate geographic locations where organization members are employed? Projects C and D had a score of 3 (6 to 15), project A had a score of 4 (16 to 30) and projects B and E score of 5 (more than 30).

6. What is the average distance of these separate units from the organization's headquarters? Projects B and D had a score of 2 (11 to 100 miles), project C had a score of 3 (101 to 500 miles), project A had

a score of 4 (501-3500 miles) and project E had a score of 5 (more than 3500 miles).

7. What proportion of the organization's total work force is located at these separate units? Project A had a score of 2 (11 to 25%), project D had a score of 3 (26 to 60%) and projects B, C and E had a score of 4 (61 to 90%).

The complexity score for project A was 19. Project A would be considered of relative moderate complexity.

Projects B, C, D and E had complexity scores of 24, 24, 23 and 28 respectively. These scores would indicate organizations of relative high complexity.

4.4.2 Cross-Case Analysis: Formalization

Formalization indicates the degree to which jobs within the organization are standardized. Total scores under 18 represent relatively low formalization; total scores above 25 indicate relatively high formalization and total scores of 18 to 25 show relative moderate formalization.

1. Are written job descriptions available for all employees? Projects A, B, D and E had a score of 5 (all employees, including senior management) and project C had a score of 3 (operative, first-line supervisory, middle and upper-management personnel).

2. Where written job descriptions exist, how closely are employees supervised to ensure compliance with standards set in the job description? Projects A and D had a score of 3 (moderately loose) and projects B, C and E had a score of 4 (close).

3. How much latitude are employees allowed from the standards? Projects B, C and E had a score of 3 (a moderate amount) and projects A and D had a score of 4 (very little).

4. What percentage of non-managerial employees is given written operating instructions or procedures for their jobs? Projects B and E had a score of 2 (21-40%), project C had a score of 4 (61-80%) and projects A and D had a score of 5 (81-100%).

5. Of those non-managerial employees given written instructions or procedures, to what extent are they followed? Projects B, C and E had

a score of 4 (some) and projects A and D had a score of 5 (a great deal).

6. To what extent are supervisors and middle managers free from rules, procedures, and policies when they make decisions? Projects B and E had a score of 3 (some), project C had a score of 4 (little) and projects A and D had a score of 5 (none).

7. What percentage of all rules and procedures that exist within the organization are in writing? All the projects had a score of 5 (81-100%).

Projects A, B, C, D and E had formalization scores of 32, 26, 27, 32 and 26 respectively. These scores would indicate project organizations with relatively high formalization.

4.4.3 Cross-Case Analysis: Centralization

Centralization indicates the degree to which formal authority to make discretionary choices is concentrated in an individual, unit or level. Approximate guides for translating total scores into categories as a follows: A total score of 40 points and above represents high

centralization, total scores between 21 and 39 is moderate centralization, and total scores of 20 or less indicates low centralization.

1. How much direct involvement does top management have in gathering the information they will use in making decisions? Projects A, C and D had a score of 3 (some) and projects B and E had a score of 4 (a great deal).

2. To what degree does top management participate in the interpretation of the information input? Projects A, C and D had a score of 2 (21-40%); project E had a score of 3 (41-60%) and project B had a score of 5 (81-100%).

3. To what degree does top management directly control execution of the decision? Projects A and C had a score of 2 (21-40%); projects D and E had a score of 3 (41-60%) and project B a score of 4 (61-80%).

4. How much discretion does the typical first-line supervisor have over establishing his or her unit's budget? Project A had a score of 1 (very great) and projects B, C, D and E had a score of 2 (great).

5. How much discretion does the typical first-line supervisor have over determining how his or her unit's performance will be evaluated? Project A had a score of 1 (very great), project D had a score of 2 (great), projects C and E had a score of 3 (some) and Project B had a score of 4 (little).

6. How much discretion does the typical first-line supervisor have over hiring and firing personnel? Projects C and E had a score of 2 (great) and projects A, B and D a score of 3 (some).

7. How much discretion does the typical first-line supervisor have over personnel rewards (i.e., salary increases, promotions)? Project C had a score of 2 (great), projects B and E a score of 3 (some) and projects A and D a score of 4 (little).

8. How much discretion does the typical first-line supervisor have over purchasing of equipment and supplies? Projects A and D had a score of 3 (some), project B and C a score of 2 (great) and Project E had a score of 1 (very great).

9. How much discretion does the typical first-line supervisor have over establishing a new project or program? Project A had a score of 2

(great), projects B and E had a score of 3 (some) and projects C and D a score of 4 (little).

10. How much discretion does the typical first-line supervisor have over how work exceptions are to be handled? Project A had a score of 1 (very great), projects B and E had a score of 2 (great) and projects C and D a score of 3 (some).

Projects A, B, C, D and E have centralization scores of 21, 32, 25, 29 and 26 respectively, which would indicate relative moderate centralization.

4.5 Cross-Case Analysis: IT Questionnaire

1. Which type of construction does your company perform? Companies in projects A, B and D perform residential, commercial and industrial construction. Companies in projects C and E perform only commercial and industrial construction.

2. Would the company be classified as a General Contractor (GC); Design-Build (DB); Construction Manager (CM); Specialty Contractor (SC) or other (please specify)? Companies in projects A, D and E are

classified as CM/GC. The company in project C is classified as CM/DB and the company in project B is classified as CM.

3. What is your job title? The job titles of the individuals answering this questionnaire were as follows: Senior Project Manager (Project A); Project Manager (Project B); Project Engineer/Assistant Superintendent (Project C); Vice President (Project D) and Program Manager (Project E).

4. What is the gross dollar volume per year (approximately) for the company? The gross dollar volume per year for company A is \$2 billion; company B is \$4 billion; company C is \$2.5 billion; company D is \$2.6 billion and company E \$4 billion.

5. Does the company have Internet access? All the companies have Internet access.

6. If yes, do they use the Internet for work-related purposes? All the firms use the Internet for work-related purposes.

7. If yes, what information do they inquire about over the Internet? The companies use the Internet to inquire about a variety of

information including product information, contractor information, subcontractor information, architect information, owner information, company information and project information.

8. Do you use the Internet for project communication? With the exception of project D, all of the companies use the Internet for project communication.

9. If yes, please explain: The companies use the Internet to record job cost reports, to record daily reports, for logging time cards, to process Request for Information (RFIs), for submittals, etc.

10. Does the company have its own Intranet? All the companies have their own Intranet.

11. Do they use the Intranet for work-related purposes? All the firms use the Intranet for work-related purposes.

12. If yes, what information do they inquire about over the Intranet? They inquire about information on company policies, cost control reports, client information, employee information, company newsletter, etc.

13. Do they use the Intranet for project communication? If yes, explain. Yes, they use the Intranet for project communication, including to record job cost reports, to record daily reports, for logging time cards, etc.

14. Does the company have access to email? All of the firms have access to email.

15. If yes, do they use email for project related purposes? All of the firms use email for project related purposes.

16. If yes, what information do they receive or send via email? Product information, contractor information, subcontractor information, architect information, owner information, company information, project information, etc.

17. With whom do they communicate by email? They communicate with branch offices, corporate offices, contractors, subcontractors, co-workers, etc.

18. Does the company provide training for using IT? All the firms provide training for using IT.

19. If no, how do you learn to use it? N/A

20. Does the company have a web site? All of the firms have a web site.

21. If yes, what information is listed on the company web site? The information listed includes company history, company newsletters, company information, contact names, current project information, past project information, employment opportunities, etc.

22. What electronic links with other offices or consultants (members of the project team) does the project have? All of the companies had electronic links with other offices and consultants via fax and email. In addition companies in projects A and B have e-collaboration systems.

23. What web-based project management system software do the companies use? Projects A, B, C and E use Prolog Manager ®.

24. If using web-based project management software what is the dollar volume and duration of the project? Project A \$21 million with duration of 18 months. Project B \$30 million with duration of 24 months. Project C \$38 million with duration of 12 months and Project E \$150 million with duration of 36 months.

25. Does your company use project web pages? Companies A, B and C use project web pages.

26. If yes, what information is listed on the project web page? The information listed includes contacts, site photographs, scanned photographs, reports, transmittals, etc.

27. Does this project have a web page? N/A.

28. If yes, what is the dollar volume and duration of the project? N/A.

4.6 Summary

This chapter has presented the case study projects and cross-case analyses concerning our conjectures, measures of organization structure and IT-questionnaire responses (documentary information). Our next

chapter will present the findings, conclusions and recommendations followed by our last chapter which will present a step-by-step practical methodology, using the extended framework that construction project managers can use as another tool for designing construction project organizations.

CHAPTER 5

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This dissertation used a case study approach to investigate the application of Mintzberg's design parameters, information technology-enabled variables, and measures of organization to construction project organization structure. Cross-case analyses were presented in Chapter 4. Appendixes A-E contain detailed reports of the cases. This chapter presents findings, conclusions, and recommendations for future research.

5.2 Findings

The research findings are organized around the design parameters of organizational structures and measures of organization.

Mintzberg's Design Parameters

Unit Grouping

The project organization in each case study grouped positions into units using a combination of bases: Grouping by work process or activity used by the worker, and grouping by business function (e.g., accounting, financing, marketing, and so on). The company level organization in each case, however, grouped on a market basis (i.e. regions, areas and projects). At the project level groupings were functional (work processes and business function). There were virtual collaborative teams grouping components in all but one case study.

Unit Size

The unit size of construction project management personnel assigned to the projects varied from seven to fourteen, with three of the five cases at the lower end. The Project Manager span of control ranged from 3 sub-units in four cases to 4 sub-units in the remaining case. The levels in the hierarchy went from two levels to four. Electronic linking did not impact the unit size in the project organization, except in Project A, in which it has tended to decrease the size. Technological leveling did not cause a reduction on the management levels in any of the projects.

Liaison Devices

The projects used a combination of liaison devices, from liaison positions through coordinating meetings, to integrating managers. In all of the projects, the project manager was the key integrating manager and coordinating face-to-face meetings were the conventional liaison devices. In addition, all cases used a combination of electronic communications (fax, e-mail, web-based linking and collaboration systems) as liaison devices. None of the projects used technological matrixing.

Planning and Control Systems

All the projects used both action planning, as well as, 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 establish control budgets, scheduled milestones and performance standards. To a high degree, all cases used intranet systems and a combination of computer software tools for planning and control. All the projects used Primavera Project Planner (P3) ® as their planning and scheduling

system in combination with Prolog ® internet-based collaborative system for project control.

Decision-Making System

All the cases used selective/limited vertical and horizontal decentralization. In the vertical dimension, formal authority for different types of decisions was delegated to work units at various levels of the hierarchy. Different types of administrative and operational decisions were delegated at various levels. Financial, budget and personnel decisions were taken by the project manager selectively and within limits. In the horizontal dimension, managers made selective use of staff unit expertise and experience in horizontal decentralization of decision-making. Technical decisions were delegated to staff personnel depending upon the level of expertise required, responsibility and scope of work. In these successful projects studied, IT systems have better enabled the decentralization of information and the decision making process. It has allowed team members instant on-line communication; thereby facilitating the decentralization process, but not necessarily transfer of formal decision-making authority.

Design of Positions

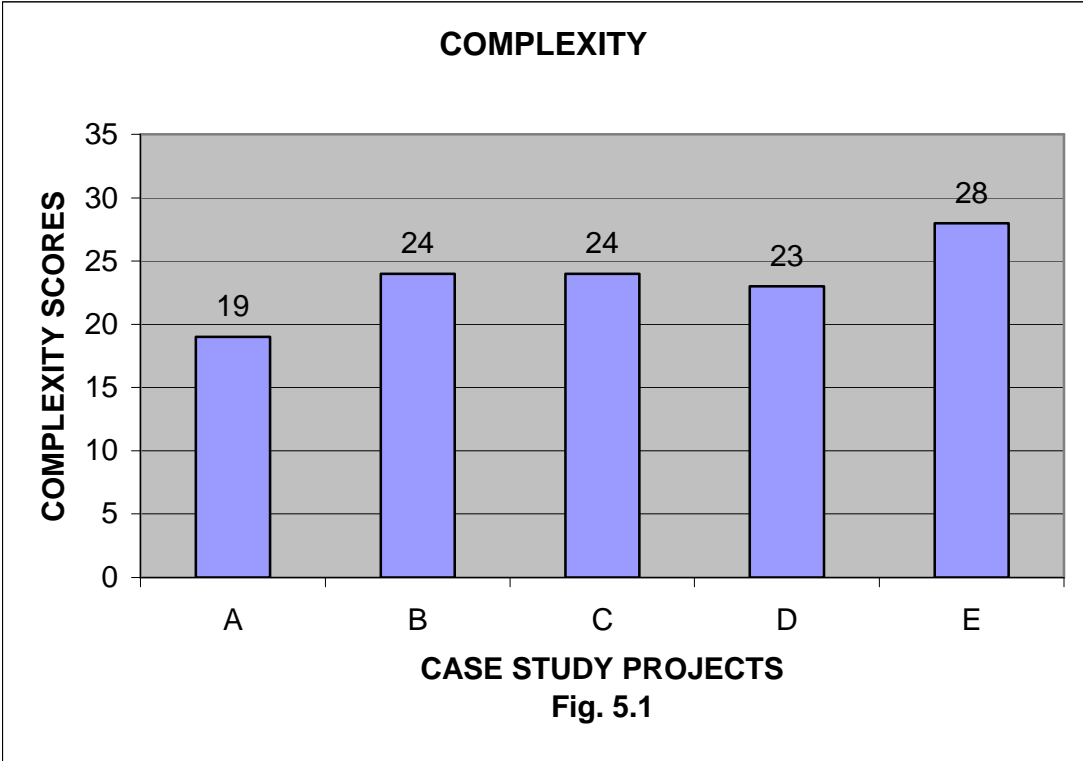
In all the cases, the specialization of jobs was low. Flexibility and adaptability were key qualities. Information technology had an impact on both horizontal and vertical job enlargements. In horizontal job enlargement, the worker engaged in a wide variety of tasks and in vertical job enlargement the worker gained more administrative control. Formalization tended to be high. Jobs were formalized by job descriptions specified in the employee handbook. Information technology impacted behavior through on-line links in terms of accessibility. Employees have on-line access to job descriptions, career paths, regulations, rules, etc. Training and experience in a construction related discipline was a key requirement in the design of positions of project personnel. In all cases information technology had an impact on training and experience requirements of project personnel. Information technology had a significant impact on the delivery of training. There has been a considerable increase in the number of on-line delivery of training programs.

Robbins' Measures of Organization

For a complete explanation of Robbins' measures of organization structure, the scoring interpretation and questionnaires see Appendix G.

Complexity

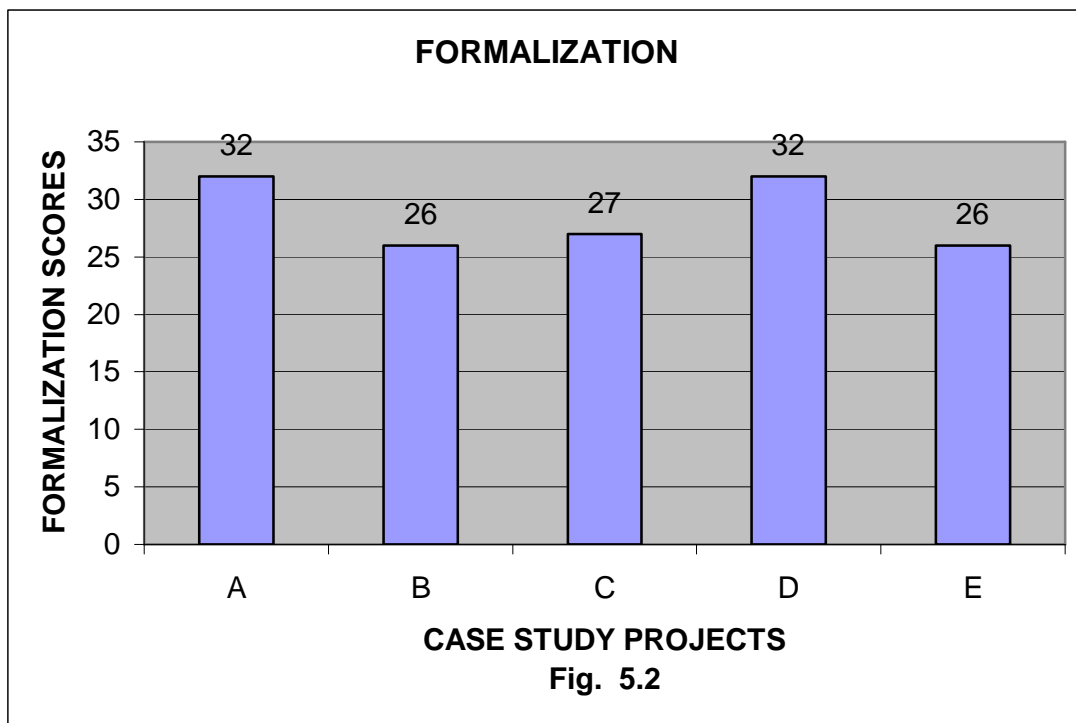
Complexity refers to the degree of differentiation (horizontal, vertical and spatial). Scores developed in the questionnaires of Appendixes A-E with values under 15 represent relatively low complexity; scores above 22 indicate relatively high complexity and scores of 15 to 22 make up the moderate range. All the cases had relative high complexity with the exception of Project A that exhibited a moderate-high complexity. Figure 5.1 illustrates the complexity scores of the case study projects. The high complexity scores are consistent with our findings. The higher the complexity, the greater the need for effective communication and liaison devices and the greater demand on management to ensure that differentiated and dispersed activities are working smoothly and together toward achieving the project organization's goal. All the projects had a great use of conventional liaison devices, as well as, a combination of electronic linking/communications, IT-coordinating liaison devices.



Formalization

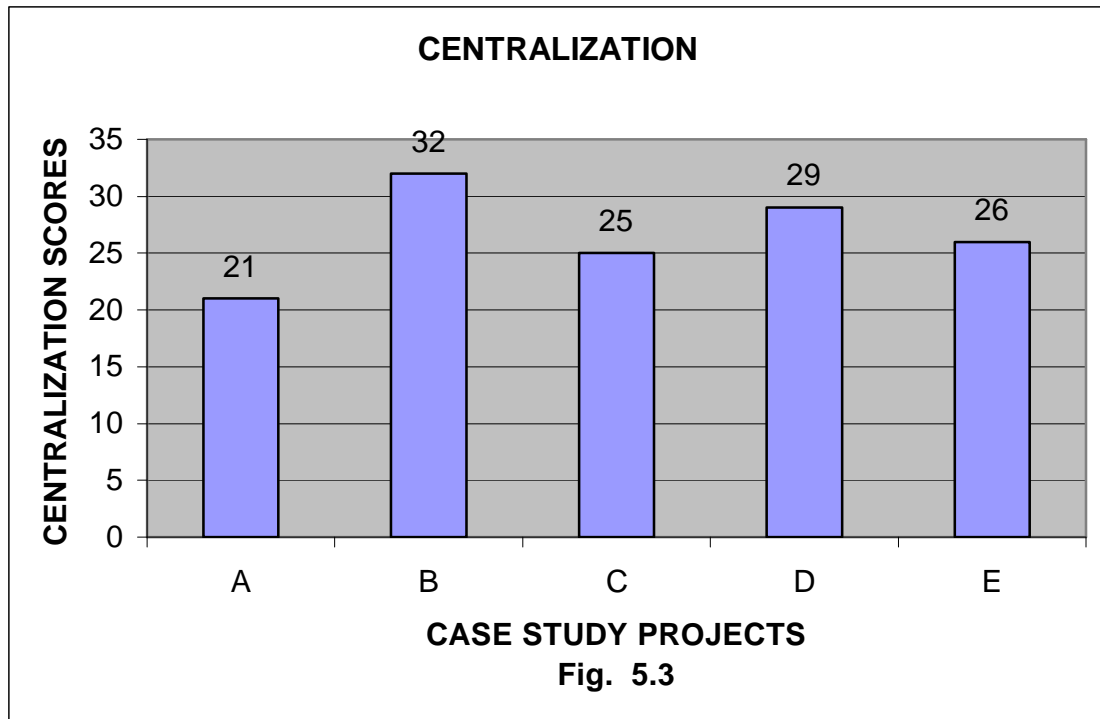
Formalization refers to the degree to which jobs within the organization are standardized by explicit job descriptions, procedures, specifications of materials and workmanship requirements. Standardization develops consistency and promotes coordination. Managers use a number of techniques to bring about standardization by selection, role requirements, rules, procedures, specifications, policies

and training (on-the-job and off-the-job). Organizations choose to formalize jobs whenever possible so as to get the most effective performance at the lowest cost. The questionnaire tapped the major elements in formalization: the degree to which job descriptions are specified, the degree of supervision and the degree to which work regulations exist and are followed. All of the projects scored above 25 indicating relatively high formalization. Figure 5.2 illustrate the formalization scores of our case studies. We found out from our interviews and document reviews that formalization tended to be high. These results are consistent with our formalization findings.



Centralization

Centralization refers to the degree to which decision-making is concentrated at a single point in the organization. A high concentration implies high centralization. If decisions are programmed by organizational policies, a high degree of centralization exists. The questionnaire tapped the degree of centralization-decentralization that top management has over key parts of the decision-making process and the amount of discretion that the typical first-line supervisor has over the critical elements of his or her job. Scores of 40 points and above represent high centralization, scores of 21 to 39 are moderate and scores of 20 or less indicate low centralization. All of the projects had moderate centralization; they scored between 21 and 39, which is considered the moderate range. Figure 5.3 illustrate the centralization scores (out of a possible 50). All the cases studied used selective/limited vertical and horizontal centralization-decentralization. The degree being within the moderate range is consistent with the selective/limited finding from the case studies.



5.3 Conclusions

This section presents conclusions based on the research findings. Firstly, it looks at Mintzberg's design parameters, Lucas' extensions and Robbins' measures of organization structure; secondly, it focuses on the importance of the research study findings and thirdly, it gives an overall summary.

Mintzberg's Design Parameters, Lucas' Extensions and Robbins' Measures of Organization

Complexity, formalization and centralization (Robbins' measures of organization) were consistent with the findings, and can be used for corroborating the reliability of the framework and the research findings. *The high complexity scores* were consistent with the findings. The higher the complexity, the greater the need for effective communication and liaison devices. All the projects made a great use of conventional liaison devices, as well as, a combination of electronic linking/communications, IT-coordinating liaison devices. *The high formalization scores* were also consistent with the findings. The higher the formalization, the greater the need for explicit job descriptions, procedures and specifications of workmanship requirements. All the projects had a great use of rules, procedures, specifications and explicit regulations. Lastly, *the moderate centralization scores* were also consistent with the findings. Different types of administrative and operational decisions were decentralized at various levels. All these successful project had limited/selective centralization/decentralization.

Importance of the Research Study and its Findings

The importance of this research study and its findings is of significance for (A) construction project managers and (B) the contribution to the construction management literature.

What is the applicability of this extended theoretical framework to designing construction project organizations? Construction project managers, for the most part, use experience and adaptation for construction project organizational structuring. Using the extended framework can help construction project managers design a better organizational fit for the project situation to better achieve project goal and performance objectives. Chapter 6 (Practical Methodology) presents a step-by-step process, using the extended framework, that construction project management professionals can use, as another tool for organizational structuring.

The literature on construction project organizations is primarily limited to organization charts. This extended study using Mintzberg's design parameters, Lucas's extensions and Robbins' measures of organization is unique in its integrated methodology.

Summary

The proposed methodology and extended theoretical framework is useful when applied to construction project organizations similar to the study projects. We can use this extended theoretical framework to provide insights into project organizations, information technology-enabled capabilities and measurements to make relative comparisons among different construction management organizations. Information technology-enabled variations included virtual collaborative groupings, electronic linking coordination liaison devices, internet-based conferencing, web-based collaborative systems for project control and decision making processes. The main lesson is to consider design parameters and information technology enabled variables simultaneously in structuring the project organization. Information technology must be an integral part of project organization design.

The extended theoretical framework depicts the basic components of organizational structure. Using this extended framework, it is possible to analyze how the project organization functions. Furthermore, its application provides a systematic process for analysis.

5.4 Recommendations for further research

Application of this methodology and theoretical framework can help us identify areas for future resolution. The theoretical framework can be used as the basis for further study in the following areas:

- Application of this methodology and theoretical framework at the construction company level.
- Development of more refined measures of existing design parameters and information technology-enabled variables, to define different types of projects and capture the dynamics of project organizations.
- Greater understanding of situational factors, such as the economy, markets, regional variations and technical systems.
- Expansion of methodologies to develop systematic methods for organization design analyses.
- Development of more precise methods of measuring organization structures.
- Increased understanding of relationships between situation and project organization structure. In theory, maximizing fit with situation would maximize performance.

- To further develop rational approaches of organizational design analysis and evaluation of coordination methods.
- To study in more detail IT and training & development and its relative impacts on productivity and costs at the project and company levels.

CHAPTER 6

PRACTICAL METHODOLOGY

6.1 Introduction

The extended framework for organization introduced in Chapters 1 and 2 has been used as a reference against which to interpret the descriptive in-person interview and questionnaire results that form the basis of the present work, and to draw prescriptive lessons about how construction project teams can be better organized. These prescriptive conclusions are summarized in this chapter, which attempts to present a practical methodology — perhaps more accurately described as practical advice — for making organizational decisions in construction project organizations. This practical methodology comprises the principal practical recommendations of the present study.

The organizational structures in each of the five cases studied share a number of similarities. As the cases were chosen to represent successful construction projects, a supposition is implicitly made that the shared organizational structures contributed to that success. Clearly, this cannot be demonstrated based only on the internal results of the case studies, since no negative cases were studied from which to draw contrasting conclusions. That is, all of the projects studied were

successful projects; none were unsuccessful. Follow-on work to the present study should expand the purview to include unsuccessful examples.

The industry managers involved in the five case study projects principally used past experience and adaptation in making organizational structuring decisions. Project changes and other demands for managers' time and attention prevented methodically designing many elements of the structure. Furthermore, like most construction industry managers, those in the study cases lacked formal training in or even exposure to formal organizational 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 the extended framework introduced earlier may provide construction project managers with some level of rational guidance for use in designing project organizations. The intent is more specific definition of organizational structure and a better fit between structure and project situation.

6.2 Procedure

The proposed procedure uses a step-by-step process, applying the extended framework of Chapter 2, to make decisions about a construction project organization.

The process proposes eight steps based on the extended framework, with lessons learned from the present interview results:

- (1) define the project goal and performance objectives;
- (2) devise the grouping;
- (3) determine the unit size;
- (4) provide liaison devices;
- (5) add planning and control systems;
- (6) define the decision-making system;
- (7) design the positions and
- (8) implementation.

A consideration in making these organizational decisions is the applicability of information technology at each step in the structuring process.

Step 1: Define Project Goal and Performance Objectives

The first design step is to define project goal — that is, the desired end result that meet the owner’s needs as well as the contractor’s scope of work — and rank order performance objectives for these end results. This necessarily influences how the project is structured and how resources should be allocated. This was explicitly undertaken in all the project cases studied, which should not be surprising.

In the five cases studied, project performance objectives included, cost, schedule, quality and safety. (Table 6.1) Policy statements provided a starting point in defining and setting priorities among conflicting project performance objectives. Priorities between performance objectives influenced the elements of organization.

Of the five projects studied, projects A and E had quality as the top priority, while projects B, C, and D had schedule as the top priority. Projects A and E devoted greater resources for quality assurance and quality control systems. In projects B, C and D greater resources were allocated for planning and control systems including strict compliance with scheduling reporting (Table 6.2).

PROJECT	PRIORITY				EXPLANATORY FACTORS	
	Cost	Schedule	Quality	Safety	Client	Technical Complexity
A			•		State	High
B		•			University	Low
C		•			University	Medium
D		•			University	Low
E			•		Federal	High

Table 6.1 Case study project performance objectives

The explanatory variables in these cases are client and project technical complexity: Projects A and E each involves a public-sector client and a technologically complex project. Project A is a state museum, while project E is a federal hospital.

DESIGN STEP	QUESTIONS	SOLUTIONS	INFORMATION TECHNOLOGY APPLICABILITY
1. Define Project Goal and Performance Objectives	Priorities between performance objectives influence the elements of organization.	N/A	N/A

Table 6.2 Design step 1 — Questions identified in case studies and solutions inferred from managers' responses.

Step 2: Devise 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). The first step is identifying alternatives to group the interdependent units of the line-staff organization.

The alternatives for grouping range from traditional single responsibility structure to the matrix structure (dual responsibility and dual reporting). The single or matrix responsibility structure may group organizational elements by a particular basis or combination of bases. It is through the process of grouping into units that the hierarchy of the organization is built.

On what basis or combination of bases should the project organization group positions into units and units into larger ones? Seven main bases are discussed in the literature of organization structuring. (Table 6.3)

BASES IN LITERATURE	BASES IN CASE STUDIES
<p>(1) Grouping by the knowledge and skills that members bring to the job.</p> <p>(2) Grouping by work process or activity used by the worker.</p> <p>(3) Grouping by business function – accounting, financing, marketing, and so on.</p> <p>(4) Grouping by time, according to when the work is done, as in the case of different shifts at the jobsite.</p> <p>(5) Grouping by output, units are formed on the basis of the products.</p> <p>(6) Grouping by client, to deal with different types of clients.</p> <p>(7) Grouping by place, according to the different areas in which the organization operates.</p>	<p>(A) Grouping by work process or activity used by the worker.</p> <p>(B) Grouping by business function – accounting, financing, marketing, and so on.</p>

Table 6.3 Bases for grouping

Our research findings on the cases studied is that they all used a combination of only work process and business functions as a means for setting levels and devising groupings, that is, items two and three in the list above. They did not use any of the other five bases often cited in the literature.

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 functions 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. (Table 6.4)

FUNCTIONAL REQUIREMENTS	DETAILED ACTIVITIES
administrative functions	estimating, planning, scheduling, accounting, etc
work processes at the project level	superintending, project methods, fabrication, assembly, etc

Table 6.4 Work and business functions affecting grouping.

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. (Table 6.5)

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 the 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 (Appendixes A, E). 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.

Examples from the case studies appear to suggest that substituting virtual for local organizational components can result in cost savings. This seemed to be especially true for logistical operations such as materials supply chain activities, as has been suggested by others (Galliers and Baets 1998).

DESIGN STEP	QUESTIONS	SOLUTIONS	INFORMATION TECHNOLOGY APPLICABILITY
2. Devise the Grouping	<p>On what basis should positions be grouped into units?</p> <p>What opportunities are there to create virtual components?</p>	Group along work process and business function bases. (See Organization Charts, Appendixes A through E).	Virtual components: Virtual raw materials inventory; virtual departmental grouping, i.e. collaborative organizational unit components enabled by information technology. (See projects A and E in Appendixes).

Table 6.5 Design step 2 — Questions identified in case studies and solutions inferred from managers' responses.

Step 3: Determine 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.

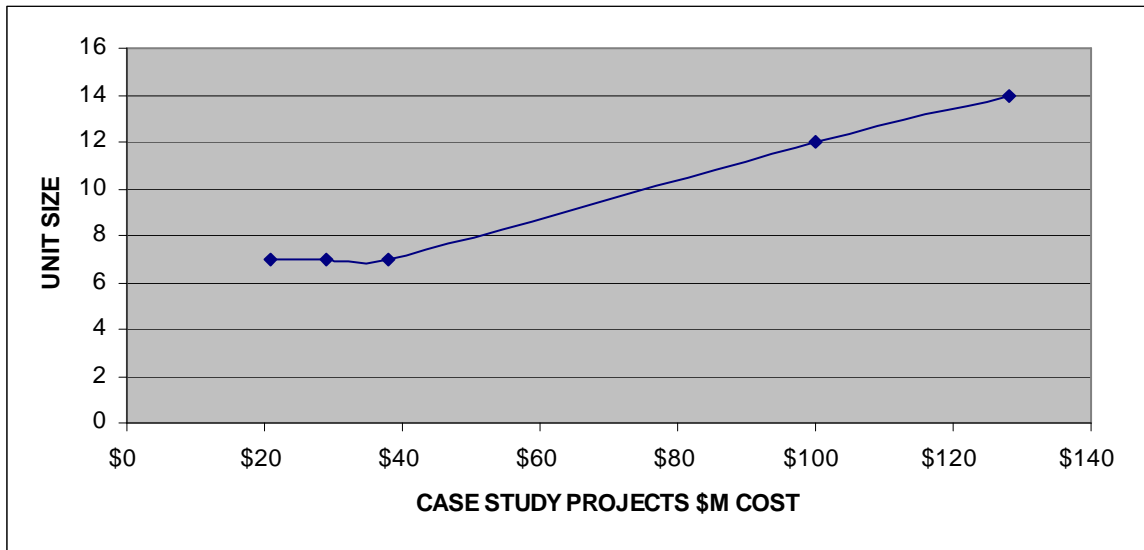


Figure 6.1 Unit Size vs. Job Size (\$M Cost)

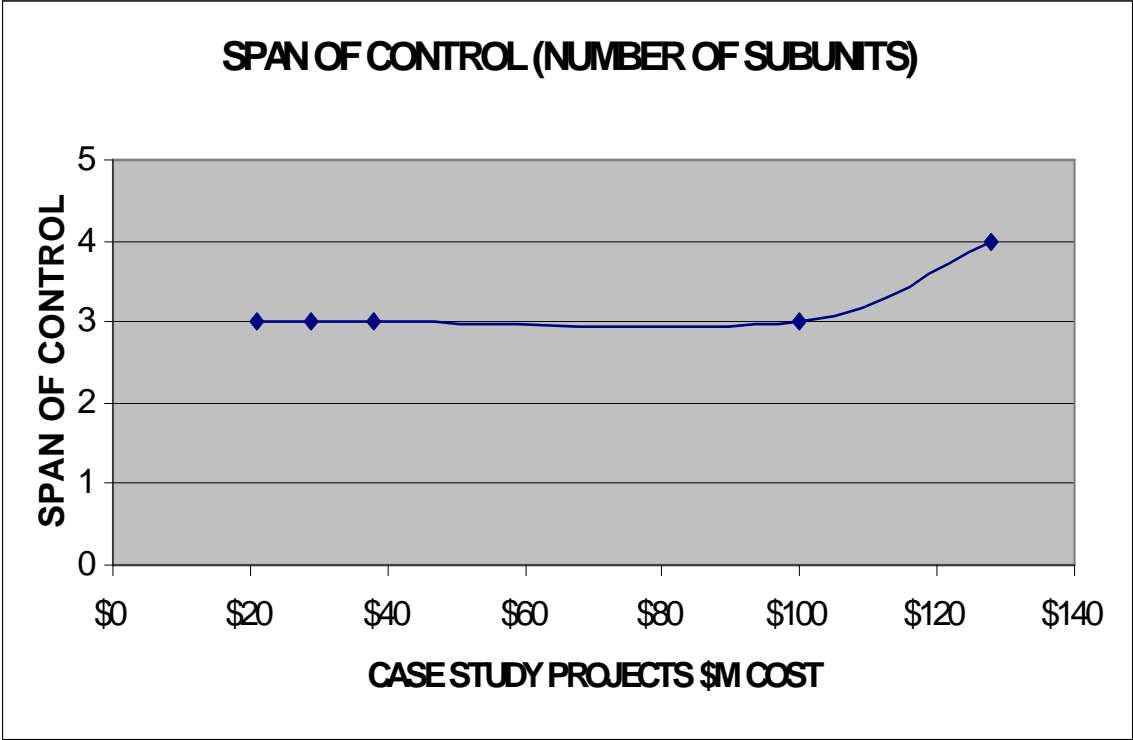


Figure 6.2 Span vs. Job Size (\$M Cost)

In the case studies, unit sizes varied from seven in Projects A, B and C to fourteen in Project D (Figure 6.1). 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. (Figure 6.2). The levels in the hierarchy went from two levels in projects A, B and C to four levels. (Figure 6.3)

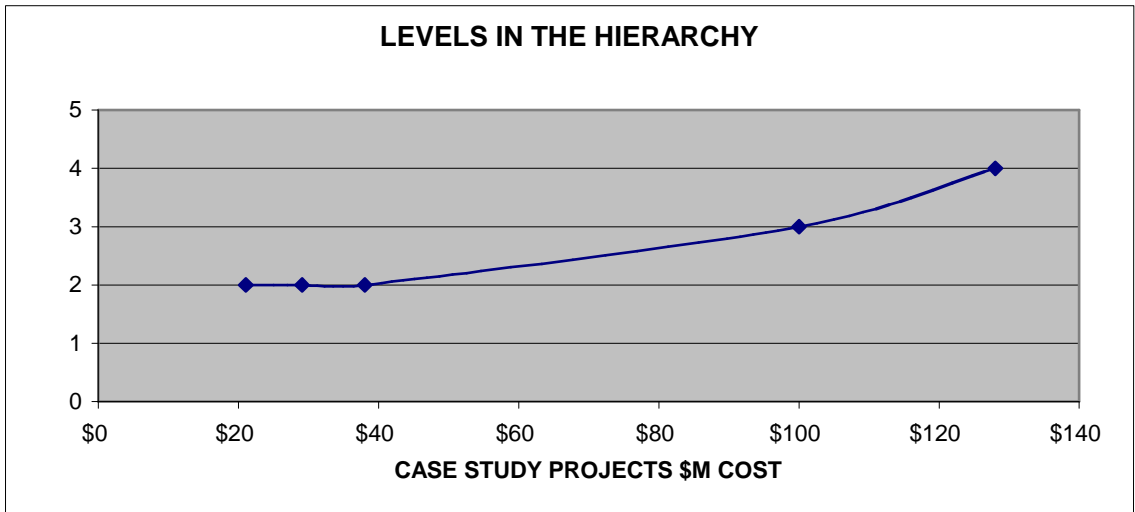


Figure 6.3 Level vs. Job Size (\$M Cost)

These findings suggest an initial relationship between unit size, span of control, and levels vs. job size, although the number of case studies is too small for statistically valid inferences.

PROJECT	A	B	C	E	D
\$ M Cost	21	29	38	100	128
Unit Size	7	7	7	12	14
Span of Control	3	3	3	3	4
Levels	2	2	2	3	4

Table 6.6 Summary numerical data for case study organizations

If a project is about \$100M the cases suggest a unit size of about 12, a span of control of about three sub-units, and about three levels in the hierarchy.

It is at this step that one should ask how electronic linking affected the case study organizations. 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.

In Project A, electronic linking was used to process Requests for Information (RFI), Change Orders, and Submittals online. This reduced the number of project management personnel (unit size) from nine to seven, which represents a savings of \$100,000/year, assuming an average salary of \$50,000 each.

DESIGN STEP	QUESTIONS	SOLUTIONS	INFORMATION TECHNOLOGY APPLICABILITY:
3. Determine the Unit Size	How large should unit size be? How many individuals should report to a given manager (span of control)? Levels? Can we use technological leveling to minimize the number of layers in the organizational?	Relationship between unit size, span of control and levels vs. job size. (See Figures 6.1, 6.2, 6.3 and Table 6.1)	Technological leveling, substituting information technology for layers of management and a number of management tasks. In Project A, information technology used electronic linking for RFIs, COs and submittals.

Table 6.7 Design step 3 — Questions identified in case studies and solutions inferred from managers' responses.

Step 4: Provide 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: expeditors, 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, the sending and receiving of text/images of pages between two locations using a phone line, 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, using the internet network to send and receive messages, 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.

Project	Fax	Email	Web-based collaborative Highest usage	\$M Cost	Duration (months)
A	•	•		\$21	18
B	•	•		\$29	24
C	•	•		\$38	12
D	•	•	•	\$128	32
E	•	•	•	\$100	36

Table 6.8 Case study usage of electronic liaison devices

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. (Table 6.8)

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.

From what project managers have experienced, the combined usage of these electronic liaison devices has provided overall improvement in communication and coordination, a general reduction in the number of face-to-face meetings, and a decrease in duration of such meetings. (Table 6.9)

DESIGN STEP	QUESTIONS	SOLUTIONS	INFORMATION TECHNOLOGY APPLICABILITY:
4. Provide Liaison Devices	What liaison devices should be established to facilitate mutual adjustment among positions and units? What opportunities are there for electronic linking/communications in the project organization?	In all the projects that were researched, the project manager was the key-integrating manager and coordinating meetings were the conventional liaison devices used for coordination.	All projects researched, used a combination of electronic linking/communications (fax, e-mail, web-based linking/conferencing and collaboration systems) as information technology liaison devices.

Table 6.9 Design step 4 — Questions identified in case studies and solutions inferred from managers' responses.

Step 5: Add 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. (Table 6.10)

	ACTION PLANNING	PERFORMANCE CONTROL
ACTIVITIES	action programs, expenditures guidelines, detailed CPM scheduling, operating performance specifications	control budgets, scheduled milestones performance standards
SOFTWARE SUPPORT	Primavera Project Planner (P3)®	Prolog® internet-based collaborative system

Table 6.10 Planning and control systems in the case studies.

All the case study projects used intranet systems and a combination of computer software tools for planning and control. All the projects used Primavera Project Planner (P3) ® 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 can be produced to compare scheduled, actual and earned projections.

One of the features of the system utilized in these projects was web-browser access and online collaboration, which allowed for intranet publishing of resources, cost management performance reports and graphics.

The 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. Following are the five main features of this control system:

(1) The collaboration feature included three main modules: Communication (requests for information, submittals, meeting minutes, etc.), data (reports, queries) and documents (drawings, graphics, planning documents, schedules). This collaboration feature was used to manage and record all the pre-designed and designed management communications.

(2) The purchasing management feature divided the design into logical groups creating and distributing sub-bid packages to prospective subcontractors and suppliers. Sub-bid responses are retrieved and analyzed allowing subcontracts and purchase orders to be awarded to the most responsive and complete bidders.

(3) The cost control feature managed the financial aspects of the project including budgets, change management, billings to subcontractors and purchase orders.

(4) The document management feature managed all the documents associated with the project, tracked and archived them in the database for distribution and retrieval. Documents included drawings, specifications, transmittals, request for information, meeting minutes, submittals, change orders, issues, etc.

(5) The field administration feature managed and collected information from the field. Information included daily reports, inspections, materials delivered, tests, safety notices, punch lists, etc.

Not all the features were implemented in all the projects. Project E used all the features except the purchasing management feature. Purchasing was handled directly from the main office. The system allows limited and selective access to subcontractors. They were very pleased with the system specially the collaborative features, document management tracking and cost control features. In project B only the collaboration feature was implemented. The other features were not implemented because of technical difficulties with the maintenance of

the system, which requires trained personnel on site to maintain and update the system. (The issue of training will be addressed in step 7 design of positions). The comments from all managers were positive concerning the system; they considered it a good tracking tool. In addition, the system allowed select personnel to have access to all the information and to make decisions at their respective levels.

Two main ones were cited problems with the information technology system. The first had to do with customization. The system does not lend itself well to customization. The second had to do with not having access to the system when the Internet was down.

The lesson learned, is that all five construction companies use web-based collaborative features in setting up planning and control systems, but insufficient advantages is being made of collaborative features of these 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. (See Table 6. 11)

DESIGN STEP	QUESTIONS	SOLUTIONS	INFORMATION TECHNOLOGY APPLICABILITY:
5. Add Planning and Control Systems	What are the means of coordination in terms of planning and control systems? What information technology systems or combination of systems can we use?	Planning: expenditures guidelines, CPM, performance specs. Control: budgets, milestones, performance standards.	Information technology systems: MIS, Project Management systems, and other software/groupware systems. All projects investigated used two main PM systems: Primavera Project Planner (P3) ® and Prolog ® collaborative systems.

Table 6.11 Design step 5 — Questions identified in case studies and solutions inferred from managers' responses.

Step 6: Define 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, and probably should be used.

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 and query facilities, etc.; thereby, facilitating the decentralization process and enabling personnel to make decisions at their level.

DESIGN STEP	QUESTIONS	SOLUTIONS	INFORMATION TECHNOLOGY APPLICABILITY:
6. Define Decision-Making System	What level of decentralization should we employ? What decisions should be delegated in the vertical and horizontal dimensions? Consider the applicability of information technology in vertical/horizontal decentralization.	Projects studied used selective/limited vertical and horizontal decentralization. In the vertical dimension, the PM took financial and personnel decisions selectively and within certain limits. In the horizontal dimension, made selective use of staff unit expertise and experience.	In the projects studied, information technology systems facilitated the decentralization process, by setting up different levels of accessibility and selectivity, enabling personnel to make decisions at their decentralization level.

Table 6.12 Design step 6 — Questions identified in case studies and solutions inferred from managers' responses.

The main lesson here is that these IT systems have facilitated the selective/limited decentralization process which was the hallmark of all

these successful projects by setting up different levels of accessibility and selectivity to project personnel. Therefore, the recommendation concerning this step is that in designing the decision-making system for the project organization, to 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. (Table 6.12)

Step 7: Design 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.

From the grouping of Step two, determine the extent of job specialization for individual positions within the groupings. Horizontal job specialization deals with breadth: If a job is enlarged horizontally the position engages in a wide variety of tasks. Vertical job specialization separates performance of the work from the administration of it. If a job is enlarged vertically, the position has

more administrative control. The more enlarged the work the less specialized the nature of the work.

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. Formalization — in the sense that descriptions were written — was measured by determining what percentage of all rules and procedures that existed within the organization were in writing, if the organization had a policies-and-procedures manual, and to what extent were project management personnel free from policies and procedures to make decisions and the level of compliance observed where written job descriptions existed.

In all cases studied, all rules and procedures were in writing and project management personnel followed them when making decisions.

Overall level of compliance was high. The jobs were formalized by written job descriptions specified in the employee handbook. 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. Training is the design parameter by which standardization of skills is affected. Where a body of knowledge has been recorded for a given job and required skills specified, individuals need to have experience and training. The job of construction project management is classified as highly professional, because the work is complex, it cannot be easily specialized and the coordination is often achieved by the standardization of skills through extensive professional experience and training programs.

In designing positions a clear explanation of training, skills, knowledge, abilities, experience and other characteristics needed to perform the job have to be specified.

In all cases studied, the firms offered extensive construction project management training through on-the-job-training, mentoring

programs, as well as off-the-job training through extensive workshops and seminars. Simultaneously, the implementation of information technology systems generated a need for professional skills and knowledge in the use and maintenance of the information systems. As project information technology grows more complex, the complexity of the project organization increases as well. These major construction firms are adding chief information officers, and some have created whole new departments to help the organization manage and keep pace with rapidly changing information technology. All the firms in the cases studied had information technology departments at the company level. The main function is to assist project personnel in keeping up with information technology systems. Project C included an information technology specialist as part of the project (as opposed to corporate) organization structure.

Concerning formalization, project personnel had on-line accessibility to job descriptions, career paths, rules and regulations. Regarding training, in all our cases studied, information technology has had significant applicability in terms of the number of on-line delivery of training programs. (Table 6.13)

DESIGN STEP	QUESTIONS COMMENTS	SOLUTIONS	INFORMATION TECHNOLOGY APPLICABILITY
7.Design the Positions	Determine the extent of job specialization (horizontal and vertical) for individual positions within the groupings. Consider the applicability of information technology in horizontal and vertical specializations. Formalize the positions. Consider the applicability of information technology in formalization. Determine Training and Experience Requirements. Consider the applicability of information technology in Training.	In all the projects studied, specialization of jobs of the project management personnel tended to be low. Flexibility and adaptability were the key qualities. In all the projects investigated, jobs were formalized by job descriptions and rules specified in the employee handbook. In all our cases, training and experience in construction and/or construction related discipline was a key requirement.	Information technology applicability: Use of different software programs in horizontal specialization (different tasks to be performed) and vertical specialization (administrative tasks to be performed). Information technology applicability in terms of on-line accessibility to job descriptions, career paths, rules and regulations. Information technology had a significant impact in terms of on-line delivery of training programs.

Table 6.13 Design step 7 — Questions identified in case studies and solutions inferred from managers' responses.

Step 8: Implementation

Finally, the actual qualifications of available personnel may require changes in the project organization design and continuing

iterations. It may alter the grouping, unit size, liaison devices, planning and control systems, and decision-making system. The iterative process concludes when a reasonable balance between qualification requirements and the personnel assignments have been achieved. (Table 6-14)

The practical methodology presented in this final chapter, considering the extended framework and based on the case studies researched, provides a starting point for a methodological process that can assist construction project managers in designing construction project management organization structures.

DESIGN STEP	QUESTIONS	SOLUTIONS	INFORMATION TECHNOLOGY APPLICABILITY:
8. Implementation	Assign personnel that meet the qualification requirements of the designed positions. It is an iterative process. The process concludes when a reasonable balance between the qualification requirements and the personnel assigned have been achieved.	N/A	N/A

Table 6.14 Design step 8 — Questions identified in case studies and solutions inferred from managers’ responses.

APPENDIX A: PROJECT A

I. PROJECT A: CASE STUDY NARRATIVE

Project A is a building museum in downtown Baltimore. The state of Maryland is the owner of the project. The state's general services department is the owner's agency. The CM/GC for the project is major general contracting firm based in Baltimore, Maryland. It is ranked 19th in the Engineering News-Record's Top 400 Contractors in the USA with a total revenue volume of \$1,874.0 millions and new contracts totaling \$ 2,250.0 millions (ENR, 2003). The company is the CM/GC for the project.

The estimated cost for the project is \$21,000,000. The estimated contract completion time is 18 months. The CM/GC provides a wide range of services including pre-construction, design-build, construction management and general contracting. Every project falls under the direction of a senior vice president/group manager who assigns a senior project manager. The senior project manager assigned stays with the job from award to closeout.

The department of general services for the state of Maryland has established a field office on the project site. The office is equipped with job site computers. The owner's representative (resident engineer) carries out the following duties and responsibilities: daily inspecting for quality control; protecting the owner's contractual rights during construction, on-site approval of change orders (<\$50,000); checking shop drawings and processing change orders; call regular meetings on site on a biweekly basis for reviewing the progress of the work; progress reports and the checking and approving of the GC's payment requests.

The state's general services department created a web site for items like: on-line project drawings and details; on-line daily project records and project photographs. The web site enables the upper management and administrators to check the progress of the work. Virtual components of the owner's organization are enabled by IT links with the local architect office, the main A/E office in North Carolina, the General Services Office and the GC's office.

The GC's office is fully computer equipped and networked. The GC uses Meridian Prolog software in the entire operations. E-mail and

faxing is fully utilized, as well as, face-to-face meetings on-site, including weekly site meetings between project management and subs; a monthly site meeting with the owner reps and A/E reps and weekly staff meetings. The project organization chart is as follows:

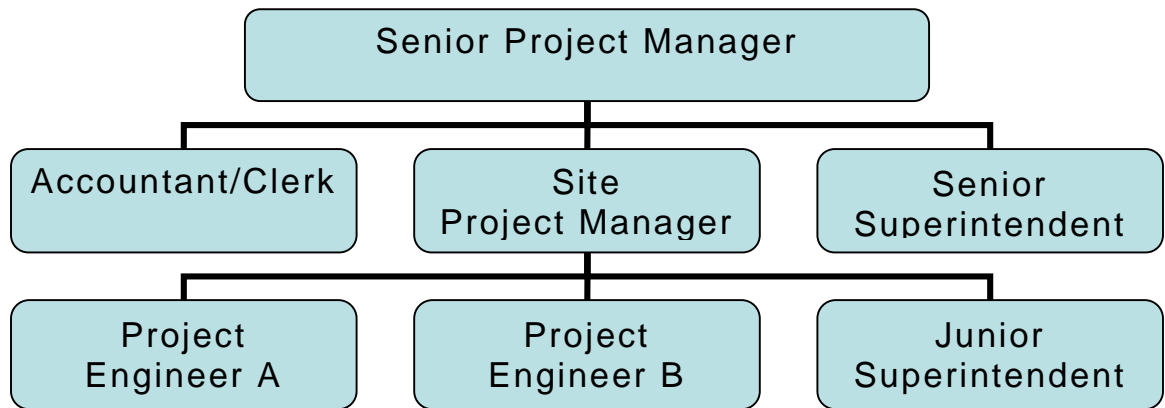


Figure A. 1 Project A Organization Chart

II. PROJECT A: CASE STUDY REPORT (1-UNIT GROUPING, 2-UNIT SIZE, 3-LIAISON DEVICES, 4-PLANNING AND CONTROL SYSTEMS, 5-DECISION-MAKING SYSTEM AND 6-DESIGN OF POSITIONS).

1-Unit Grouping

The CM/GC uses a combination of bases to group positions into units and units into larger ones. At the company level the main groupings are of a market bases, i.e. regions, areas, projects. At the project level is mainly functional, i.e. work processes and function bases.

The project organization uses IT to create organizational unit components/collaborative team groupings in other than conventional form, that is, as virtual components. Those virtual components include the mechanical/electrical unit grouping, the scheduling unit specialist grouping and the museum unit specialist grouping. They are separate organizations but integral departmental project units enabled by IT.

2-Unit Size

The total number of construction project management personnel assigned to the project was seven. The span of control of the senior project manager consists of three sub-units: The site/building sub-unit headed by the project manager; the construction sub-unit headed by the superintendent and the Accounts sub-unit headed by the office accountant. There are two levels in the hierarchy: (a) Senior PM-PM-Project Engineers and (b) Senior PM-Senior Superintendent-Superintendent.

IT, through electronic linking, has impacted the unit size of the project organization. It has decrease the unit size from nine to seven. In this particular size project, technological leveling has had no direct effect on the management layers at the project level. The project organization, with or without IT, is a flat project organization structure.

3-Liaison Devices

As far as the continuum of liaison devices, from liaison positions through coordinating meetings to integrating managers, the senior

project manager is the key integrating manager and coordinating meetings are the conventional liaison devices used for coordination.

The senior project manager conducts the following coordinating meetings:

On a weekly basis:

-Mondays: field staff meeting for review and clarifications.

-Tuesdays: subcontractor's meeting. The main issues are construction operation activities and workflow.

On a biweekly basis:

-Meeting with owner representatives and principal A/E for reviews, clarifications and improvements.

On a monthly basis:

-Meeting with the home office for updating resources (work force, materials, equipment, financial/cash flow).

The project uses electronic linking/communications as IT liaison devices. The company has an intranet linked to the job site. The owner has also developed a project website to facilitate communication/coordination of information with the GC/CM; A/E and other agencies.

Technological matrixing, using electronic linking/communications to create matrix organizations, was not used.

4-Planning and Control Systems

The project used both performance planning and control, as well as, detailed action planning and control systems for coordination. Through performance planning they establish objectives, sub-objectives, budgets, CPM milestones and other standards. Through the detailed action plan they develop action programs and detailed implementation and operating schedules. The senior project manager evaluates the activities in progress (% completion) regularly on a weekly basis.

5-Decision Making (Decentralization)

The project uses selective/limited vertical and horizontal decentralization. In the vertical dimension, different types of decisions are delegated at various levels and in the horizontal dimension managers make selective use of staff unit experts, according to how technical are the decisions they must make.

Concerning financial (budget) decisions, these are taken by the senior project manager. He has an accountant/clerk under him. Progress payment requests are sent to the home office for collection.

Technical decisions are delegated (to some extent) to the junior project management level and they are usually decided in consultation with the appropriate party having the expertise.

Operational/administrative decisions are delegated to the appropriate level, as far down as the junior construction superintendent and field engineers.

On this project, IT has not had any significant impact as far as vertical/horizontal decentralization.

6-Design of Positions

The specialization of jobs tends to be low. Flexibility (the ability to adapt) is one of the key qualities. IT has had an impact on both horizontal and vertical job enlargement.

Jobs are formalized by job descriptions specified in the employee handbook, which are provided to new hires during orientation sessions. The handbook also informs on career paths and the company in general.

IT has changed the way of formalization concerning information, through on-line links. Employees have on-line access to the employee handbook where they can look into job descriptions, career paths, company programs, incentives, etc.

Concerning training and experience, the company hires project management personnel based on their professional background. New hires come from backgrounds in the engineering, architectures and/or

construction sciences. The company provides formal training, as well as, on-the-job training. IT has had an impact on the delivery of training. The company uses IT to deliver on-line training programs.

III. PROJECT A: MEASURES OF ORGANIZATION STRUCTURE
(1-COMPLEXITY, 2-FORMALIZATION & 3-CENTRALIZATION).

Complexity Questionnaire Responses

Indicate (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all seven items. The sum of the item scores is the degree of complexity (out of a possible 35). Complexity is defined by the degree of horizontal, vertical and spatial differentiation. Scores under 15 represent relatively low complexity; scores above 22 indicate relatively high complexity and scores of 15 to 22 make up the moderate range.

1. How many different job titles are there?

a. very few

- b. small number
- c. moderate number *
- d. large number
- e. great number

2. What proportion of employees hold advanced degrees or have many years of specialized training?

- a. 0-10%
- b. 11-20% *
- c. 21-50%
- d. 51-75%
- e. 76-100%

3. How many vertical levels separate the chief executive from those employees working on output in the deepest single division?

- a. 1 or 2
- b. 3 to 5 *
- c. 6 to 8
- d. 9 to 12
- e. more than 12

4. What is the mean number of levels for the organization as a whole?

- a. 1 or 2
- b. 3 to 5 *
- c. 6 to 8
- d. 9 to 12
- e. more than 12

5. What is the number of separate geographic locations where organization members are employed?

- a. 1 or 2
- b. 3 to 5
- c. 6 to 15
- d. 16 to 30 *
- e. more than 30

6. What is the average distance of these separate units from the organization's headquarters?

- a. less than 10 miles

- b. 11 to 100 miles
- c. 101 to 500 miles
- d. 501 to 3500 miles *
- e. more than 3500 miles

7. What proportion of the organization's total work force is located at these separate units?

- a. less than 10%
- b. 11 to 25% *
- c. 26 to 60%
- d. 61 to 90 %
- e. more than 90%

The complexity score is 19. This project would be considered of relative moderate complexity.

Formalization Questionnaire Responses

Indicate with a (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all seven items. The

sum of the item scores is the degree of formalization (out of a possible 35). Formalization indicates the degree to which jobs within the organization are standardized. Scores under 18 represent relatively low formalization, scores above 25 indicate relatively high formalization, and scores of 18 to 25 show relative moderate formalization.

1. Written job descriptions are available for
 - a. operative employees only
 - b. operative employees and first-line supervisors only
 - c. operative, first-line supervisory, and middle management personnel
 - d. operative, first-line supervisory, middle and upper-middle management personnel
 - e. all employees, including senior management *

2. Where written job descriptions exist, how closely are employees supervised to ensure compliance with standards set in the job description?
 - a. very loose
 - b. loose

- c. moderately close *
- d. close
- e. very close

3. How much latitude are employees allowed from the standards?

- a. a great deal
- b. a large amount
- c. a moderate amount
- d. very little *
- e. none

4. What percentage of nonmanagerial employees is given written operating instructions or procedures for their jobs?

- a. 0-20%
- b. 21-40%
- c. 41-60%
- d. 61-80%
- e. 81-100% *

5. Of those nonmanagerial employees given written instructions or procedures, to what extent are they followed?

- a. none
- b. little
- c. some
- d. a great deal
- e. a very great deal *

6. To what extent are supervisors and middle managers free from rules, procedures, and policies when they make decisions?

- a. a very great deal
- b. a great deal
- c. some
- d. little
- e. none *

7. What percentage of all rules and procedures that exist within the organization are in writing?

- a. 1-20%

- b. 21-40%
- c. 41-60%
- d. 61-80%
- e. 81-100% *

The formalization score is 32, which indicate a relatively high formalization.

Centralization Questionnaire Responses

Indicate with a (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all ten items. The sum of the item scores is the degree of centralization (out of possible 50). Centralization indicates the degree to which formal authority to make discretionary choices, is concentrated in an individual, unit or level. Approximate guides for translating scores into categories are as follows: 40 points and above represents high centralization, 21 to 39 is moderate, and 20 or less indicates low centralization (or decentralization)

1. How much direct involvement does top management have in gathering the information they will use in making decisions?

- a. none
- b. little
- c. some *
- d. a great deal
- e. a very great deal

2. To what degree does top management participate in the interpretation of the information input?

- a. 0-20%
- b. 21-40% *
- c. 41-60%
- d. 61-80%
- e. 81-100%

3. To what degree does top management directly control execution of the decision?

- a. 0-20%
- b. 21-40% *
- c. 41-60%
- d. 61-80%
- e. 81-100%

4. How much discretion does the typical first-line supervisor have over establishing his or her unit's budget?

- a. very great *
- b. great
- c. some
- d. little
- e. none

5. How much discretion does the typical first-line supervisor have over determining how his or her unit's performance will be evaluated?

- a. very great *
- b. great
- c. some
- d. little

e. none

6. How much discretion does the typical first-line supervisor have over hiring and firing personnel?

a. very great

b. great

c. some *

d. little

e. none

7. How much discretion does the typical first-line supervisor have over personnel rewards (i.e., salary increases, promotions)?

a. very great

b. great

c. some

d. little *

e. none

8. How much discretion does the typical first-line supervisor have over purchasing of equipment and supplies?

a. very great

b. great

c. some *

d. little

e. none

9. How much discretion does the typical first-line supervisor have over establishing a new project or program?

a. very great

b. great *

c. some

d. little

e. none

10. How much discretion does the typical first-line supervisor have over how work exceptions are to be handled?

- a. very great *
- b. great
- c. some
- d. little
- e. none

Centralization score is 21, which would indicate a relative moderate to low centralization. Or moderate to high decentralization.

In summary Project A has a relative moderate complexity (19), high formalization (32) and moderate to low centralization (21).

IV. PROJECT A: IT QUESTIONNAIRE RESPONSES **(DOCUMENTARY INFORMATION).**

Check (*) all that apply.

1. Which type of construction does your company perform?

- a. residential *
- b. commercial *

- c. industrial *
- d. heavy highway
- e. other

2. Would the company be classified as a:

- a. general contractor *
- b. design build firm
- c. construction manager *
- d. specialty contractor
- e. other

3. What is your job title? Senior Project Manager

4. What is the gross dollar volume per year for the company? Approx.
\$ 2 billion dollars.

5. Does the company have Internet access?

- a. Yes *
- b. no

6. If yes, do you use the Internet for work-related purposes?

- a. Yes * b. no

7. If yes, what information do you inquire about over the Internet?

(Check all that apply.)

- a. product information *
- b. contractor information *
- c. subcontractor information
- d. architect information
- e. owner information
- f. company information *
- g. project information *
- h. other

8. Do you use the Internet for project communication?

- a. yes * b. no

9. If yes, please check all that apply:

- a. to record job cost reports *
- b. to record daily reports *
- c. logging time cards *

d. other

10. Does the company have its own Intranet?

a. yes * b. no

11. Do you use the Intranet for work-related purposes?

a. yes * b. no

12. If yes, what information do you inquire about over the Intranet?

a. company policies *

b. cost control reports *

c. client information *

d. employee information *

e. company newsletter

f. other

13. Do you use the Intranet for project communication?

a. to record job cost reports *

- b. to record daily reports *
- c. logging time cards *
- d. other

14. Does the company have access to email?

- a. yes *
- b. no

15. If yes, do you use email for project related purposes?

- a. Yes *
- b. no

16. If yes, what information do you receive or send via email?

- a. product information *
- b. contractor information *
- c. subcontractor information *
- d. architect information *
- e. owner information *
- f. company information *
- g. project information *
- h. other

17. With whom do you communicate by email?

- a. to branch offices *
- b. to corporate office *
- c. to contractors *
- d. to subcontractors *
- e. to coworkers *
- f. other

18. Does the company provide training for using IT?

- a. Yes *
- b. no

19. If no, how do you learn to use it?

- a. self-taught
- b. attend training course(s)
- c. other

20. Does the company have a web site? a. yes * b. no

21. If yes, what information is listed on the company web site?

- a. company history *
- b. company newsletter *
- c. company information *
- d. company contact name *
- e. present project information *
- f. past project information *
- g. employment opportunities *
- h. other

22. What electronic links with other offices or consultants (members of the project team) does the project have?

- a. Fax *
- b. Email *
- c. e-collaboration *
- d. other(s)

23. Is the company project(s) using any of the following web-based project management system software?

- a. E-builder

- b. Expedition with Webster
- c. Prolog Manager *
- d. Constructware
- e. Other
- f. None

24. If using web-based project management software what is the dollar volume and duration (months) of the project?

\$ 21,325,000; duration 18 (months).

25. Does your company use project web pages? a. yes * b. no

26. If yes, what information is listed on the project web page?

- a. Contacts *
- b. CAD files
- c. site photographs *
- d. scanned photographs
- e. reports
- f. transmittals
- g. other types of documents

27. Does this project have a web page?

a. yes b. no *

28. If yes, what is the dollar volume and duration of the project (months)? N/A.

APPENDIX B: PROJECT B

I. PROJECT B: CASE STUDY NARRATIVE

The CM for this project is a major international general contracting firm. It is ranked 8th in the Engineering News-Record's Top 400 contractors with a total revenue volume of \$3,745.0 millions and new contracts totaling \$3,856.8 millions (ENR, 2003). The firm operates in five continents. The firm offers program management consulting for capital projects and comprehensive services including managing and coordinating all design procurement and construction activities. At the construction management level, it provides all technical and administrative management services from initial bid stage through the certificate of occupancy and final closeout.

This project is an institutional building on the campus of the University of Maryland Eastern Shore. The cost of the facility is estimated at \$29,000,000 and is scheduled for 24 months. This is a 115,000 SF facility. This project will provide classrooms, laboratories, faculty offices, and support spaces in a state of the art facility for social sciences, education and the health sciences. It will also accommodate the graduate education program in physical therapy, as

well as, rehabilitation services, counseling and teachers education, sociology, criminal justice, and the offices of the dean of agricultural & natural sciences, and of the art & the professions.

The project organization chart is as follows:

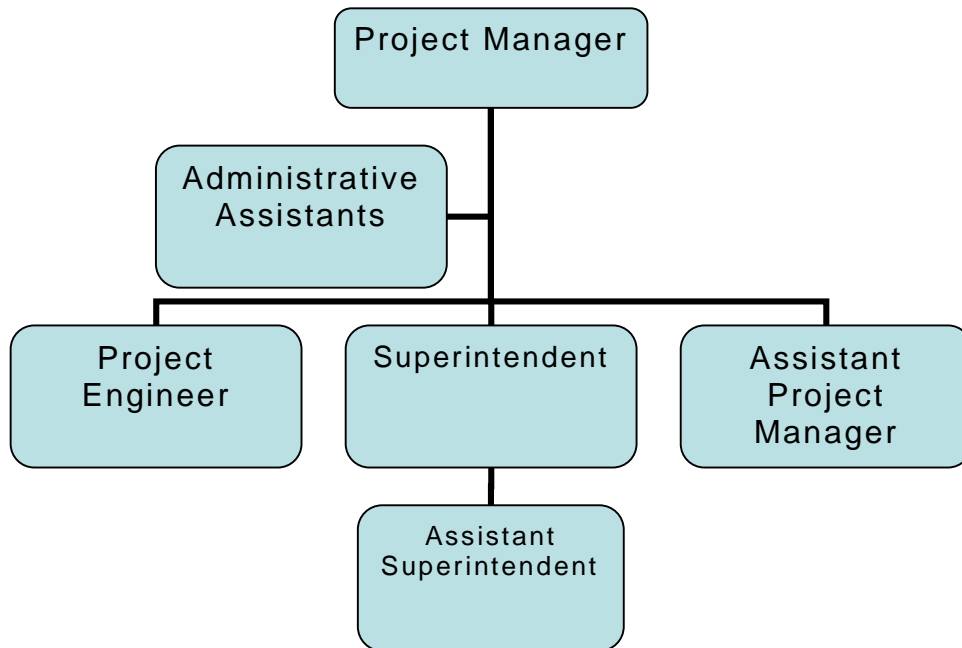


Figure B.1 Project Organization Chart

II. PROJECT B: CASE STUDY REPORT (1-UNIT GROUPING, 2-UNIT SIZE, 3-LIAISON DEVICES, 4-PLANNING AND CONTROL SYSTEMS, 5-DECISION-MAKING SYSTEM AND 6-DESIGN OF POSITIONS).

1-Unit Grouping

The firm uses a combination of bases to group positions into units and units into larger ones. At the company level the main groupings are of market basis, i.e. regional, areas, projects. At the project level is mainly functional, i.e. function and work processes.

Through the firm's intranet the project has collaborative (virtual) team groupings with the home office, A/E and others associated with the project. The intranet contributes to the project's effectiveness and enhances project communication.

2-Unit Size

The total number of construction project management personnel assigned to the project was seven. The span of control of the project manager consists of three sub-units: project engineering, superintending and the assistant project management. Formally, there are two levels of hierarchy on this project.

IT, through electronic linking, has not impacted the unit size of the project organization; rather it is a tool for better communication. IT has had no direct effect on the management layers at the project level.

3-Liaison Devices

As far as the continuum of liaison devices, from liaison positions through coordinating meetings to integrating managers, the project manager is the key-integrating manager between the home office and the owner's representative. The project engineer is the key liaison position between the A/E and the CM. Coordinating meetings are the conventional liaison devices used for coordination.

Coordinating meetings:

-Weekly meetings among the project team members on site. These meetings are held so there is face-to-face interaction with all project members.

-Weekly meetings with subcontractors.

-Monthly owner/project team meetings.

The project uses electronic linking/communications as coordinating devices. The company has its own intranet linked to the job site. Most of the correspondence is through e-mail. Fax and other means are also used.

Technological matrixing, using electronic linking and communications to create matrix organizations, was not used.

4-Planning and Control Systems

The project uses both performance planning and control, as well as, detailed action planning and control systems for coordination. Through performance planning they establish objectives, budgets and CPM milestones. Through detailed action planning they develop action programs and detailed implementation and operating schedules.

The CM firm uses a construction accounting software system, as well as, Excel® to set up and control the project budget and subcontracts.

Suretrack® and Primavera® are used for planning, scheduling, monitoring and control. Each element is cost loaded to help track costs. The payout is based on the percentage complete of work done using the loaded schedule. The project team is connected to the company's intranet, which facilitates information/communication.

5-Decision-Making System

The project uses selective vertical and horizontal decentralization for decision-making. Concerning financial (budget) decisions, the project manager has exclusive responsibility. All other decisions are selectively delegated within the project team. For example technical (design) decisions are divided between the project engineer and the assistant project manager. In general project team members have decision-making ability based on their responsibility and scope of work.

IT has not had any significant impact as far as vertical decentralization. As far as horizontal decentralization, IT has played a role of allowing team members instant on-line communication, thereby enabling/facilitating horizontal decentralization.

6-Design of Positions

The specialization of jobs tends to be low. Flexibility is key. In effect the assistant project manager can do RFIs, which happens to be the project engineer's responsibility. The roles of team members can intermix somewhat, but come decision-making time, each team member has to make their decisions based on their scope of responsibilities. IT has had a relative impact on job enlargement.

Jobs have a high degree of formalization at the project level.

Concerning training and experience backgrounds, the firm hires project personnel with construction management, engineering or related backgrounds.

Training is informal and usually on-the-job training, as well as, on-line training. Training involves primarily managerial, computer software and safety training.

III. PROJECT B: MEASURES OF ORGANIZATION STRUCTURE
(1-COMPLEXITY, 2-FORMALIZATION & 3-CENTRALIZATION).

Complexity Questionnaire Responses

Indicate (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all seven items. The sum of the item scores is the degree of complexity (out of a possible 35). Complexity is defined by the degree of horizontal, vertical and spatial differentiation. Scores under 15 represent relatively low complexity, scores above 22; indicate relatively high complexity and scores of 15 to 22 make up the moderate range.

1. How many different job titles are there?

- a. very few
- b. small number
- c. moderate number *
- d. large number
- e. great number

2. What proportion of employees hold advanced degrees or have many years of specialized training?

a. 0-10%

b. 11-20%

c. 21-50%

d. 51-75% *

e. 76-100%

3. How many vertical levels separate the chief executive from those employees working on output in the deepest single division?

a. 1 or 2

b. 3 to 5

c. 6 to 8 *

d. 9 to 12

e. more than 12

4. What is the mean number of levels for the organization as a whole?

a. 1 or 2

- b.3 to 5
- c.6 to 8 *
- d.9 to 12
- e. more than 12

5. What is the number of separate geographic locations where organization members are employed?

- a.1 or 2
- b.3 to 5
- c.6 to 15
- d.16 to 30
- e. more than 30 *

6. What is the average distance of these separate units from the organization's headquarters?

- a. less than 10 miles
- b.11 to 100 miles *
- c.101 to 500 miles
- d.501 to 3500 miles
- e. more than 3500 miles

7. What proportion of the organization's total work force is located at these separate units?

a. less than 10%

b. 11 to 25%

c. 26 to 60%

d. 61 to 90 % *

e. more than 90%

The complexity score is 24. The organization would be considered of relative high complexity.

Formalization Questionnaire Responses

Circle your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all seven items. The sum of the item scores is the degree of formalization (out of a possible 35). Formalization indicates the degree to which jobs within the organization are standardized. Scores under 18 represent relatively low formalization, scores above 25 indicate relatively high formalization, and scores of 18 to 25 show relative moderate formalization.

1. Written job descriptions are available for
 - a. operative employees only
 - b. operative employees and first-line supervisors only
 - c. operative, first-line supervisory, and middle management personnel
 - d. operative, first-line supervisory, middle and upper-middle management personnel
 - e. all employees, including senior management *

2. Where written job descriptions exist, how closely are employees supervised to ensure compliance with standards set in the job description?
 - a. very loose
 - b. loose
 - c. moderately close
 - d. close *
 - e. very close

3. How much latitude are employees allowed from the standards?

- a. a great deal
- b. a large amount
- c. a moderate amount *
- d. very little
- e. none

4. What percentage of nonmanagerial employees is given written operating instructions or procedures for their jobs?

- a.0-20%
- b.21-40% *
- c.41-60%
- d.61-80%
- e.81-100%

5. Of those nonmanagerial employees given written instructions or procedures, to what extent are they followed?

- a. none
- b. little
- c. some

- d. a great deal *
- e. a very great deal

6. To what extent are supervisors and middle managers free from rules, procedures, and policies when they make decisions?

- a. a very great deal
- b. a great deal
- c. some *
- d. little
- e. none

7. What percentage of all rules and procedures that exist within the organization are in writing?

- a. 1-20%
- b. 21-40%
- c. 41-60%
- d. 61-80%
- e. 81-100% *

The formalization score is 26, which indicate a relative high formalization.

Centralization Questionnaire Responses

Indicate (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all ten items. The sum of the item scores is the degree of centralization (out of possible 50). Centralization indicates the degree to which formal authority to make discretionary choices, is concentrated in an individual, unit or level. Approximate guides for translating scores into categories are as follows: 40 points and above represents high centralization, 21 to 39 is moderate, and 20 or less indicates low centralization (or decentralization).

1. How much direct involvement does top management have in gathering the information they will use in making decisions?

- a. none
- b. little
- c. some

- d. a great deal *
- e. a very great deal

2. To what degree does top management participate in the interpretation of the information input?

- a.0-20%
- b.21-40%
- c.41-60%
- d.61-80%
- e.81-100% *

3. To what degree does top management directly control execution of the decision?

- a.0-20%
- b.21-40%
- c.41-60%
- d.61-80% *
- e.81-100%

4. How much discretion does the typical first-line supervisor have over establishing his or her unit's budget?

- a. very great
- b. great *
- c. some
- d. little
- e. none

5. How much discretion does the typical first line supervisor have over determining how his or her unit's performance will be evaluated?

- a. very great
- b. great
- c. some
- d. little *
- e. none

6. How much discretion does the typical first line supervisor have over hiring and firing personnel?

- a. very great

- b. great
- c. some *
- d. little
- e. none

7. How much discretion does the typical first-line supervisor have over personnel rewards (i.e., salary increases, promotions)?

- a. very great
- b. great
- c. some *
- d. little
- e. none

8. How much discretion does the typical first-line supervisor have over purchasing of equipment and supplies?

- a. very great
- b. great *
- c. some
- d. little
- e. none

9. How much discretion does the typical first-line supervisor have over establishing a new project or program?

- a. very great
- b. great
- c. some *
- d. little
- e. none

10. How much discretion does the typical first-line supervisor have over how work exceptions are to be handled?

- a. very great
- b. great *
- c. some
- d. little
- e. none

Centralization score is 32, which would indicate a relatively moderate degree of centralization.

In summary, Project B has a relative high complexity (24), high formalization (26) and a moderate degree of centralization (32).

IV. PROJECT B: IT QUESTIONNAIRE RESPONSES
(DOCUMENTARY INFORMATION).

Please respond to each of the following items, check (*) all that apply.

1. Which type of construction does your company perform?

- a. residential *
- b. commercial *
- c. industrial *
- d. heavy highway
- e. other

2. Would the company be classified as a:

- a. general contractor
- b. design build firm

- c. construction manager *
- d. specialty contractor
- e. other

3. What is your job title? Project Manager

4. What is the gross dollar volume per year for the company?

\$ 4 billion

5. Does the company have Internet access?

- a. Yes *
- b. no

6. If yes, do you use the Internet for work-related purposes?

- a. Yes *
- b. no

7. If yes, what information do you inquire about over the Internet?

(Check all that apply.)

- a. product information *

- b. contractor information *
- c. subcontractor information *
- d. architect information *
- e. owner information *
- f. company information *
- g. project information *
- h. other

8. Do you use the Internet for project communication?

- a. yes *
- b. no

9. If yes, please check all that apply:

- a. to record job cost reports *
- b. to record daily reports
- c. logging time cards
- d. other

10. Does the company have its own Intranet?

- a. yes *
- b. no

11. Do you use the Intranet for work-related purposes?

- a. yes *
- b. no

12. If yes, what information do you inquire about over the Intranet?

- a. company policies *
- b. cost control reports *
- c. client information *
- d. employee information *
- e. company newsletter *
- f. other

13. Do you use the Intranet for project communication?

- a. to record job cost reports *
- b. to record daily reports
- c. logging time cards
- d. other

14. Does the company have access to email?

a. yes * b. no

15. If yes, do you use email for project related purposes?

a. Yes * b. no

16. If yes, what information do you receive or send via email?

a. product information *

b. contractor information *

c. subcontractor information *

d. architect information *

e. owner information *

f. company information *

g. project information *

h. other

17. With whom do you communicate by email?

a. to branch offices *

b. to corporate office *

- c. to contractors *
- d. to subcontractors *
- e. to coworkers *
- f. other

18. Does the company provide training for using IT?

- a. Yes *
- b. no

19. If no, how do you learn to use it?

- a. self-taught
- b. attend training course(s)
- c. other

20. Does the company have a web site? a. yes * b. no

21. If yes, what information is listed on the company web site?

- a. company history *
- b. company newsletter *
- c. company information *

- d. company contact name *
- e. present project information *
- f. past project information *
- g. employment opportunities *
- h. other

22. What electronic links with other offices or consultants (members of the project team) does the project have?

- a. fax *
- b. email *
- c. e-collaboration *
- d. other(s)

23. Is the company project(s) using any of the following web-based project management system software?

- a. E-builder
- b. Expedition with Webster
- c. Prolog Manager *
- d. Constructware
- e. Other

f. None

24. If using web-based project management software what is the dollar volume and duration (months) of the project?

\$29 million duration 24 (months).

25. Does your company use project web pages? a. yes * b. no

26. If yes, what information is listed on the project web page?

a. contacts *

b. CAD files

c. site photographs *

d. scanned photographs *

e. reports *

f. transmittals *

g. other types of documents

27. Does this project have a web page?

a. yes b. no *

APPENDIX C: PROJECT C

I. PROJECT C: CASE STUDY NARRATIVE

The firm is one of the nation's oldest builders. It was founded in 1873 as a family-run carpentry and general contracting shop, building high quality homes and public buildings. During World War II the firm built large defense projects and notable public projects. The firm has also served some of the largest and most successful private sector companies like Miller Brewing Company and General Motors. The company's core competency is in managing construction. They deliver facilities in a variety of ways that meet the needs of their clients. Delivery methods include construction management, design-build and general contracting. The firm also acts either as an agent or assumes greater risk by taking contractual and financial responsibilities for the project. The company is able to take a project from concept to completion.

This particular project, which the firm was engaged in, was an addition and partial renovation to the Chemistry Building located on the University of Maryland College Park campus. The building serves the programs of the College of Life Sciences and the Department of

Chemistry. One wing of the existing building was replaced by a new wing, which includes teaching labs, offices and research space. Nearby the Satellite Central Utility Building (SCUB) includes equipment to heat and cool the new wing, with connections to the existing Chemistry Building. The total cost of the project is approximately \$38 million, the project duration 12 months; the procurement was a competitive bid. The project delivery method is a CM/GC.

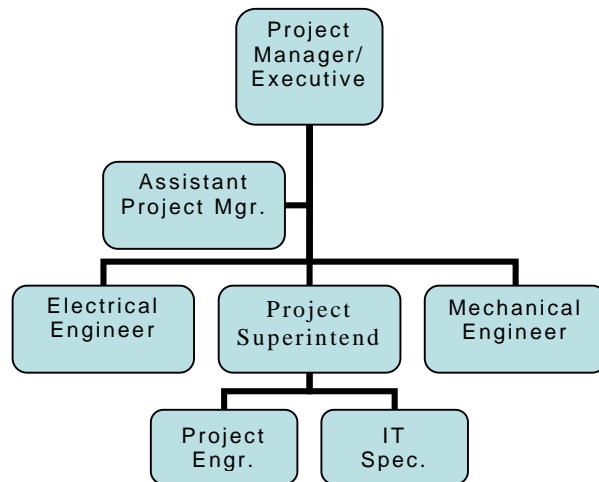


Figure C.1 Project C Organization Chart

The firm is ranked 11th in the Engineering News-Record's Top 400 contractors with a total revenue volume of \$ 2,771.3 millions and new contracts totaling \$ 3,080.6 (ENR, 2003).

II. PROJECT C: CASE STUDY REPORT (1-UNIT GROUPING, 2-UNIT SIZE, 3-LIAISON DEVICES, 4-PLANNING AND CONTROL SYSTEMS, 5-DECISION-MAKING SYSTEM AND 6- DESIGN OF POSITIONS).

1-Unit grouping

The CM/GC at the company level is grouped on a market basis (regions, areas, projects) at the project level is mainly on a function basis. There were no virtual components in the project organization structure.

2-Unit Size

The total number of construction project management personnel assigned to the project was seven. The span of control of the project manager/executive consisted of 3 subunits. There are two levels in the hierarchy. IT, through electronic linking, has not increased nor

decreased the unit size in the project organization. IT, through technological leveling, has not caused a reduction on the layers of management; it is a flat project organization structure.

3-Liaison Devices

As far as the continuum of liaison devices, from liaison positions through coordinating meetings to integrating managers, the project manager & executive is the key-integrating manager and coordinating meetings are the conventional liaison devices used for coordination. The superintendent meets with the subcontractors on a weekly basis to update schedules of work performed. The project Manager/executive as the integrating manager is responsible for completing monthly reports, which are forwarded to the vice-president. As far as electronic linking as means of coordination the project uses mostly e-mail and fax. Technological matrixing, using electronic linking communications to create matrix organizations, was not used.

4-Planning and Control Systems

The project uses budget standards and milestones, evaluated by the project executive/manager, for performance control monitoring, as well as, detailed action planning/scheduling system monitoring. The project uses Primavera ® and Prolog ®, as well as, Microsoft ® software extensively for project administration (RFIs, transmittals, submittals, etc.).

5-Decision-Making System

The project uses selective/limited vertical and horizontal decentralization. The project manager/executive has limited control over the budget and personnel. Technical decisions are delegated to the appropriate personnel at the project level. Staff personnel on this project have very limited control over decision making. IT has not had any direct impact as far as vertical or horizontal decentralization.

6-Design of Positions

The specialization of jobs tends to be low. Because of IT the jobs are less specialized and more enlarged horizontally, as well as, vertically.

The degree of formalization tends to be high. Through the company's intranet site, employees have access to project manuals, safety materials, job scope descriptions, etc.

Training and experience requirements for new hires are primarily a background in construction management or related field, as well as, field experience.

IT is playing an increasing role in training through the company's intranet site and online education courses.

III. PROJECT C: MEASURES OF ORGANIZATION STRUCTURE
(1-COMPLEXITY, 2-FORMALIZATION & 3-CENTRALIZATION).

Complexity Questionnaire Responses

Indicate (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all seven items. The sum of the item scores is the degree of complexity (out of a possible 35). Complexity is defined by the degree of horizontal, vertical and spatial differentiation. Scores under 15 represent relatively low complexity, scores above 22, indicate relatively high complexity and scores of 15 to 22 make up the moderate range.

1. How many different job titles are there?

- a. very few
- b. small number
- c. moderate number *
- d. large number

e. great number

2. What proportion of employees hold advanced degrees or have many years of specialized training?

a.0-10%

b.11-20%

c.21-50%

d.51-75%

e.76-100% *

3. How many vertical levels separate the chief executive from those employees working on output in the deepest single division?

a.1 or 2

b.3 to 5

c.6 to 8

d.9 to 12 *

e.more than 12

4. What is the mean number of levels for the organization as a whole?

- a.1 or 2
- b.3 to 5 *
- c.6 to 8
- d.9 to 12
- e.more than 12

5. What is the number of separate geographic locations where organization members are employed?

- a.1 or 2
- b.3 to 5
- c.6 to 15 *
- d.16 to 30
- e.more than 30

6. What is the average distance of these separate units from the organization's headquarters?

- a.less than 10 miles
- b.11 to 100 miles
- c.101 to 500 miles *
- d.501 to 3500 miles

e.more than 3500 miles

7. What proportion of the organization's total work force is located at these separate units?

a.less than 10%

b.11 to 25%

c.26 to 60%

d.61 to 90 % *

e.more than 90%

The complexity score is 24. The organization would be considered of relative high complexity.

Formalization Questionnaire Responses

Circle your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all seven items. The sum of the item scores is the degree of formalization (out of a possible 35). Formalization indicates the degree to which jobs within the organization are standardized. Scores under 18 represent relatively low

formalization, scores above 25 indicate relatively high formalization, and scores of 18 to 25 show relative moderate formalization.

1. Written job descriptions are available for

a.operative employees only

b.operative employees and first-line supervisors only

c.operative, first-line supervisory, and middle management personnel *

d.operative, first-line supervisory, middle and upper-middle management personnel

e.all employees, including senior management

2. Where written job descriptions exist, how closely are employees supervised to ensure compliance with standards set in the job description?

a.very loose

b.loose

c.moderately close

d.close *

e.very close

3. How much latitude are employees allowed from the standards?

- a. a great deal
- b. a large amount
- c. a moderate amount *
- d. very little
- e. none

4. What percentage of nonmanagerial employees is given written operating instructions or procedures for their jobs?

- a. 0-20%
- b. 21-40%
- c. 41-60%
- d. 61-80% *
- e. 81-100%

5. Of those nonmanagerial employees given written instructions or procedures, to what extent are they followed?

- a. none
- b. little

- c.some
- d.a great deal *
- e.a very great deal

6. To what extent are supervisors and middle managers free from rules, procedures, and policies when they make decisions?

- a.a very great deal
- b.a great deal
- c.some
- d.little *
- e.none

7. What percentage of all rules and procedures that exist within the organization are in writing?

- a.1-20%
- b.21-40%
- c.41-60%
- d.61-80%
- e.81-100% *

The formalization score is 27, which indicates a relative high formalization.

Centralization Questionnaire Responses

Indicate (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all ten items. The sum of the item scores is the degree of centralization (out of possible 50). Centralization indicates the degree to which formal authority to make discretionary choices, is concentrated in an individual, unit or level. Approximate guides for translating scores into categories are as follows: 40 points and above represents high centralization, 21 to 39 is moderate, and 20 or less indicates low centralization (or decentralization).

1. How much direct involvement does top management have in gathering the information they will use in making decisions?

a.none

b.little

c.some *

d.a great deal

e.a very great deal

2. To what degree does top management participate in the interpretation of the information input?

a.0-20%

b.21-40% *

c.41-60%

d.61-80%

e.81-100%

3. To what degree does top management directly control execution of the decision?

a.0-20%

b.21-40% *

c.41-60%

d.61-80%

e.81-100%

4. How much discretion does the typical first-line supervisor have over establishing his or her unit's budget?

a.very great

b.great *

c.some

d.little

e.none

5. How much discretion does the typical first line supervisor have over determining how his or her unit's performance will be evaluated?

a.very great

b.great

c.some *

d.little

e.none

6. How much discretion does the typical first line supervisor have over hiring and firing personnel?

a.very great

b.great *

c.some

d.little

e.none

7. How much discretion does the typical first-line supervisor have over personnel rewards (i.e., salary increases, promotions)?

a.very great

b.great *

c.some

d.little

e.none

8. How much discretion does the typical first-line supervisor have over purchasing of equipment and supplies?

a.very great

b.great *

c.some

d.little

e.none

9. How much discretion does the typical first-line supervisor have over establishing a new project or program?

a.very great

b.great

c.some

d.little *

e.none

10. How much discretion does the typical first-line supervisor have over how work exceptions are to be handled?

a.very great

b.great

c.some *

d.little

e.none

The centralization score is 25, which would indicate a relatively moderate degree of centralization.

In summary, Project C has a relative high complexity (26), high formalization (27) and a moderate degree of centralization (25).

IV. PROJECT C: IT QUESTIONNAIRE RESPONSES
(DOCUMENTARY INFORMATION).

Please respond to each of the following items, check (*) all that apply.

1. Which type of construction does your company perform?

- a.residential
- b.commercial *
- c.industrial *
- d.heavy highway
- e.other

2. Would the company be classified as a:

- a.general contractor
- b.design build firm *

c.construction manager *

d.specialty contractor

e.other

3. What is your job title? Project Eng/Asst Super.

4. What is the gross dollar volume per year for the company? \$2.5 billion

5. Does the company have Internet access?

a.yes * b. no

6. If yes, do you use the Internet for work-related purposes?

a.yes * b. no

7. If yes, what information do you inquire about over the Internet?

(Check all that apply.)

a.product information *

b.contractor information *

c.subcontractor information *

d.architect information *

e.owner information

f.company information *

g.project information

h.other

8. Do you use the Internet for project communication?

a. yes * b. no

9. If yes, please check all that apply:

a.to record job cost reports

b.to record daily reports

c.logging time cards

d.other * (submittals/RFI's)

10. Does the company have its own Intranet?

a.yes * b. no

11. Do you use the Intranet for work-related purposes?

a.yes * b. no

12. If yes, what information do you inquire about over the Intranet?

a.company policies *

b.cost control reports *

c.client information

d.employee information *

e.company newsletter *

f.other

13. Do you use the Intranet for project communication?

a.to record job cost reports *

b.to record daily reports

c.logging time cards

d.other

14. Does the company have access to email?

a. yes * b. no

15. If yes, do you use email for project related purposes?

- a. Yes *
- b. no

16. If yes, what information do you receive or send via email?

- a. product information *
- b. contractor information *
- c. subcontractor information
- d. architect information
- e. owner information
- f. company information *
- g. project information
- h. other

17. With whom do you communicate by email?

- a. to branch offices
- b. to corporate office *
- c. to contractors *
- d. to subcontractors
- e. to coworkers *

f.other

18. Does the company provide training for using IT?

a.Yes * b. no

19. If no, how do you learn to use it?

a.self-taught

b.attend training course(s)

c.other

20. Does the company have a web site? a. yes * b. no

21. If yes, what information is listed on the company web site?

a.company history *

b.company newsletter *

c.company information *

d.company contact name *

e.present project information *

f.past project information *

g.employment opportunities *

h.other

22. What electronic links with other offices or consultants (members of the project team) does the project have?

a.fax *

b.email *

c.e-collaboration

d.other(s)

23. Is the company project(s) using any of the following web-based project management system software?

a.E-builder

b.Expedition with Webster

c.Prolog Manager *

d.Constructware

e.Other * (Prolog Web)

f.None

24. If using web-based project management software what is the dollar volume and duration (months) of the project?

\$ 40million duration 24 (months).

25. Does your company use project webpages? a.yes b. no

26. If yes, what information is listed on the project webpage?

a.contacts

b.CAD files

c.site photographs *

d.scanned photographs *

e.reports *

f.transmittals

g.other types of documents

27. Does this project have a webpage?

a. yes b. no *

28. If yes, what is the dollar volume and duration of the project (months)?

APPENDIX D: PROJECT D

I. PROJECT D: CASE STUDY NARRATIVE

The firm's construction group, is today one of the nation's most experienced and respected providers of construction services, headquartered in Bethesda, Maryland, it is ranked 12th in the Engineering News-Record's top 400 contractors with a total revenue volume of \$ 2,640.3 millions and new contracts totaling \$ 2,917.8 millions (ENR, 2003). The company's depth of experience spans a variety of public and commercial building markets across the country, including millions of square feet of office buildings, research facilities, schools, retail centers, manufacturing facilities and sports convention facilities. The firm performs pre-construction, construction management, general contracting, trade work, design/build and consulting services to meet clients' construction needs. From the initial stages of project planning and development through the construction phase and project delivery, the company works in partnership with clients under a variety of contract types and delivery methods, including lump sum, guarantee maximum price and negotiated procurement. The firm supports each project with a technical staff of

highly trained construction professionals and a team of specialists in partnering, estimating, purchasing, scheduling, cost engineering, risk management, safety, and community relations. The in-house expertise provides clients with all technical and administrative needs.

The project is a \$128 million building complex for Georgetown University, the Southwest Quadrangle Project. It totaled over 860,000 SF. The complex included three new residence halls, dining facility, underground parking garage, a bus maintenance facility and a Jesuit community residence. The project duration is 32 months.

Designed as three connected buildings, the 315,400 SF residence halls provide 784 additional beds for undergraduate students. Facilities include kitchens, classrooms, recreation and multipurpose rooms, laundry facilities, study space, as well as, chaplain and faculty residence apartments. Replacing an existing facility, the new 81,170 SF dining hall will serve 1200 students daily. Blending elements of traditional and modern design, the building occupies a pie-shaped footprint with an arching façade to the southwest.

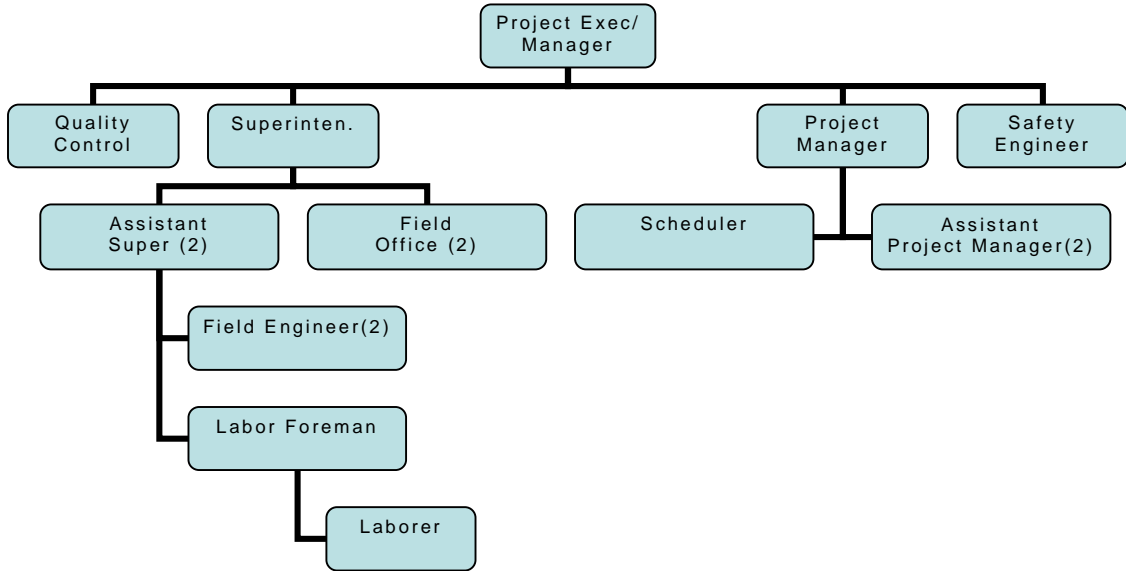


Figure D.1 Project D Organization Chart

II. PROJECT D: CASE STUDY REPORT (1-UNIT GROUPING, 2-UNIT SIZE, 3-LIAISON DEVICES, 4-PLANNING AND CONTROL SYSTEMS, 5-DECISION-MAKING SYSTEM AND 6-DESIGN OF POSITIONS).

1-Unit Grouping

The firm uses a combination of bases. At the company level the main groupings are of a market bases, i.e. regions, projects. At the project level is mainly functional: function basis.

Concerning virtual (collaborative team groupings) components in the project organization structure, the firm supports each project with a technical staff (virtual collaborative groupings) of highly trained construction professionals and a team of specialists in partnering, estimating, purchasing, scheduling, cost engineering, risk management, safety and community relations.

2-Unit size

The total number of construction project management personnel assigned to the project was fourteen. The span of control of the senior project manager, in this case the project executive is four sub-units. From the project executive to the field laborers, there are four levels in the hierarchy.

IT has not impacted the unit size of the project organization, or the layers of management (management levels) of the project organization structure.

3-Liaison Devices

As far as the continuum of liaison devices, from liaison positions through coordinating meetings to integrating managers, the project manager is the key integrating manager and coordinating meetings the conventional liaison device used for coordination.

There are owner's meetings every two weeks. Staff meetings and foremen meetings on a weekly basis. The project uses electronic

conferencing, e-mail and fax as electronic linking/communicating devices.

Matrix organization through technological matrixing was not used.

4-Planning and Control Systems

The project used performance planning and control, as well as, detailed action planning and control systems for coordination. Budget standards and milestones are used to control the subcontractors' work in terms of the cost and timing of execution. Earned value is used for self-performed work.

Primavera ® is the main IT system software used for project management.

5-Decision-Making System

The project uses selective/limited vertical and horizontal decentralization. In the vertical dimension, different types of decisions are delegated at various levels. For example the project manager

handles Change Orders of less than \$10,000. The Vice President handles change Orders higher than \$10,000 but less than \$250,000. Change Orders of over \$250,000 must go through the main office.

In the horizontal dimension managers make selective use of staff unit experience and expertise in decentralization of decision-making.

IT has not had any significant impact as far as vertical/horizontal decentralization.

6-Design of Positions

The project is characterized by low specialization of jobs. IT has had an impact on horizontal and vertical job enlargement and according to one of the vice presidents, the impact may be negative in terms of time usage efficiency.

In terms of formalization, everyone has a written job description. They must also be flexible and be able to work outside their scope description.

Cross training is encouraged as much as possible. IT has impacted job formalization, as far as, on-line accessibility is concerned.

Concerning training and experience, new hires come from diverse backgrounds in the business, architecture and engineering fields. The company provides formal training and on-line training for new hires.

III. PROJECT D: MEASURES OF ORGANIZATION STRUCTURE (1-COMPLEXITY, 2-FORMALIZATION & 3-CENTRALIZATION)

Complexity Questionnaire Responses

Indicate (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all seven items. The sum of the item scores is the degree of complexity (out of a possible 35). Complexity is defined by the degree of horizontal, vertical and spatial differentiation. Scores under 15 represent relatively low complexity, scores above 22, indicate relatively high complexity and scores of 15 to 22 make up the moderate range.

1. How many different job titles are there?

- a.very few
- b.small number
- c.moderate number
- d.large number *
- e.great number

2. What proportion of employees hold advanced degrees or have many years of specialized training?

- a.0-10%
- b.11-20%
- c.21-50%
- d.51-75%
- e.76-100% *

3. How many vertical levels separate the chief executive from those employees working on output in the deepest single division?

- a.1 or 2
- b.3 to 5

- c.6 to 8
- d.9 to 12 *
- e.more than 12

4. What is the mean number of levels for the organization as a whole?

- a.1 or 2
- b.3 to 5 *
- c.6 to 8
- d.9 to 12
- e.more than 12

5. What is the number of separate geographic locations where organization members are employed?

- a.1 or 2
- b.3 to 5
- c.6 to 15 *
- d.16 to 30
- e.more than 30

6. What is the average distance of these separate units from the organization's headquarters?

- a. less than 10 miles
- b. 11 to 100 miles *
- c. 101 to 500 miles
- d. 501 to 3500 miles
- e. more than 3500 miles

7. What proportion of the organization's total work force is located at these separate units?

- a. less than 10%
- b. 11 to 25%
- c. 26 to 60% *
- d. 61 to 90 %
- e. more than 90%

The complexity score is 23. This project would be considered of relative high complexity.

Formalization Questionnaire Responses

Circle your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all seven items. The sum of the item scores is the degree of formalization (out of a possible 35). Formalization indicates the degree to which jobs within the organization are standardized. Scores under 18 represent relatively low formalization, scores above 25 indicate relatively high formalization, and scores of 18 to 25 show relative moderate formalization.

1. Written job descriptions are available for
 - a.operative employees only
 - b.operative employees and first-line supervisors only
 - c.operative, first-line supervisory, and middle management personnel
 - d.operative, first-line supervisory, middle and upper-middle management personnel
 - e.all employees, including senior management *

2. Where written job descriptions exist, how closely are employees supervised to ensure compliance with standards set in the job description?

- a.very loose
- b.loose
- c.moderately close *
- d.close
- e.very close

3. How much latitude are employees allowed from the standards?

- a.a great deal
- b.a large amount
- c.a moderate amount
- d.very little *
- e.none

4. What percentage of nonmanagerial employees is given written operating instructions or procedures for their jobs?

- a.0-20%

- b.21-40%
- c.41-60%
- d.61-80%
- e.81-100% *

5. Of those nonmanagerial employees given written instructions or procedures, to what extent are they followed?

- a.none
- b.little
- c.some
- d.a great deal
- e.a very great deal *

6. To what extent are supervisors and middle managers free from rules, procedures, and policies when they make decisions?

- a.a very great deal
- b.a great deal
- c.some
- d.little
- e.none *

7. What percentage of all rules and procedures that exist within the organization are in writing?

- a.1-20%
- b.21-40%
- c.41-60%
- d.61-80%
- e.81-100% *

The formalization score is 32, which indicates a relatively high formalization.

Centralization Questionnaire Responses

Indicate (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all ten items. The sum of the item scores is the degree of centralization (out of possible 50). Centralization indicates the degree to which formal authority to make discretionary choices, is concentrated in an individual, unit or level. Approximate guides for translating scores into categories are as

follows: 40 points and above represents high centralization, 21 to 39 is moderate, and 20 or less indicates low centralization (or decentralization).

1. How much direct involvement does top management have in gathering the information they will use in making decisions?

- a.none
- b.little
- c.some *
- d.a great deal
- e.a very great deal

2. To what degree does top management participate in the interpretation of the information input?

- a.0-20%
- b.21-40% *
- c.41-60%
- d.61-80%
- e.81-100%

3. To what degree does top management directly control execution of the decision?

a.0-20%

b.21-40%

c.41-60% *

d.61-80%

e.81-100%

4. How much discretion does the typical first-line supervisor have over establishing his or her unit's budget?

a.very great

b.great *

c.some

d.little

e.none

5. How much discretion does the typical first line supervisor have over determining how his or her unit's performance will be evaluated?

a.very great

b.great *

c.some

d.little

e.none

6. How much discretion does the typical first line supervisor have over hiring and firing personnel?

a.very great

b.great

c.some *

d.little

e.none

7. How much discretion does the typical first-line supervisor have over personnel rewards (i.e., salary increases, promotions)?

a.very great

b.great

c.some

d.little *

e.none

8. How much discretion does the typical first-line supervisor have over purchasing of equipment and supplies?

a.very great

b.great

c.some *

d.little

e.none

9. How much discretion does the typical first-line supervisor have over establishing a new project or program?

a.very great

b.great

c.some

d.little *

e.none

10. How much discretion does the typical first-line supervisor have over how work exceptions are to be handled?

a.very great

b.great

c.some *

d.little

e.none

Centralization score is 29, which would indicate a relative moderate to low centralization.

In summary, Project D has a relative high complexity (23), high formalization (32) and moderate centralization (29).

IV. PROJECT D: IT QUESTIONNAIRE RESPONSES
(DOCUMENTARY INFORMATION).

Please respond to each of the following items, check (*) all that apply.

1. Which type of construction does your company perform?

a.residential *

b.commercial *

c.industrial *

d.heavy highway

e.other

2. Would the company be classified as a:

a.general contractor *

b.design build firm

c.construction manager *

d.specialty contractor

e.other

3. What is your job title? Vice President

4. What is the gross dollar volume per year for the company? Over \$ 2 billion.

5. Does the company have Internet access?

a.yes * b. no

6. If yes, do you use the Internet for work-related purposes?

a.yes * b. no

7. If yes, what information do you inquire about over the Internet?

(Check all that apply.)

a.product information *

b.contractor information *

c.subcontractor information

d.architect information

e.owner information

f.company information *

g.project information *

h.other

8. Do you use the Internet for project communication?

a. yes b. no *

9. If yes, please check all that apply:

a.to record job cost reports

b.to record daily reports

c.logging time cards

d.other

10. Does the company have its own Intranet?

a.yes * b. no

11. Do you use the Intranet for work-related purposes?

a.yes * b. no

12. If yes, what information do you inquire about over the Intranet?

a.company policies *

b.cost control reports

c.client information *

d.employee information

e.company newsletter

f.other

13. Do you use the Intranet for project communication?

- a.to record job cost reports *
- b.to record daily reports *
- c.logging time cards
- d.other

14. Does the company have access to email?

- a. yes *
- b. no

15. If yes, do you use email for project related purposes?

- a. Yes *
- b. no

16. If yes, what information do you receive or send via email?

- a.product information *
- b.contractor information *
- c.subcontractor information *
- d.architect information *
- e.owner information *
- f.company information *
- g.project information *
- h.other

17. With whom do you communicate by email?

a.to branch offices

b.to corporate office *

c.to contractors

d.to subcontractors

e.to coworkers *

f.other

18. Does the company provide training for using IT?

a.yes * b. no

19. If no, how do you learn to use it?

a.self-taught

b.attend training course(s)

c.other

20. Does the company have a web site? a. yes * b. no

21. If yes, what information is listed on the company web site?

- a. company history *
- b. company newsletter
- c. company information *
- d. company contact name *
- e. present project information *
- f. past project information *
- g. employment opportunities *
- h. other

22. What electronic links with other offices or consultants (members of the project team) does the project have?

- a. fax *
- b. email *
- c. e-collaboration
- d. other(s)

23. Is the company project(s) using any of the following web-based project management system software in this project?

- a.E-builder
- b.Expedition with Webster
- c.Prolog Manager
- d.Constructware
- e.other
- f.none *

24. If using web-based project management software what is the dollar volume and duration (months) of the project? N/A

25. Does your company use project webpages? a.yes b. no *

26. If yes, what information is listed on the project webpage?

- a.contacts
- b.CAD files
- c.site photographs
- d.scanned photographs
- e.reports
- f.transmittals
- g.other types of documents

27. Does this project have a webpage?

a. yes b. no *

28. If yes, what is the dollar volume and duration of the project (months)?

APPENDIX E: PROJECT E

I. PROJECT E: CASE STUDY NARRATIVE

The project is a new hospital at the Virginia Hospital Center in Arlington. The Arlington County Government is the owner of the project. The Program Manager (PM) for the project is a major international general contracting firm. The firm regional base is in Washington D.C.

The Program Manager serves as the single point of contact to the owner to coordinate and manage the various other parties involved in planning, design, procurement and construction. This differs from the professional construction management, who is but one of two or three parties reporting more directly to the owner, and the owner is usually more closely a part of the team. The firm offers program management consulting for capital projects and comprehensive services including managing and coordinating all design procurement and construction activities. At the construction management level, it provides all technical and administrative management services from initial bid stage through the certificate of occupancy and final closeout. The firm relies on good management, a thorough understanding of the market sectors

and the ability to procure the best contractors and suppliers while managing the cost and quality objectives.

The project is located on the existing campus, formerly known as Arlington Hospital, situated on North George Mason Drive in Arlington, Virginia. Established in 1944, the hospital serves the greater northern Virginia community. The medical staff is more than 700. The hospital center is also a teaching hospital affiliated with Georgetown University's School of Medicine.

This \$ 100 million program management project, involves 67,000 SF of demolition, 436,000 SF of new construction and 94,000 SF of interior renovations. The demolition removed the oldest and least functional buildings on the campus and provided the space necessary for new construction adjacent to the hospital. Upon completion, the hospital will have nine levels. The first three levels of the addition will contain functions such as emergency imaging, outpatient services, surgery and critical care. The next two levels will contain medical office space and the top four levels will contain inpatient-nursing units. The new facility will be connected to the existing hospital at the ground level, first and second floors.

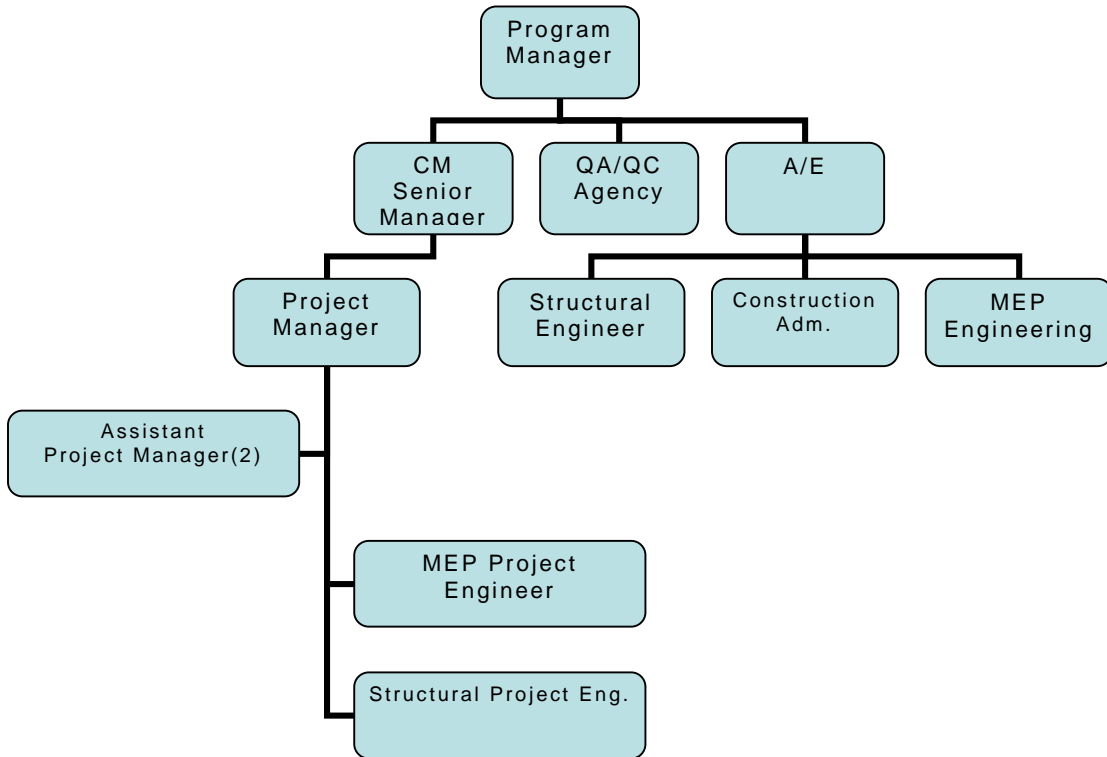


Figure E.1 Project E Organization Chart

A new garage, having 1,080 spaces, will be connected to the existing medical office building parking garage at two levels. Subsequent to the new construction, there will be renovations within the existing hospital. These renovations will occur following occupancy of the new hospital. Construction began in July 2001 and the expected completion is November 2004.

The firm is ranked 8th in the Engineering News-Record's Top 400 contractors with a total revenue volume of 3,745 millions and new contracts totaling \$3,856.8 millions (ENR, 2003).

II. PROJECT E: CASE STUDY REPORT (1-UNIT GROUPING, 2-UNIT SIZE, 3-LIAISON DEVICES, 4-PLANNING AND CONTROL SYSTEMS, 5-DECISION-MAKING SYSTEM AND 6-DESIGN OF POSITIONS).

1-Unit Grouping

The PM uses a combination of bases to group positions into units and units into larger ones. At the company level the main groupings

are of a market bases, i.e. regions, areas, projects. At the project level is mainly functional.

The PM uses IT to create collaborative team groupings with the A/E and CM located in Nashville, Tennessee. They communicate through the Internet and conference calling.

2-Unit Size

The total PM/CM personnel assigned to the project are twelve. They include senior managers, project managers, project engineers, office administrators, superintendents and field engineers.

The span of control of the PM consists of three sub-units: the A/E; the QA/QC Agency and the CM. There are three levels in the management hierarchy.

Electronic linking has not had a significant impact on the unit size, nor technological leveling caused a reduction on the layers of management.

3-Liaison Devices

As far as the continuum of liaison devices, from liaison positions through coordinating meetings to integrating managers, the Program Manager is the key integrating manager and coordinating meetings the conventional liaison devices used for coordination.

Weekly staff meetings dealing with design and construction issues, such as scheduling, submittals, etc. and subcontractor meetings dealing mainly with coordination of tasks and procurement issues.

The project uses electronic linking/communications as coordinating devices. E-mail is used for coordination of RFIs and submittal documentation. The Program Manager uses video/teleconferencing with companies out of Nashville.

Technological matrixing, using electronic linking communications to create matrix organizations, was not used.

4-Planning and Control Systems

The project used performance planning and control, as well as, detailed action planning and control systems for coordination.

As far as the usage extent of IT, the company has an intranet, at the project level it uses Prolog ® in combination with Excel ® to control budgets and Suretrack ® and Primavera ® for scheduling and project management.

Budget controls are linked to the accounting software. The company uses JD Edwards's AS400 ®. It tracks salaries, trade contract payments, reimbursables, etc.

5-Decision-Making System

The project uses selective/limited vertical and horizontal decentralization. In the vertical dimensions, administrative decisions are delegated at various levels. In the horizontal dimensions technical decisions are delegated depending upon the level of expertise required. IT has provided employees with easier access to information, enabling to make decisions at their level. In this sense, IT has had an impact on the decentralization of decision-making.

6-Design of Positions

Personnel in this project deal with a broader scope of issues and have more administrative control. Therefore, specialization tends to be low.

IT has had an impact on both horizontal and vertical job enlargement and in the integration of information.

Jobs are formalized by job descriptions. IT has impacted formalization from the viewpoint of all employees having access job description information on-line.

Background and training in the areas of CM, civil engineering and related fields are standard requirements. IT has had an impact on jobs with the accessibility and availability of on-line training.

III. PROJECT E: MEASURES OF ORGANIZATION STRUCTURE (1-COMPLEXITY, 2-FORMALIZATION & 3-CENTRALIZATION).

Complexity Questionnaire Responses

Indicate (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2,

c=3, d=4, e=5. Add up the score for all seven items. The sum of the item scores is the degree of complexity (out of a possible 35). Complexity is defined by the degree of horizontal, vertical and spatial differentiation. Scores under 15 represent relatively low complexity, scores above 22, indicate relatively high complexity and scores of 15 to 22 make up the moderate range.

1. How many different job titles are there?

- a.very few
- b.small number
- c.moderate number *
- d.large number
- e.great number

2. What proportion of employees hold advanced degrees or have many years of specialized training?

- a.0-10%
- b.11-20%
- c.21-50%
- d.51-75% *

e.76-100%

3. How many vertical levels separate the chief executive from those employees working on output in the deepest single division?

a.1 or 2

b.3 to 5

c.6 to 8 *

d.9 to 12

e.more than 12

4. What is the mean number of levels for the organization as a whole?

a.1 or 2

b.3 to 5

c.6 to 8

d.9 to 12 *

e.more than 12

5. What is the number of separate geographic locations where organization members are employed?

- a.1 or 2
- b.3 to 5
- c.6 to 15
- d.16 to 30
- e.more than 30 *

6. What is the average distance of these separate units from the organization's headquarters?

- a.less than 10 miles
- b.11 to 100 miles
- c.101 to 500 miles
- d.501 to 3500 miles
- e.more than 3500 miles *

7. What proportion of the organization's total work force are located at these separate units?

- a.less than 10%
- b.11 to 25%
- c.26 to 60%
- d.61 to 90 % *

e.more than 90%

The complexity score is 28. This project would be considered of relative high complexity.

Formalization Questionnaire Responses

Indicate with a (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all seven items. The sum of the item scores is the degree of formalization (out of a possible 35). Formalization indicates the degree to which jobs within the organization are standardized. Scores under 18 represent relatively low formalization, scores above 25 indicate relatively high formalization, and scores of 18 to 25 show relative moderate formalization.

1. Written job descriptions are available for

a.operative employees only

b.operative employees and first-line supervisors only

c.operative, first-line supervisory, and middle management personnel

d.operative, first-line supervisory, middle and upper-middle management personnel

e.all employees, including senior management *

2. Where written job descriptions exist, how closely are employees supervised to ensure compliance with standards set in the job description?

a.very loose

b.loose

c.moderately close

d.close *

e.very close

3. How much latitude are employees allowed from the standards?

a.a great deal

b.a large amount

c.a moderate amount *

d.very little

e.none

4. What percentage of nonmanagerial employees is given written operating instructions or procedures for their jobs?

a.0-20%

b.21-40% *

c.41-60%

d.61-80%

e.81-100%

5. Of those nonmanagerial employees given written instructions or procedures, to what extent are they followed?

a.none

b.little

c.some

d.a great deal *

e.a very great deal

6. To what extent are supervisors and middle managers free from rules, procedures, and policies when they make decisions?

a.a very great deal

b.a great deal

c.some *

d.little

e.none

7. What percentage of all rules and procedures that exist within the organization are in writing?

a.1-20%

b.21-40%

c.41-60%

d.61-80%

e.81-100% *

The formalization score is 26, which indicates a relatively high formalization.

Centralization Questionnaire Responses

Indicate (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all ten items. The sum of the item

scores is the degree of centralization (out of possible 50). Centralization indicates the degree to which formal authority to make discretionary choices, is concentrated in an individual, unit or level. Approximate guides for translating scores into categories are as follows: 40 points and above represents high centralization, 21 to 39 is moderate, and 20 or less indicates low centralization (or decentralization).

1. How much direct involvement does top management have in gathering the information they will use in making decisions?

- a.none
- b.little
- c.some
- d.a great deal *
- e.a very great deal

2. To what degree does top management participate in the interpretation of the information input?

- a.0-20%
- b.21-40%

c.41-60% *

d.61-80%

e.81-100%

3. To what degree does top management directly control execution of the decision?

a.0-20%

b.21-40%

c.41-60% *

d.61-80%

e.81-100%

4. How much discretion does the typical first-line supervisor have over establishing his or her unit's budget?

a.very great

b.great *

c.some

d.little

e.none

5. How much discretion does the typical first line supervisor have over determining how his or her unit's performance will be evaluated?

a.very great

b.great

c.some *

d.little

e.none

6. How much discretion does the typical first line supervisor have over hiring and firing personnel?

a.very great

b.great *

c.some

d.little

e.none

7. How much discretion does the typical first-line supervisor have over personnel rewards (i.e., salary increases, promotions)?

a.very great

- b.great
- c.some *
- d.little
- e.none

8. How much discretion does the typical first-line supervisor have over purchasing of equipment and supplies?

- a.very great *
- b.great
- c.some
- d.little
- e.none

9. How much discretion does the typical first-line supervisor have over establishing a new project or program?

- a.very great
- b.great
- c.some *
- d.little
- e.none

10. How much discretion does the typical first-line supervisor have over how work exceptions are to be handled?

a.very great

b.great *

c.some

d.little

e.none

The centralization score is 26, which would indicate a relative moderate centralization.

In summary, Project E has a relative high complexity (28), high formalization (26) and moderate centralization (26).

IV. PROJECT E: IT QUESTIONNAIRE RESPONSES

(DOCUMENTARY INFORMATION).

Please respond to each of the following items, check (*) all that apply.

1. Which type of construction does your company perform?

- a.residential
- b.commercial *
- c.industrial *
- d.heavy highway
- e.other

2. Would the company be classified as a:

- a.general contractor *
- b.design build firm
- c.construction manager *
- d.specialty contractor
- e.other

3. What is your job title? Program Manager

4. What is the gross dollar volume per year for the company? About \$3 billion.

5. Does the company have Internet access?

- a.Yes *
- b. no

6. If yes, do you use the Internet for work-related purposes?

a.yes * b. no

7. If yes, what information do you inquire about over the Internet?

(Check all that apply.)

a.product information *

b.contractor information *

c.subcontractor information *

d.architect information *

e.owner information *

f.company information *

g.project information *

h.other

8. Do you use the Internet for project communication?

a. yes * b. no

9. If yes, please check all that apply:

- a.to record job cost reports
- b.to record daily reports *
- c.logging time cards
- d.other

10. Does the company have its own Intranet?

- a.yes *
- b. no

11. Do you use the Intranet for work-related purposes?

- a.yes *
- b. no

12. If yes, what information do you inquire about over the Intranet?

- a.company policies
- b.cost control reports *
- c.client information
- d.employee information *
- e.company newsletter *
- f.other

13. Do you use the Intranet for project communication?

a.to record job cost reports

b.to record daily reports *

c.logging time cards

d.other

14. Does the company have access to email?

a. yes * b. no

15. If yes, do you use email for project related purposes?

a.yes * b. no

16. If yes, what information do you receive or send via email?

a.product information

b.contractor information

c.subcontractor information *

d.architect information *

e.owner information

f.company information *

g.project information *

h.other

17. With whom do you communicate by email?

a.to branch offices *

b.to corporate office *

c.to contractors *

d.to subcontractors *

e.to coworkers *

f.other

18. Does the company provide training for using IT?

a.yes * b. no

19. If no, how do you learn to use it?

a.self-taught

b.attend training course(s)

c.other

20. Does the company have a web site? a. yes * b. no

21. If yes, what information is listed on the company web site?

a. company history *

b. company newsletter *

c. company information *

d. company contact name *

e. present project information

f. past project information

g. employment opportunities *

h. other

22. What electronic links with other offices or consultants (members of the project team) does the project have?

a. fax *

b. email *

c. e-collaboration

d. other(s)

23. Is the company project(s) using any of the following web-based project management system software?

- a.E-builder
- b.Expedition with Webster
- c.Prolog Manager *
- d.Constructware
- e.other
- f.none

24. If using web-based project management software in this project, what is the dollar volume and duration (months) of the project?

25. Does your company use project webpages? a.yes b.no *

26. If yes, what information is listed on the project webpage?

- a.contacts
- b.CAD files
- c.site photographs
- d.scanned photographs
- e.reports

f.transmittals

g.other types of documents

27. Does this project have a webpage?

a. yes b. no *

28. If yes, what is the dollar volume and duration of the project
(months)? \$

APPENDIX F: CASE STUDY QUESTIONS

(1-UNIT GROUPING, 2-UNIT SIZE, 3-LIAISON DEVICES, 4-PLANNING AND CONTROL SYSTEMS, 5-DECISION-MAKING SYSTEM, 6-DESIGN OF POSITIONS)

1-Unit Grouping

On what basis or combination of bases does the project organization group positions into units and units into large ones? (project organization chart)

Market basis (products, clients, region, area)

Functional basis (function, knowledge/skill, work process)

Are there virtual components in the project organization structure? If so, explain.

2-Unit Size

What is the total number of project personnel assigned to the project?

How many sub-units (span of control) is the project manager heading?

How many levels are there in the hierarchy?

Has IT, through electronic linking, impacted the unit size in the project organization? If so, how? (increased, decreased or N/A)

Has IT, through the IT-enabled variable of technological_leveling, caused a reduction of the management levels resulting in a flatter project organization structure? How much of a reduction? Explain.

3-Liaison Devices

(Continuum of liaison devices, from liaison positions through coordinating meetings to integrating managers)

Are there liaison positions for coordination? Elaborate.

Are there regular coordinating meetings? (staff, client/management, etc)? Elaborate.

Are there integrating area managers? Matrix managers? Project managers? Elaborate, if there are.

Are there electronic liaison devices (electronic linking) (e-mail, fax, video-conferencing web-based...) as means of coordination?

Is technological matrixing (matrix grouping using IT for dual reporting via e-mail and groupware) used?

4-Planning and Control Systems

Explain the kinds of action planning and performance control system the project uses. (a) performance control monitoring (i.e. budget standards, milestones, earned value); (b) detailed action planning/scheduling system monitoring.

What is the usage extent of IT project management control systems for planning and control means of coordination on the project organization? Elaborate on the project management software used.

5- Decision-Making System

Concerning key decisions: financial (budget) decisions; technical (design) decisions; operational decisions). What decisions are delegated (vertically decentralized) down the chain of authority? How far down the chain are they delegated (vertically decentralized)? Has IT contributed to vertically decentralize decision-making? To what extent, staff personnel control decision-making (horizontal decentralization)? Has IT played a role on the horizontal decentralization of decision-making?

6-Design of Positions

How specialized (high, moderate, low) are the positions in the project organization? How has IT impacted job specialization?

To what extent (high, moderate or low) is the degree of behavior formalization? How has IT impacted behavior formalization?

What are the training and experience requirements for construction project management personnel? How has IT impacted training and experience requirements?

APPENDIX G: ROBBINS' MEASURES OF ORGANIZATION STRUCTURE

(1-COMPLEXITY, 2-FORMALIZATION & 3-CENTRALIZATION)

1-Complexity Questionnaire

Indicate (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all seven items. The sum of the item scores is the degree of complexity (out of a possible 35). Complexity is defined by the degree of horizontal, vertical and spatial differentiation. Scores under 15 represent relatively low complexity, scores above 22 indicate relatively high complexity and scores of 15 to 22 make up the moderate range.

1. How many different job titles are there?

- a.very few
- b.small number
- c.moderate number

d.large number

e.great number

2. What proportion of employees hold advanced degrees or have many years of specialized training?

a.0-10%

b.11-20%

c.21-50%

d.51-75%

e.76-100%

3. How many vertical levels separate the chief executive from those employees working on output in the deepest single division?

a.1 or 2

b.3 to 5

c.6 to 8

d.9 to 12

e.more than 12

4. What is the mean number of levels for the organization as a whole?

- a.1 or 2
- b.3 to 5
- c.6 to 8
- d.9 to 12
- e.more than 12

5. What is the number of separate geographic locations where organization members are employed?

- a.1 or 2
- b.3 to 5
- c.6 to 15
- d.16 to 30
- e.more than 30

6. What is the average distance of these separate units from the organization's headquarters?

- a.less than 10 miles
- b.11 to 100 miles
- c.101 to 500 miles

d.501 to 3500 miles

e.more than 3500 miles

7. What proportion of the organization's total work force is located at these separate units?

a.less than 10%

b.11 to 25%

c.26 to 60%

d.61 to 90 %

e.more than 90%

2-Formalization Questionnaire

Indicate with a (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all seven items. The sum of the item scores is the degree of formalization (out of a possible 35).

Formalization indicates the degree to which jobs within the organization are standardized. Scores under 18 represent relatively low formalization, scores above 25 indicate relatively high formalization, and scores of 18 to 25 show relative moderate formalization.

1. Written job descriptions are available for
 - a. operative employees only
 - b. operative employees and first-line supervisors only
 - c. operative, first-line supervisory, and middle management personnel
 - d. operative, first-line supervisory, middle and upper-middle management personnel
 - e. all employees, including senior management

2. Where written job descriptions exist, how closely are employees supervised to ensure compliance with standards set in the job description?
 - a. very loose
 - b. loose
 - c. moderately loose
 - d. close
 - e. very close

3. How much latitude are employees allowed from the standards?

- a. a great deal
- b. a large amount
- c. a moderate amount
- d. very little
- e. none

4. What percentage of non-managerial employees is given written operating instructions or procedures for their jobs?

- a. 0-20%
- b. 21-40%
- c. 41-60%
- d. 61-80%
- e. 81-100%

5. Of those nonmanagerial employees given written instructions or procedures, to what extent are they followed?

- a. none
- b. little
- c. some

- d. a great deal
- e. a very great deal

6. To what extent are supervisors and middle managers free from rules, procedures, and policies when they make decisions?

- a. a very great deal
- b. a great deal
- c. some
- d. little
- e. none

7. What percentage of all rules and procedures that exist within the organization are in writing?

- a. 1-20%
- b. 21-40%
- c. 41-60%
- d. 61-80%
- e. 81-100%

3-Centralization Questionnaire

Indicate with a (*) your response to each of the following items as they apply to the organization in question. Scoring for all items: a=1, b=2, c=3, d=4, e=5. Add up the score for all ten items. The sum of the item scores is the degree of centralization (out of possible 50). Centralization indicates the degree to which formal authority to make discretionary choices, is concentrated in an individual, unit or level. Approximate guides for translating scores into categories are as follows: 40 points and above represents high centralization, 21 to 39 is moderate, and 20 or less indicates low centralization (or decentralization).

1. How much direct involvement does top management have in gathering the information they will use in making decisions?

- a. none
- b. little
- c. some
- d. a great deal
- e. a very great deal

2. To what degree does top management participate in the interpretation of the information input?

- a. 0-20%
- b. 21-40%
- c. 41-60%
- d. 61-80%
- e. 81-100%

3. To what degree does top management directly control execution of the decision?

- a. 0-20%
- b. 21-40%
- c. 41-60%
- d. 61-80%
- e. 81-100%

4. How much discretion does the typical first-line supervisor have over establishing his or her unit's budget?

- a. very great

- b. great
- c. some
- d. little
- e. none

5. How much discretion does the typical first-line supervisor have over determining how his or her unit's performance will be evaluated?

- a.very great
- b.great
- c.some
- d.little
- e.none

6. How much discretion does the typical first-line supervisor have over hiring and firing personnel?

- a.very great
- b.great
- c.some
- d.little
- e.none

7. How much discretion does the typical first-line supervisor have over personnel rewards (i.e., salary increases, promotions)?

a.very great

b.great

c.some

d.little

e.none

8. How much discretion does the typical first-line supervisor have over purchasing of equipment and supplies?

a.very great

b.great

c.some

d.little

e.none

9. How much discretion does the typical first-line supervisor have over establishing a new project or program?

a.very great

b.great

c.some

d.little

e.none

10. How much discretion does the typical first-line supervisor have over how work exceptions are to be handled?

a.very great

b.great

c.some

d.little

e.none

Note: Adapted from Robbins, 1987. Organization Theory: Structure, Design, and Applications. Appendix B on Measures of Organization Structure. Prentice-Hall, Inc.

APPENDIX H: IT QUESTIONNAIRE

Check (*) all that apply:

1. Which type of construction does your company perform? (Please check all that apply.)

- a. residential
- b. commercial
- c. industrial
- d. heavy highway
- e. other (please specify)

2. Would the company be classified as a: (Please check all that apply.)

- a. general contractor
- b. design build firm
- c. construction manager
- d. specialty contractor (please specify)
- e. other (please specify)

3. What is your job title?

4. What is the gross dollar volume per year for the company?

5. Does the company have Internet access?

a. yes

b. no

6. If yes, do you use the Internet for work-related purposes?

a. yes

b. no

7. If yes, what information do you inquire about over the Internet?

(Check all that apply.)

a. product information

b. contractor information

c. subcontractor information

d. architect information

e. owner information

f. company information

g. project information

h. other (please specify)

8. Do you use the Internet for project communication?

a. yes b. no

9. If yes, please check all that apply:

a. to record job cost reports

b. to record daily reports

c. logging time cards

d. other, please specify

10. Does the company have its own internal intranet?

a. yes

b. no

11. Do you use the intranet for work-related purposes?

a. yes

b. no

12. If yes, what information do you inquire about over the intranet?

- a. company policies
- b. cost control reports
- c. client information
- d. employee information
- e. company newsletter
- f. other (please specify)

13. Do you use the intranet for project communication? (Please check all that apply.)

- a. to record job cost reports
- b. to record daily reports
- c. logging time cards
- d. other (please specify)

14. Does the company have access to email?

- a. yes
- b. no

15. If yes, do you use email for project related purposes?

a. yes

b. no

16. If yes, what information do you receive or send via email? (Please check all that apply.)

a. product information

b. contractor information

c. subcontractor information

d. architect information

e. owner information

f. company information

g. project information

h. other (please specify)

17. With whom do you communicate by email? (Please check all that apply.)

a. to branch offices

b. to corporate office

- c. to contractors
- d. to subcontractors
- e. to coworkers
- f. other (please specify)

18. Does the company provide training for using IT?

- a. yes
- b. no

19. If no, how do you learn to use it? (Please check all that apply.)

- a. self-taught
- b. attend training course(s)
- c. other (please specify)

20. Does the company have a web site? a. yes b. no

21. If yes, what information is listed on the company web site?

(Please check all that apply.)

- a. company history

- b. company newsletter
- c. company information
- d. company contact name
- e. present project information
- f. past project information
- g. employment opportunities
- h. other (please specify)

22. What electronic links with other offices or consultants (members of the project team) does the project have? (Please check all that apply).

- a. fax
- b. email
- c. e-collaboration
- d. other(s) (please specify)

23. Is the company project(s) using any of the following web-based project management system software? (Please check all that apply.)

- a. E-builder ®
- b. Expedition with Webster ®
- c. Prolog Manager ®

- d. Constructware ®
- e. Other (Please specify)
- f. None

24. If using web-based project management software what is the dollar volume and duration (months) of the project?

25. Does your company use project web pages?

- a. yes
- b. no

26. If yes, what information is listed on the project web page? (Please check all that apply.)

- a. contacts
- b. CAD files
- c. site photographs
- d. scanned photographs
- e. reports
- f. transmittals
- g. other types of documents

27. Does this project have a web page?

a. yes b. no

28. If yes, what is the dollar volume and duration (months) of the project?

Note: Adapted from Orth, 2000. The Use of the Internet, Intranet, E-Mail, and Web-Based Project Management in the Construction Industry. Proceedings of the 36th Annual Conference of the Associated Schools of Construction.

GLOSSARY

Centralization: The degree to which formal authority to make discretionary choices is concentrated in an individual, unit, or level.

Complexity: The degree of horizontal, vertical and spatial differentiation in an organization.

Electronic linking/communications: Using electronic mail, electronic or video-conferencing, and fax messages, to form communication links within and across all organizational boundaries.

Formalization: The degree to which jobs within the organization are standardized.

Horizontal differentiation: The degree of differentiation among units based on the orientation of members, the nature of the tasks they perform, and their education and training.

Information Technology (IT): The acquisition, processing, storage and dissemination of vocal, pictorial, textual and numerical information by

means of computers and telecommunications. In this study, it refers to the use of the Internet, intranet, e-mail, fax and web-based systems.

Job enlargement: Horizontal expansion of a job by adding related tasks.

Job enrichment: Vertical expansion of a job by adding administrative control responsibilities.

Matrix: A structural design that assigns specialists from functional departments to work on one or more interdisciplinary teams that are led by project leaders.

Organization design: The construction and change of an organization's structure.

Organization structure: The structure of an organization can be defined simply as the sum total of the ways in which it divides its labor into distinct tasks and then achieves coordination among them.

Spatial differentiation: The degree to which the location of an organization's facilities and personnel are dispersed geographically.

Technological leveling: The action of IT substituting for layers of management. In some organizations, layers of management exist to look at, edit, and approve messages. With electronic communications, some of these layers can be eliminated.

Technological matrixing: Creating matrix organizational units through the use of electronic communications. For example a company could form a task force from different departmental functions and have participants report electronically to their departmental supervisors and the task force leader, forming a matrix organization based on technology.

Vertical differentiation: The number of hierarchical levels between top management and operatives.

Virtual component: An organizational unit component that appears to exist in a particular way but does not exist that way in reality. For example, a group of workers may appear from an organization chart to be co-located in a physical department, but each member may actually be in a different location, and work may be accomplished through electronic communications. A firm may have virtual components with suppliers, other partners, etc.

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