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## DETERMINANTS OF PROJECT SUCCESS

by

David Charles Murphy, D.B.A.

Bruce N. Baker, D.P.A.

Dalmar Fisher, D.B.A.

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## I. EXECUTIVE SUMMARY

### 1.1 Nature and Purpose

Previous studies in the area of project management have tended to focus on a few select variables; being concerned with single types of projects; and utilizing relatively small sample populations. The result of this is that the studies are fragmentary, many are redundant, and that while many particulars have been studied little has been done in the way of formulating a complete theory of project effectiveness.

In general, research methodologies may be selective, following the "other things being equal" philosophy, or wholistic, attempting to explain multi-dimensional phenomena. Utilizing the selective philosophy, statements have been made and theories constructed concerning project effectiveness. Following the contrary philosophy, a whole new set of questions arises. So treated, there is a paucity of truly wholistic theory, and the need for meaningful statements.

For such reasons, the objective of this study was not restricted to the investigation of selected variables, but designed to include as many variables as possible -- within reason -- which are important to project effectiveness. Specifically, the purpose of this study was to determine the interactions of numerous project characteristics with particular reference to project performance.

## 1.2 Methodology

To obtain the data necessary to fulfill this purpose, a detailed questionnaire was developed containing 206\* response items. The instrument was designed to include those variables which had been indicated by previous research as determinants of success; those suggested as determinants during interview and pretest stages; and those suggested by general management theory and research.

The instrument was directed to 3408 individuals who had had direct project management experience. The survey was restricted to a single, recently completed project in which the respondent had been directly involved.

The 646 usable responses represented a variety of industries (34% manufacturing, 22% construction, 17% government, and 27% services, transportation and others). The respondents themselves had been directly involved in the particular project they chose to describe in their questionnaire. Of the total sample, 50% had been the project manager, 31% had been in other positions on the project team, and another 10% had been the project manager's superior. About one-third of the projects were described as being public in nature, and the remaining two-thirds as being in the private sector. The types of contracts or agreements involved included cost plus fixed fee(32%), in-house work orders (28%), fixed price (21%), and fixed price with incentive (14%). The major activity or

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\*The instrument contained 177 items; the remaining 29 were derived from combinations of the reported data.

end product involved in the projects included construction (43%), hardware or equipment (22%), new processes or software (14%), and studies, services and tests (11%).

### 1.3 Analysis

To achieve the purpose of the study the data were analyzed in seven ways. These analyses were conducted in two major partitions: the first utilizing raw data, the second utilizing factored data. With the raw data, variance, correlation, and factor analysis techniques were used. One of the results of a factor analysis is a set of factor scores. With these factor scores, variance, correlation, regression, and path analysis techniques were used.

The various statistical analyses yield immediate conclusions regarding determinants of project success. More important, however, are conclusions based upon the analyses when considered collectively. When so considered, more general and more important conclusions can be formulated. In this chapter such conclusions are presented.

### 1.4 Complexity

A significant aspect of this study has been the large number of statistically significant relationships uncovered. Of the 206 individual questionnaire items, 82 were found to be correlated with success at the .001 level; 18 were significant at the .01 level; and an additional 16 were significant at the .05 level. While this does not, in and of itself, describe the extent to which the various items affect success, it does tell us that they are related to success in some way.

Utilizing the correlation coefficients as indicators of the strength of relationship, 15 items were found to strongly affect success, 34 tended to affect success, and 25 appeared to be associated with success.

In an attempt to simplify the data, factor analysis was utilized. Normally, factor analysis yields only a few underlying dimensions of the data being studied. In this analysis, however, 32 independent and significant factors were uncovered. Correlation analysis indicated that all but two were significantly related to success. Multiple regression illustrated the multi-variate nature of success and path analysis delineated the interactive nature of these factors as determinants of success.

Based on the number of significant relationships uncovered, it is concluded that:

Project Management is a complex mechanism containing numerous variables of significance to project success. There is no simple approach to insure project effectiveness. Many factors contribute to project success.

The most convincing direct proof of this conclusion was shown in the multiple regression analysis (Section 4.33), in which project success was treated as the dependent variable and all the other factors were treated as independent variables. This analysis showed that at least seven factors made significant, independent contributions to project success, clearly indicating that a successful project outcome is multiply caused, not simply caused.

The multiple regression revealed that, with rare excep-

tion, the determinants of project success were management factors, things which management had the potential ability to influence, such as Coordination and Relations, Adequacy of Project Structure and Control, Success Criteria Clarity and Concensus and (minimization of) Competitive and Budgetary Pressure. This suggests that less controllable factors such as legal-political difficulties, the on-going nature of the parent organization and the behavior of the client need not necessarily be fatal obstacles to the success of a well-managed project, nor are they factors which can, by their presence or absence, make a success of a poorly managed project. On most projects, then,

- a) the determinants of success are multiple in number, and
- b) many success determinants are factors which lie within the control of those who are managing the project.

### 1.5 Success and Failure

Given the numerous determinants of success identified, F-test analysis of variance was used to analyze the ways in which the determinants worked. It was found that the determinants could be classified into three groupings:

- 1) those which tend to cause failure;
- 2) those which tend to improve success; and
- 3) those which are linearly related -- that is, are
  - a) capable of either improving success or
  - b) contributing to failure.

The first two groupings suggest that the presence of negative determinants will tend to cause failure, but that their absence will not be sufficient conditions for success. Further, the presence of positive determinants are necessary conditions for success, but will not insure against failure.

This implies that there are four possible states of project management, only one of which will assure that the potential success of a project is realized. This is depicted in Figure 1.1.

Figure 1.1

## CONDITIONS FOR PROJECT SUCCESS

		POSITIVE DETERMINANTS	
		present	absent
NEGATIVE DETERMINANTS	absent	SUCCESS is most likely	neither success nor failure can be predicted
	present	neither success nor failure can be predicted	FAILURE is most likely

Given the above, it is concluded that:

To achieve the potential success of a project it is necessary to both  
 a) encourage positive determinants,  
 and simultaneously b) discourage negative determinants.

While this conclusion is not particularly startling it is nonetheless worthy of note. It becomes more meaningful when considered in terms of specifics drawn from the analysis of the data. For example, a high degree of team spirit on the project team, good coordination and rapport between the project team, the client and the parent organization and adequate administrative, social and technical skills on the part of the project manager are ingredients often assumed to be highly related to project success. The analysis shows, however, that while the absence of these ingredients predicts project failure, their presence insures only mediocrity, not success. Success on the other hand, requires avoidance of the failure factors, plus the building in of ingredients such as appropriate project team structure, adequate control procedures and a commitment to budgets, schedules and performance goals that is shared by the client, the project team and the parent organization. The situation is analogous to Frederick Hertzberg's discovery about worker performance, namely that certain factors, such as favorable working conditions lead to an absence of worker dissatisfaction, but other kinds of factors, such as opportunity for responsibility and achievement, are necessary to bring about positive worker motivation.<sup>1</sup> Our findings about the management of projects echo those of Hertzberg on the management of people. Both findings reveal the multi-dimensional nature of the management task: many

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<sup>1</sup>Frederick Hertzberg, "One More Time: How Do You Motivate Employees", Harvard Business Review, Jan-Feb, 1968.

positive determinants must be attained, but many negative determinants must simultaneously be avoided.

#### 1.6 Management Techniques

Clearly, it must be concluded that there is no simple way of insuring the success of a project. In practice, however, uni-variate approaches have been proposed. It was found, in this study, however, that whenever used, these often create more problems than they solve.

For example, it appears that the area of project management is overly-fond of PERT-CPM. The analysis (see Section 4.4), however, shows that PERT-CPM techniques contribute relatively little to success when compared to other determinants. In some cases, it was found that PERT-CPM techniques were over-used and over-detailed, creating excessive control and thus tending to detract from project effectiveness. In other cases, over-reliance on PERT-CPM occurred to the extent that other important considerations were being neglected, again detracting from potential success.

Another example concerns the increasing emphasis within the Department of Defense and within many corporations on the creation of elaborate and detailed reporting and control systems for managing efforts under their direction. The current analysis has revealed the importance of adequate structure and control systems, but has also shown that excessive systems clearly detract from success by causing excessive delays, red-tape, superficial reports, and in-

adequate information flows.

It can be seen from such examples that over-reliance and over-use of any single or restricted set of project management techniques may likely

- 1) create adverse conditions
- 2) cause negative determinants to be tolerated rather than reduced, and
- 3) cause neglect in creating the positive determinants necessary for achieving potential success.

It is therefore concluded that:

The usefulness of project management techniques lie in their judicious use. The limitations of techniques used must be recognized and considered. Appropriate techniques must be used in concert.

### 1.7 Project Management As A System

Section 4.4 of the analysis is concerned with the development of a path model depicting the interrelationships among factors as they contribute to project success. The model derived illustrates the complexity of the project management system and attempts to detail the conclusion of Section 1.4. While the model itself is a conclusion of sorts, it further implies considerations of a more general nature.

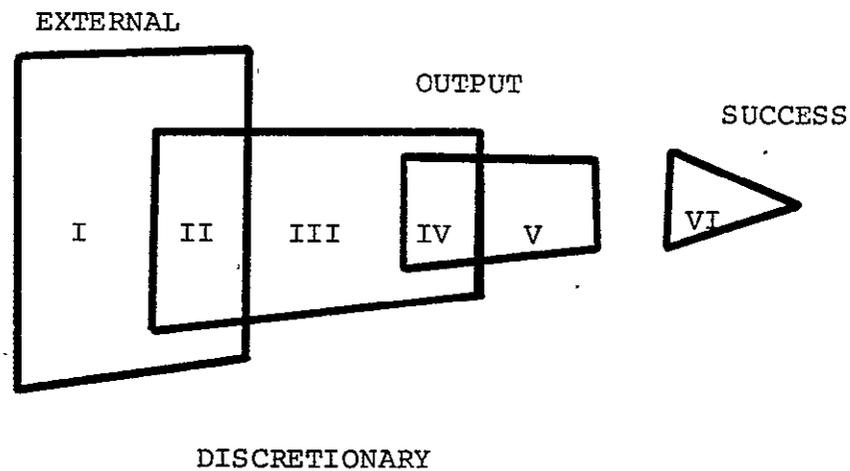
1.71 Projects have long been recognized as "systems," and have been managed by systems concepts. Indeed, systems management was formulated from the management of projects. However, the current analysis indicates that the process of project management is itself a system. It is felt important to note and to distinguish between the actual project and the management of the project in this regard. It is concluded that:

Project Management is itself a complex system, and only when so considered can optimal managerial techniques be developed and utilized effectively.

1.72 As developed in Section 4.4, the path analysis supports the contention that there are three general groupings of variables central to the success of projects: External, Discretionary, and Output. As these groupings are not mutually exclusive they form six categories of determinants:

- I. EXTERNAL factors are those over which there is little or no control; typically these describe pre-existent conditions.
- II. PROCESS/EXTERNAL factors are external or pre-determined to the specific project effort, but discretionary in the larger system.
- III. PROCESS factors are essentially discretionary -- specific to the effort.
- IV. OUTPUT/PROCESS factors represent both end-product and facilitating characteristics.

- V. OUTPUT factors are end-products of the specific project effort, they are consequent to the process.
- VI. The SUCCESS factor assesses the project output.



Considering the above, it is concluded that:

The factors affecting the success of projects include factors over which little or no management control is possible, discretionary factors which can be controlled either within the project effort itself or in the larger system, and end products which serve as the basis for the determination of degree of success.

1.73 In reviewing the nature of the factors included in the path model it is noted that the factors refer to three distinct time periods. Factors such as "Parent Size" and "Parent 5-Year Growth" occur prior to the commencement of a project. Such variables as "Initial Over-optimism" and "Buy-In Strategy" also refer to prior time frames. Factors such as "Start-up Difficulties" are determined at the commencement of the project. During the project such factors and variables as "Project Manager Authority and Influence" and "Control Techniques" are established.

Considering the time frames associated with the various factors and variables, it is concluded that:

Many determinants of success are established prior to the time period during which a project is conducted. As a result, the potential success of a project is partially established prior to its undertaking.

1.74 Throughout the analyses many variables were identified which were determined by agents external to the project team. Among these are factors determined by the client (eg., "Client Contact's Authority and Influence" and "Difficulty Coordinating With Client"); and those determined by the parent (eg., "Bureaucracy" and "Ease of Coordination").

Considering the parties involved with the determination of the various factors and variables, it is concluded that:

Many potentials for success or lack of success are partially established by parties external to the project team. As a result, the potential success of a project partially is established by agents external to the project team. The influence of the project manager and project team is therefore limited.

### 1.8 Contingency

The path diagram begins to provide insight into an area of knowledge about project management that is seriously underdeveloped: the management of projects under various conditions. Knowledge about the "contingency" management of projects would enable the practitioner to know the ways in which Project A, being conducted within a given environment, for a given type of client, under a given set of conditions, should be organized and managed differently from Project B, being conducted within a different environment, for a different type of client, under a different set of conditions.

What aspects of management need to be stressed under one set of project conditions, and what different aspects need to be emphasized under another set of conditions? The answers to this question are not yet available. Indeed, to our knowledge, no researcher or practitioner has yet identified and classified what the importantly different kinds of conditions are. While not complete or comprehensive, the path analysis begins to identify some of the important contin-

gencies and, in general ways, what kinds of management response would be appropriate under each.

For example, an adverse "Legal Political Environment", one of the "external" factors in the path analysis, has a strongly negative effect on project success. However, the path diagram shows that legal-political difficulties affect success not directly, but rather indirectly, through their strong determining effect on such factors as "Public Relations Environment", "Initial Over-optimism", "Buy-in Strategy" and (lack of) "Clearly Established Success Criteria". Given a condition of legal-political difficulties, then, the practitioner is well-advised to place special emphasis on establishing and maintaining an effective public relations program, on avoidance, if possible, of the "buy-in" negotiating strategy, on the avoidance of over-optimism and on the establishment of measurable, unambiguous success criteria.

For another example, initial over-optimism tends to inhibit project success through its adverse effects on coordination with the client, internal coordination, inadequate structure and control and lack of project team participation. These affected areas, then, would require special attention and emphasis, given a project which had been contracted, budgeted and scheduled over-optimistically at the outset.

As a final example, the path diagram indicates that a project manager who finds it necessary to operate without clearly established success criteria would seem to be well-

advised to locate himself in close physical proximity to the project site, attempt to obtain and maintain a high degree of authority and influence and to make effective use of control techniques.

While more complete knowledge about the contingency management of projects is possible and is needed, it can be concluded from the present study that:

Adverse environmental or "given" conditions do not affect project success directly, but may be seen as affecting success through their influence on other intervening conditions and management processes. An adverse environmental or given condition can therefore be avoided or overcome through astute identification of those factors which it does tend to affect directly, and through effective management action on those factors.

#### 1.9 Determinants of Success

As explained in Section 3.5, various analyses were conducted, each for differing reasons. To ascertain those variables most critical to the success of projects it was necessary to consider the separate analyses simultaneously to form such conclusions.

It is concluded that:

The major variables which affect the success of projects include:

### Project Manager

- o commitment to project goals
- o authority and influence
- o task orientation
- o administrative skill
- o human skill
- o technical skill
- o early and continued involvement
- o participation in goal setting and criteria specification

### Project Team

- o capabilities
- o commitment to goals
- o participation in
  - goal setting
  - setting budgets and schedules
  - major decision-making
  - problem solving
- o early and continued involvement
- o "sense of mission"
- o structural flexibility

### Parent Organization

- o coordinative efforts
- o structural flexibility
- o effective strategic planning
- o rapport maintenance
- o adaptability to change

- o past experience
- o external buffering
- o prompt and accurate communications
- o enthusiasm
- o project contributes to parent capabilities

#### Client Organization

- o coordinative efforts
- o rapport maintenance
- o establishment of reasonable and specific goals and criteria
- o change procedures
- o prompt and accurate communication
- o commitment
- o lack of red-tape
- o prompt decision-making
- o influence and authority of contact

#### Managerial Techniques

- o judicious, and adequate but not excessive use of planning, control, and communication systems.

#### Pre-Conditions

- o clearly established specifications and design
- o realistic schedules
- o realistic cost estimates
- o avoidance of buy-ins
- o avoidance of over-optimism

- o favorable interface with legal-political environment
- o conceptual clarity

#### 1.10 Implications

Based upon the previous conclusions it is apparent that the Client, Parent, and Project Organizations can influence the success of project efforts. The results of this study have specific implications for each of these organizations.

1.101 Client Organization -- To create positive determinants of success and to diminish negative determinants it is considered that the Client Organization and/or Principal Client Contact should:

- o Encourage openness and honesty from the start from all participants.
- o Create an atmosphere that encourages healthy, but not cut-throat, competition or "liars" contests.
- o Plan for adequate funding to complete the entire project.
- o Develop clear understandings of the relative importance of cost, schedule, and technical performance goals.
- o Seek to minimize direct public participation and involvement.
- o Develop short and informal lines of communication and flat organizational structures.
- o Delegate sufficient authority to the principal client contact and let him promptly approve or reject important project decisions.
- o Reject "buy-ins."
- o Make prompt decisions regarding contract award or go-ahead.

- o Develop close, but not meddling, working relationships with project participants.
- o Avoid arms-length relationships.
- o Avoid excessive reporting schemes.
- o Make prompt decisions regarding changes.

1.102 Parent Organization -- To create positive determinants of success and to diminish negative determinants it is considered that the Parent Organization and/or Principal Parent contact should:

- o Select, at an early point, a project manager with a proven track record of technical skills, human skills, and administrative skills (in that order) to lead the project team.
- o Develop clear and workable guidelines for the project manager.
- o Delegate sufficient authority to the project manager and let him make important decisions in conjunction with his key project team members.
- o Demonstrate enthusiasm for and commitment to the project and the project team.
- o Develop and maintain short and informal lines of communication with the project manager.
- o Avoid excessive pressure on the project manager to win the contract.
- o Avoid arbitrarily slashing or ballooning the project team's cost estimates.
- o Avoid "buy-ins."
- o Develop close, but not meddling, working relationships with the principal client contact and the project manager.

1.103 Project Organization -- To create positive determinants of success and to diminish negative determinants it is con-

sidered that the Project Manager and/or Project Team should:

- o Insist upon the right to select his own key project team members.
- o Select key project team members with proven track records in their area of expertise.
- o Develop commitment and a sense of mission from the outset among project team members.
- o Seek sufficient authority and a projectized form of organizational structure.
- o Coordinate frequently and constantly reinforce good relationships with the client, the parent, and the team.
- o Seek to enhance the public's image of the project.
- o Call upon key project team members to assist in decision-making and problem solving.
- o Develop realistic cost, schedule, and technical performance estimates and goals.
- o Develop back-up strategies and systems in anticipation of potential problems.
- o Develop an appropriate, yet flexible and flat, project team organization structure.
- o Seek to maximize influence over people and key decisions even though formal authority may not be sufficient.
- o Employ a workable and candid set of project planning and control tools.
- o Avoid pre-occupation with, or over-reliance upon, one type of project control tool.
- o Constantly stress the importance of meeting cost, schedule and technical performance goals.
- o Generally, give highest priority to achieving the technical performance mission or function to be performed by the project end-item.
- o Keep changes under control.
- o Seek to find ways of assuring the job security of effective project team members.

o Plan for an orderly phase-out of the project.

1.104 Future Research -- The primary purpose of this research was to investigate the determinants of project success in non-NASA projects. While many determinants of project mission success were identified, a somewhat unsettling finding was that effective cost performance was not uniformly associated with mission success. In fact, the data revealed that mission-successful projects more often than not show a cost overrun, often a very substantial one. Questionnaire data provided by respondents during the study (most of whom were project managers) showed, furthermore, that project success tends strongly to be defined as adequacy of technical performance and not as adequacy of cost performance. Factor analysis of the data revealed that technical performance and cost performance were independent factors, with only technical performance being strongly and positively related to overall project success.

Although the study covered a wide range of project types, ranging from construction projects to software development, the phenomenon uncovered, namely the low priority given to cost performance, is one of particular note for those managers who are becoming increasingly concerned about finding ways of improving cost performance without downgrading confidence in mission success.

While it tended to be true that cost overruns were

associated with mission-successful projects, this was not universally the case. The large existing data bank, containing quantified descriptions of more than 670 projects, includes many projects which were both mission-successful and cost-control effective. It appears reasonable, therefore, that future research be conducted to determine those organizational factors and managerial actions that differentiate projects which are both cost and mission effective from those that are not.

To further the understanding of factors leading to combined cost-mission effectiveness of project management, and to facilitate the transfer of this knowledge into improved practices, future research should be conducted with the following kinds of questions in mind:

1. What mix of organizational and management factors leads to mission success on projects where costs are effectively controlled? What is the relative importance of each of these factors and what important interrelationships exist between these factors?
2. What factors most commonly lead to cost overrun and upon what do these factors, in turn, depend? Which of these factors are most readily subject to management control? In what ways can the "givens" (relatively uncontrollable factors which tend to have adverse effects on costs) be dealt with effectively? What organization

designs and management strategies were employed on projects which did not show cost overruns despite adverse circumstances?

3. What are the differences in organizational and management profiles among projects which have each of the four outcome patterns, A, B, C and D shown below?

		Mission Success	
		High	Low
Cost Control	High	A	C
	Low	B	D

A comparison of outcome patterns A, B and C will be of particular importance to future research efforts since the aim would be to distinguish project management techniques which lead to combined cost and mission success from those which lead to mission success at the expense of cost overrun on the one hand, and cost performance at the expense of mission success on the other.

Research conducted by methods designed to answer the above questions and to reveal determinants and interrelationships which were not anticipated by the present analysis

will yield a revised model having direct policy and action implications for the management of both NASA and non-NASA programs and projects.

## II. PERSPECTIVES ON PROJECT MANAGEMENT

Recent literature in the field of project management includes the usual prescriptive articles, individual case experiences, and some research reports. Even the systematic research studies tend more often than not to be limited to studies of projects in particular industries or governmental agencies. Moreover, most project management research has ignored external environmental factors in searching for explanations of project success or failure. The present study has attempted to reach conclusions of more general value by including projects from a wide range of settings as well as by including an array of environmental variables.

### 2.1 Selected Variables Affecting Project Success

The present study owes much to those previous researches which, taken as a whole, indicate the large quantity and variety of variables which can affect project success. The multiplicity and wide ranging nature of the determinants of project success is shown clearly by the following examples of determinants identified by previous researches. For each example, the success determinant is listed in the left-hand column and a brief summary of the research is given in the right-hand column:

Type of Project Organization (for R&D work)	Projects in which administrative personnel report to the project manager are less likely to have cost or schedule overruns. <sup>1</sup>
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<sup>1</sup>Donald G. Marquis and David M. Straight, Organizational Factors in Project Performance, Washington, D. C.: National Aeronautics and Space Administration, July 25, 1965.

Type of Project Organization  
(for R&D work)

"...A hybrid form is the best possible option. Total project organizations or functional organizations are inferior to the compromise form in which there is a small project team and more than half of the technical personnel remain in their functional departments. Such an organization is more likely to achieve technical excellence, and, at the same time, to meet the cost and schedule deadlines."<sup>2</sup>

Combinations of  
Structure and Tools  
(for R&D work)

"A functional organization that does not use PERT and does a great deal of subcontracting is more likely to overrun its cost and schedule deadline. A project team which uses PERT and does very little subcontracting should have no trouble meeting its deadlines.

However, we also discovered that projects organized on a functional

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<sup>2</sup>Donald G. Marquis, "A Project Team & PERT = Success. Or Does It?" Innovation, Number Five, 1969, pp. 26-33.

basis produce better technical results. This would indicate that the best organization for R&D efforts is a basically functional structure, with a small project team that uses PERT or some other sophisticated planning technique."<sup>3</sup>

Additional work by Rubin and Seelig indicates that with respect to:

Competitive Environment  
(for R&D work)

"...Sole source projects achieve higher levels of technical performance than competitive projects."<sup>4</sup>

Priority Assigned  
(for R&D work)

"...The higher the level of (internal) priority the better the technical performance."<sup>5</sup>

Experience of  
Project Manager  
(for R&D work)

"...Level of experience has no direct effect on performance."<sup>6</sup>

Subcontracting  
(for R&D work)

"The more you subcontract, the

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<sup>3</sup>Ibid.

<sup>4</sup>Irwin M. Rubin and Wyckham Seelig, "Experience as a Factor in the Selection and Performance of Project Managers", IEEE Transactions in Engineering and Management, Vol. EM-14, No. 3, September, 1967.

<sup>5</sup>Ibid.

<sup>6</sup>Ibid.

lower the technical performance of the project. Contrary to our expectations, percent subcontract is unrelated to cost and schedule performance."<sup>7</sup>

Anthony found that with respect to:

Implementation of Controls  
(in industrial research  
organizations)

"There is no necessary relation between the type of control devices that are used and the degree of control that actually exists. The effectiveness of the device depends as much upon the way it is used as upon the device itself."<sup>8</sup>

Teamwork  
(unmanned NASA projects)

"Lunar Orbiter benefited from a strong sense of teamwork within both the customer and contractor organizations and in their relations with each other. Surveyor was handicapped by the lack of an equivalent sense of teamwork, particularly in the early years of the program. Senior management

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<sup>7</sup>Irwin Rubin, "Factors in the Performance of R and D Projects", 20th National Conference on the Administration of Research, Denver: Denver Research Institute, The University of Denver, p. 69.

<sup>8</sup>R. N. Anthony, Management Controls in Industrial Research Organizations, Boston: Harvard University Graduate School of Business Administration, 1952.

was committed to full support of the Lunar Orbiter project and was personally involved in overall direction as both the NASA field center and in the prime contractor's organization. There was far less support and involvement in the case of Surveyor."<sup>9</sup>

Maintaining Original Objectives (unmanned NASA projects)

"The Lunar Orbiter experience bears out the positive value of commitment throughout all organizations involved in a project to fulfilling objectives within a set time and specified resource limits. Lunar Orbiter managers were dedicated to building and flying the original hardware design while restricting change to the minimum. The Surveyor and Centaur experiences, conversely, illustrate that if you do not control change, you can expect schedule delays and cost escalation."<sup>10</sup>

<sup>9</sup>Erasmus H. Kloman, Unmanned Space Project Management - Surveyor and Lunar Orbiter, a Report Prepared by the National Academy of Public Administration and sponsored by the National Aeronautics and Space Administration, Washington, D. C.: U. S. Government Printing Office, 1972.

<sup>10</sup>Ibid.

Environment  
(unmanned NASA projects)

"From a management viewpoint, the greatest contrast between the Surveyor and Lunar Orbiter projects was the nature of the relationships of participating organizations, or what might be called the institutional environment. For Surveyor, there was an unusual degree of conflict and friction between Headquarters, JPL and the prime contractor. For Lunar Orbiter, harmony and teamwork prevailed. Institutions and people worked together in a spirit of mutual respect."<sup>11</sup>

Informal Relationships

"No formal arrangements can replace the dynamic system of personal and informal relations developed by key members of the project team to meet that project's particular needs."<sup>12</sup>

## 2.2 Limitations of Project Management Research

In addition to suggesting the diversity and multiplicity

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<sup>11</sup>Ibid.

<sup>12</sup>Richard L. Chapman, with the assistance of Robert H. Pontious and Lewis B. Barnes, Project and Program Management in NASA: The System and the Men, Washington, D. C.: National Academy of Public Administration, 1971.

of factors that influence project success, the foregoing examples indicate two important limitations of most project management research studies to date. First, in most studies, as in most of the above examples, factors affecting project success are treated one at a time rather than in combination. The effects of multiple factors, considered simultaneously rather than in laboratory-like isolation from each other, are seldom investigated or discussed. Interdependencies between factors bearing on success are rarely discussed in the project management literature, nor is the possibility that some factors may have indirect rather than direct effects on project success. The assumption underlying most studies seems to be that each determining factor, whether it be teamwork, subcontracting, type of project structure, or whatever, has a simple and direct causal effect on project success. Certain of the analytic techniques used in the present study, notably multiple regression and path analysis, represent departures from the limited viewpoint that success is determined by factors acting simply, directly and one-at-a-time.

The second limiting aspect of most studies to date is that they fail to take a "contingency" approach to the study of project management. In this respect, project management research has lagged behind the general field of organizational theory, wherein the contingency concept has become widely accepted in recent years. The contingency approach is based on the idea that for an organization to be effective, its internal functioning must be consistent with the demands of its external environment, technology, organizational task and

the needs of its members. Researchers no longer assume that there is one best way to organize and operate under all conditions. Instead, they have tended more and more to examine the functioning of organizations in relation to the situations facing them. This approach seems to be leading to the development of a "contingency theory" of organization with the appropriate structures and processes of the organization contingent upon external requirements and member needs.<sup>13</sup>

Three landmark studies support this conclusion. In the first, Burns and Stalker found important structural differences between the successful firms in two different industries, a dynamic, changing industry (electronics) and a more established, stable industry (textiles).<sup>14</sup> In the stable industry, successful firms tended to be what the authors called "mechanistic". There was more reliance on formal rules and procedures; decisions were made at higher levels; spans of supervisory control were narrow. Successful firms in the dynamic industry were termed "organic", and were characterized by less formality, wider spans of control and decision-making at lower organizational levels.

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<sup>13</sup>See for example Paul R. Lawrence and Jay W. Lorsch, Organization and Environment (Homewood, Illinois: Irwin, 1969); Joan Woodward, Industrial Organization: Theory and Practice (London: Oxford University Press, 1965); Tom Burns and G. M. Stalker, The Management of Innovation (London: Tavistock Publications 1961); Victor H. Vroom, Work and Motivation (New York: Wiley, 1964); Fred E. Fiedler, A Theory of Leadership Effectiveness (New York: McGraw-Hill, 1967); Arthur N. Turner and Paul R. Lawrence, Industrial Jobs and the Worker (Boston: Harvard Business School, 1965).

<sup>14</sup>Burns and Stalker, Ibid.

The second study, conducted by Joan Woodward, showed that economically successful firms in industries with different technologies tended to have different organizational structures.<sup>15</sup> For example, successful firms in industries with unit or job shop technology had wider spans of supervisory control and fewer hierarchical levels than did successful firms with continuous process technologies.

In the third study, Lawrence and Lorsch found that different organizational environments require varying degrees of differentiation among the subunits within an organization.<sup>16</sup> Successful organizations in complex, diverse environments, for example, exhibited a high degree of difference between internal subunits in terms of subunit structures and attitudes of subunit managers. In addition, Lawrence and Lorsch found that the required kinds and amounts of integrative devices (coordinative roles, project teams, information systems, etc.) differed, depending upon the degree of differentiation that existed within the organization.

The project management literature is beginning to reflect the trend toward contingency thinking. Researchers and other commentators on project management are increasingly answering questions about appropriate authority systems, management tools and project organization structures with the response, "It depends." Benningson, for example, observes that the project

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<sup>15</sup>Joan Woodward, Industrial Organization: Theory and Practice

<sup>16</sup>Paul R. Lawrence and Jay W. Lorsch, Organization and Environment.

management system (managers, organization, planning tools, control tools, information system) exists within several "environmental shells".<sup>17</sup> He suggests that the nature of these, taken in combination with the degree of priority assigned to each of several project criteria (time, cost, performance, satisfaction, follow-on, spin-off, change), should be the basis for decisions affecting the design of the project system. By this approach, he is obviously rejecting the notion that there is one best way to organize and manage a project.

More specifically, the subject of authority/control systems for projects has been treated in a contingency manner in two recent publications. Steiner and Ryan, based on a conference conducted with sixteen successful project managers, suggest that extensive regulation and close supervision of project performance tends to insure satisfactory performance, but at the same time tends to inhibit both state-of-the-art and cost cutting innovations.<sup>18</sup> They conclude that close control does work well in instances where higher priority is placed on producing a conventional product than on pushing the state-of-the-art. Middleton, discussing the amount of authority and control possessed by the project manager, observes that

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<sup>17</sup>Lawrence Benningson, "The Strategy of Running Temporary Projects", Innovation, No. 24, 1971, pp. 32-41

<sup>18</sup>George A. Steiner and William G. Ryan, Industrial Project Management (Toronto: Collier-Macmillan Canada, Ltd., 1968), pp. 145-146.

wide variations exist.<sup>19</sup> He notes that some organizations have found that a project manager can adequately control a project even though none of the units working on the project report directly to him, while other organizations have found the opposite to be true. He suggests that the outcome depends upon the effectiveness, responsiveness and attitude of the functional units.

An overall contingency theory relating to organizational design for project management is beginning to emerge. Jay Galbraith notes that there is a continuum of organizational designs, running from pure functional to fully projectized form, and that the factors that determine choice are the diversity and rate of change of the product line, interdependencies among subunits, level of technology, presence of economies of scale and organization size.<sup>20</sup> Powers and Dickson express a similar contingency-based view.<sup>21</sup> They suggest that different structure and process factors (for example, use of documentation standards, experience of project personnel, size of systems staff) are related to different success criteria (time, cost, client satisfaction, operational success), implying that project structures and operating mechanisms need to be chosen differently, depending on the

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<sup>19</sup>C. J. Middleton, "How to Set Up a Project Organization", Harvard Business Review, March-April, 1967, pp. 73-82.

<sup>20</sup>Jay R. Galbraith, "Matrix Organization Designs", Business Horizons, XIV, 1, February, 1971, pp. 29-40.

<sup>21</sup>Richard F. Powers and Gary W. Dickson, "MIS Project Management: Myths, Opinions and Reality", California Management Review, XV, Spring, 1973, pp. 147-156.

profile of success criteria desired.

While most writers have merely suggested what variables need to be considered, some authors have begun to state how such variables are interrelated. Chapman, for example, concludes that a matrix structure works best for (1) small, inhouse projects; (2) where project duration is two years or less; (3) where assignments to technical divisions are minimal, and (4) where a field installation has substantial fluctuation in the amount of project activity it is handling.<sup>22</sup> He argues that the matrix structure begins to lose its flexibility on large, long duration projects, and that a more fully projectized structure is appropriate in these circumstances. In a similar vein, Wileman suggests a contingency fit between project organization structure and the kinds of organizations involved in the project.<sup>23</sup> He proposes an "internal functional" structure (project team drawn from functional areas) for inhouse projects, a matrix structure for projects involving coordination of several organizations, and project management via "contractor support" in instances where most or all of the actual operation of the project can be contracted out. Marquis presents evidence that a functional structure yields higher technical performance, while project team structure tends to produce lower technical, but better schedule and cost

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<sup>22</sup>Richard L. Chapman, "Project Management in NASA", a report of The National Academy of Public Administration Foundation, January, 1973.

<sup>23</sup>David L. Wileman, "Project Management as a Transferable Management System", Working Paper No. 21, Syracuse University, September, 1969.

performance.<sup>24</sup>

Some specific relationships between particular project control techniques, the nature of the situation in which they are used, and project success have been suggested. Avots notes that some techniques may be too sophisticated for the particular use, citing a large construction company which used elaborate network techniques, issued stacks of computer printouts on each project, and found that very limited use was actually made of these data.<sup>25</sup> Only after a simplified bar chart technique was introduced could required decisions be made. Marquis found that use of PERT was not related to technical performance, but was related to better cost and schedule performance, implying that the utility of the technique depends on the importance of particular performance criteria.<sup>26</sup>

Contingency studies of project management which include systematic empirical research are few and far between, though the Marquis and Powers and Dickson studies are notable exceptions to this rule. Two conclusions seem quite clear, however: (1) that many of project management's most esteemed and competent commentators are urging that contingency research is the way to go, and (2) that the current need is for more research which shows not just what situation variables,

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<sup>24</sup> Donald Marquis, "A Project Team + PERT = Success. Or Does it?" Innovation, No. 5, 1969, pp. 26-33.

<sup>25</sup> Ivars Avots, "Why Does Project Management Fail?", California Management Review, VII, 1, Fall 1969, pp. 77-82.

<sup>26</sup> Donald Marquis, Op. Cit.

project structure and process variables and project outcome variables are interrelated, but how they are interrelated.

### III. METHODOLOGY

#### 3.1 Purpose

Previous studies in the area of project management have tended to focus on a few select variables; being concerned with single types of projects; and utilizing relatively small sample populations. The result of this is that the studies are fragmentary, many are redundant, and that while many particulars have been studied little has been done in the way of formulating a complete theory of project effectiveness.

In general, research methodologies may be selective, following the "other things being equal" philosophy, or wholistic, attempting to explain multi-dimensional phenomena. Utilizing the selective philosophy, statements have been made and theories constructed concerning project effectiveness. Following the contrary philosophy, a whole new set of questions arises. So treated, there is a paucity of truly wholistic theory, and the need for meaningful statements.

For such reasons, the objective of this study was not restricted to the investigation of selected variables, but designed to include as many variables as possible -- within reason -- which are important to project effectiveness. Specifically, the purpose of this study was to determine the interactions of numerous project characteristics with particular reference to project performance.

To fulfill this research objective it was necessary to consider a large number of variables simultaneously. Further,

it was necessary for the sample to be quite large and to represent considerable variation regarding the response items. To assist in statistical measurement and analysis it was desirable for all data to be continuous in nature. It was further necessary for all responses to be varied and comparable. These considerations largely dictated instrument design and application as indicated in the following.

### 3.2 Research Instrument

To obtain the data necessary to fulfill the purpose of this study a detailed questionnaire (see Appendix A) was developed containing 206\* response items. In all cases the questionnaire was directed to an individual who had had direct project management experience. Additionally, the questions were restricted to a single, recently completed project. The instrument was designed to include those variables which had been indicated by previous research as determinants of success; those suggested as determinants during interview and pre-test stages; and those suggested by general management theory and research.

- o Existing and well-known research efforts have indicated that complexity and change are potential determinants to effectiveness.
- o The major variables affecting organizations in general, as well as organizational effectiveness, can be classified as either economic, legal, social, and political.
- o Further, these may be either internal or external to the effort.

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\*The instrument contained 177 items; the remaining 29 were derived from combinations of the reported data.

- o For all undertakings, the managerial process may be classified as planning, organization, control, coordination, and motivation.
- o Further, all of these characteristics exist within the client, parent, and project organizations.

Using this five dimensional construct 206 instrument items were generated. As effectiveness of project management was a prime consideration of the study, multiple measures of project success were constructed. Success may be measured in various ways. Among these are technical success, schedule and budget considerations, follow-on and capability build-up, and the satisfaction of all parties involved. Since success is a multi-dimensional concept, multiple measures, both objective and subjective, were included in the instrument.

To insure comparability among the items over a large number of respondents, Lickert-type scales were utilized for most response items. The remaining were parametric in nature.

### 3.3. Sample Population

Data were gathered from 670 respondents. Two such mailings were undertaken. The first mailing was to 708 members of the Project Management Institute.\* The second mailing included 2,700 additional individuals whose names were also supplied by the Project Management Institute. The individuals surveyed were experienced in project management covering a wide range of public and private projects. These groups of individuals were selected for two reasons: 1) each was believed to have had direct project management experience;

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\*Project Management Institute, P.O. Box 43, Drexel Hill, Pa. 19026

and 2) the types of projects likely to be represented covered a wide range of characteristics. Considering the nature and objectives of this study, these two elements were essential.

Six hundred and seventy responses were received from the mailings, yielding a 46% return for this first mailing and 12% for the second. Ninety-six percent of the total responses were useable. The remaining were disregarded for numerous reasons, the greatest number due to late receipt of responses. As evidenced by the data, the responses covered a wide range with regard to all variables included. Particularly, the range of technical complexity and project size, including defense and aerospace projects as well as those of a commercial nature, allows generalization of the findings.

The 646 useable responses represented a variety of industries (34% manufacturing, 22% construction, 17% government, and 27% services, transportation and other). Most of the respondents themselves had been directly involved in the particular project they chose to describe in their questionnaire. Of the total sample, 50% had been the project manager, 31% had been in other positions on the project team, and another 10% had been the project manager's superior. About one-third of the projects were described as being public in nature, and the remaining two-thirds as being in the private sector. The types of contracts or agreements involved included cost plus fixed fee (32%), in-house work orders (28%), fixed price (21%), and fixed price with incentive (14%). The major activity or end product involved in the projects included

construction (43%), hardware or equipment (22%), new processes or software (14%), and studies, services and tests (11%).

### 3.4 Analytic Techniques

The purpose of this study was to determine the interactions of numerous project management characteristics, with particular reference to project success. To achieve this purpose, the data were analyzed in seven ways. These analyses were conducted in two major partitions: the first utilizing raw data, the second utilizing factored data.

Using the raw data, variance, correlation, and factor analysis techniques were used. One of the results of a factor analysis is a set of factor scores. Utilizing these factor scores, variance, correlation, regression, and path analysis techniques were used. The total analysis may be summarized as in Figure 3.11 Description of the various techniques used follow.

#### 3.41 Correlation

A popular method for determining the relationship of two variables is correlation analysis. Continuous variables are suited to this method of analysis. The product-moment correlation tests for linear association between two variables. The correlation coefficient ( $r$ ) indicates the degree of linearity between the two variables being considered. Further, the square of  $r$  is the proportion of variance in one variable explained by the other variable. Additionally, a standard significance test indicates if the observed correlation

differs significantly from zero.

While correlation is not causal in nature, it specifies observed surface associations between any two variables. The correlation coefficient ( $r$ ) indicates the strength of association while the significance test indicates if any association statistically exists. In essence, the correlation analysis allows us to determine if variables tend to be associated with each other, and the degree to which they are associated.

### 3.42 Analysis of Variance

While correlation analysis is a useful way of discovering that a relationship exists between two variables, it has the disadvantage that it assumes this relationship to be continuous and linear across the full range of both variables. Thus, a high correlation between Project Success and some other variable, say, rapport with client, might mask the fact that rapport with client was associated more strongly with the avoidance of project failure than with the attainment of a high level of project success. Analysis of variance was used in order to discover which variables were associated with project failure but not with success, which with success but not failure, and which were associated with both success and failure.

The F-test -- one way analysis of variance -- was the specific method used. This special case of analysis of variance tests the difference among means for more than two groupings of an independent variable. For these tests, project success was treated as the "independent" variable and three groupings

were formed consisting of the highest third, the middle third and the lowest third of the project success distribution. Each of the other study variables was in turn treated as a "dependent" variable, with the exception of those which were of a categorized rather than a continuous nature. The F-test partitions the total variation into "among group" variation (differences in group means) and "within group" variation (differences of individual scores about the group mean). The F-test is formed by taking the ratio of measures of "among group" variation to the "within group" variation. The larger this ratio, the more likely that group differences exist.

### 3.43 Factor Analysis

Factor analysis is a statistical technique which analyzes the relationships between any number of variables and produces a set of "factors" or underlying dimensions -- each of which represents some combination of the original variables. This has the important advantage of reducing the number of variables to be studied. Beyond this "data simplification", scales constructed from the factor analysis are designed to be independent and hence tend to be more reliable. Moreover, factor analysis has the advantage of being a "multi-dimensional" technique.

While the previous methods of analysis allow the investigation of relationships of particular variables, factor analysis allows us to study the total pattern of relationships among all of the variables. By studying these overall patterns it is possible to discover those underlying dimensions which

account for the relationships among variables. Further, these new dimensions or factors may be analyzed by other statistical methods to investigate the interaction of these underlying dimensions.

### 3.44 Multiple Regression

Multiple regression is a causal analysis which is useful for developing and testing a model which predicts a dependent variable from several independent variables. Like correlation, regression is suited to continuous data. However, regression is superior to correlation in that it discusses the relationship of one variable to many others; correlation is restricted to discussing two variables at a time.

The result of multiple regression analysis is a prediction equation which mathematically relates a set of independent variables to a dependent variable. Of particular importance to the explanatory value of the multiple regression equation are the regression coefficients and the multiple correlation coefficient. The regression coefficients are essentially the correlation coefficients between each independent variable and the dependent variable, with the effects of other variables held constant. The regression coefficient is superior to the correlation coefficient in that it goes beyond describing surface relationships -- it describes more basic relationships in that it partials out the effects of other variables. The multiple correlation coefficient ( $R$ ), and particularly its square,  $R^2$ , is of further significance in that it describes the amount of total variation in the

dependent variable which is explained by the independent variables as a group.

### 3.45 Path Analysis

Path analysis is a relatively new technique of causal analysis. The result of a path analysis is a model which explains the interaction of a large number of variables. Such a model illustrates the causality entertained in a network of relationships. The strength of these relationships are measured by path coefficients. These coefficients are standardized measures which can be compared to determine the relative predictive power of each independent variable with the effects of the other variables being partialled out.

The particular value of path analysis is that it illustrates the working relationships of all variables in a network of relative predictive powers; thus allowing one to understand the relationships among variables in a systemic manner.

The previous methods of analysis may be summarized as in Figure 3.12.

FIGURE 3.01  
 PARENT ORGANIZATION CHARACTERISTICS  
 N=627

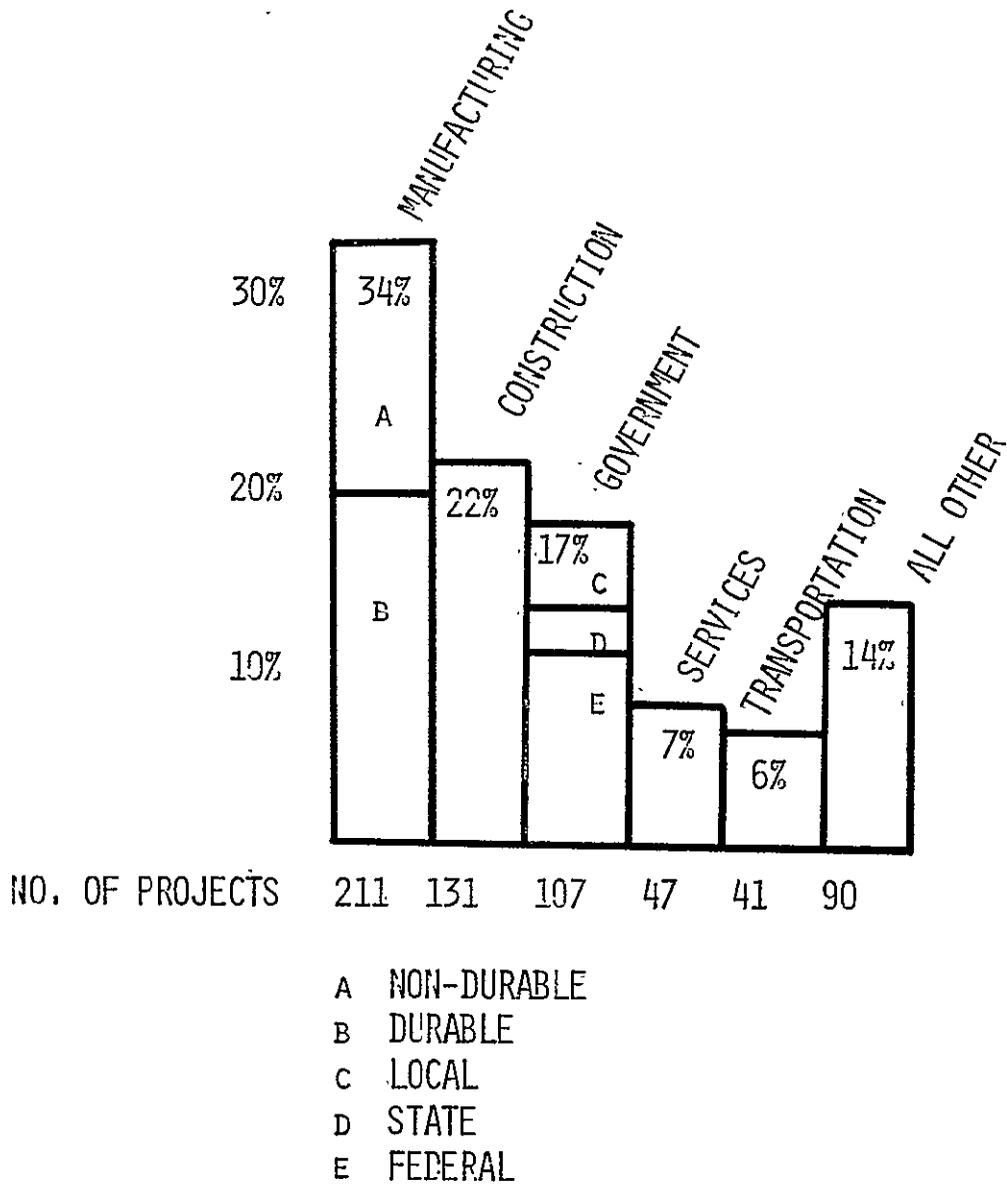


FIGURE 3.02  
 RESPONDENT'S  
 INDIVIDUAL ROLE (A)  
 N=641

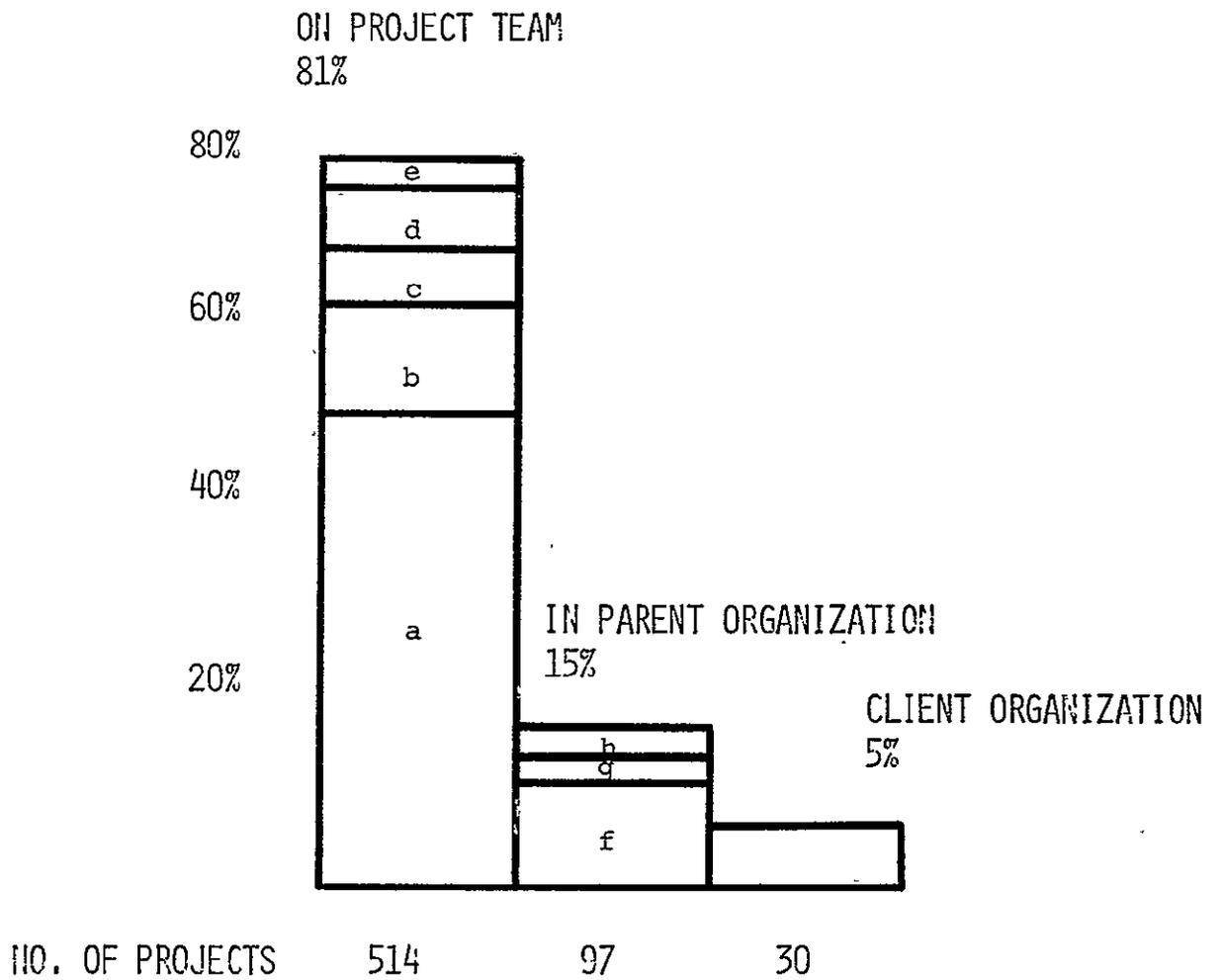


FIGURE 3.03  
 RESPONDENT'S  
 INDIVIDUAL ROLE (B)  
 N=641

ON PROJECT TEAM		
PROJECT MANAGER	313	50%
MANAGER ON PROJECT TEAM	75	12
ADMINISTRATIVE TEAM MEMBER	62	10
TECHNICAL TEAM MEMBER	42	6
OTHER	22	3
IN PARENT ORGANIZATION	—	
PROJECT MANAGER'S SUPERIOR	62	10
MANAGER IN PARENT ORGANIZATION	29	4
OTHER	6	1
IN CLIENT ORGANIZATION	.30	.5
	641	100%

FIGURE 3.04  
NATURE OF PROJECTS

	PUBLIC 38%	PRIVATE 62%
	240	398
CONSTRUCTION	81	197
NON-CONSTRUCTION	159	201

FIGURE 3.05  
TYPES OF CONTRACT  
OR AGREEMENT  
N=631

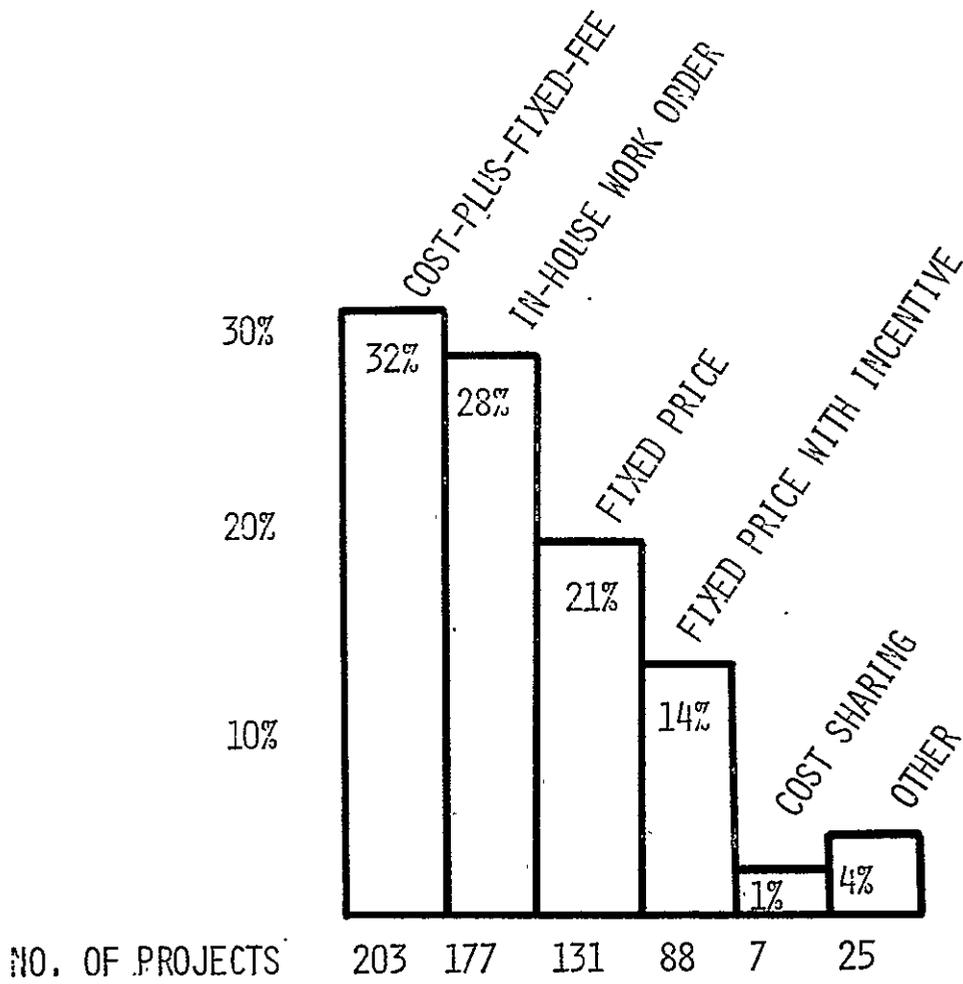


FIGURE 3.06  
 PROJECT ACTIVITIES  
 OR  
 END PRODUCTS  
 N=637

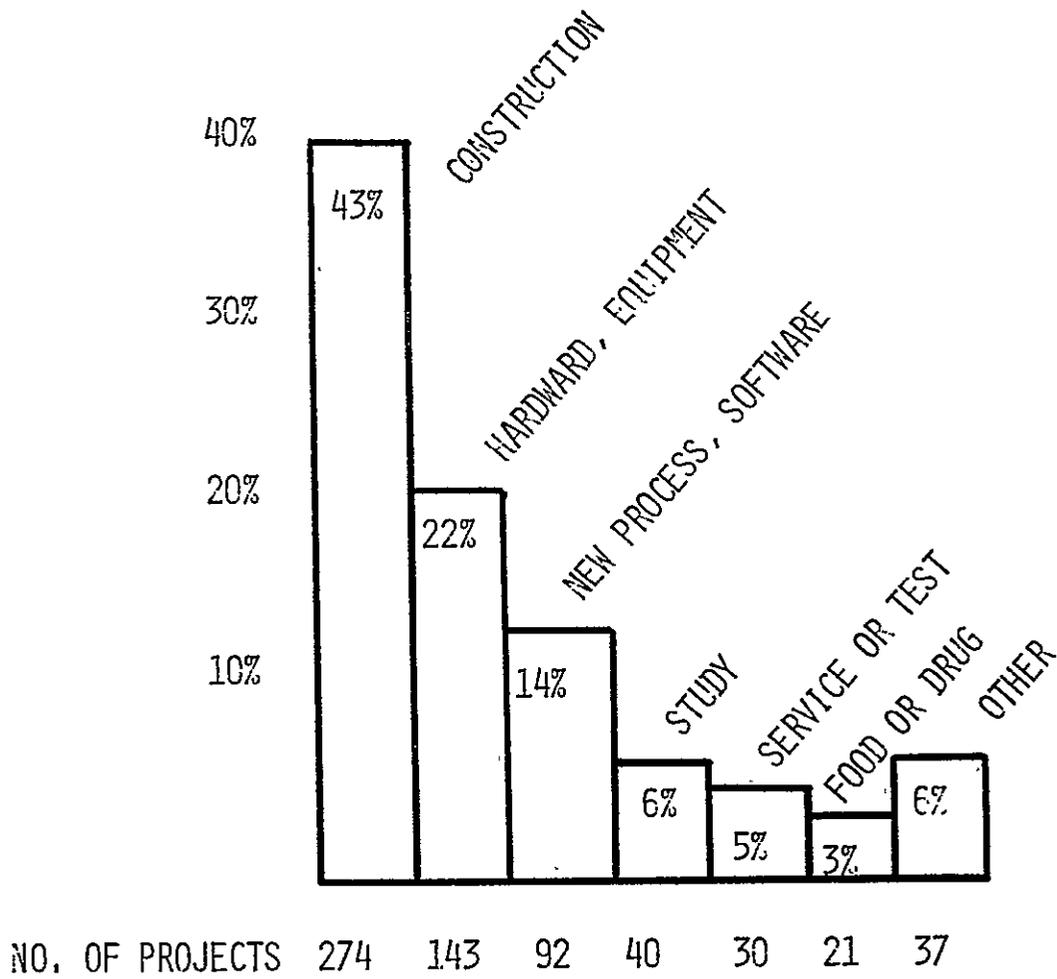
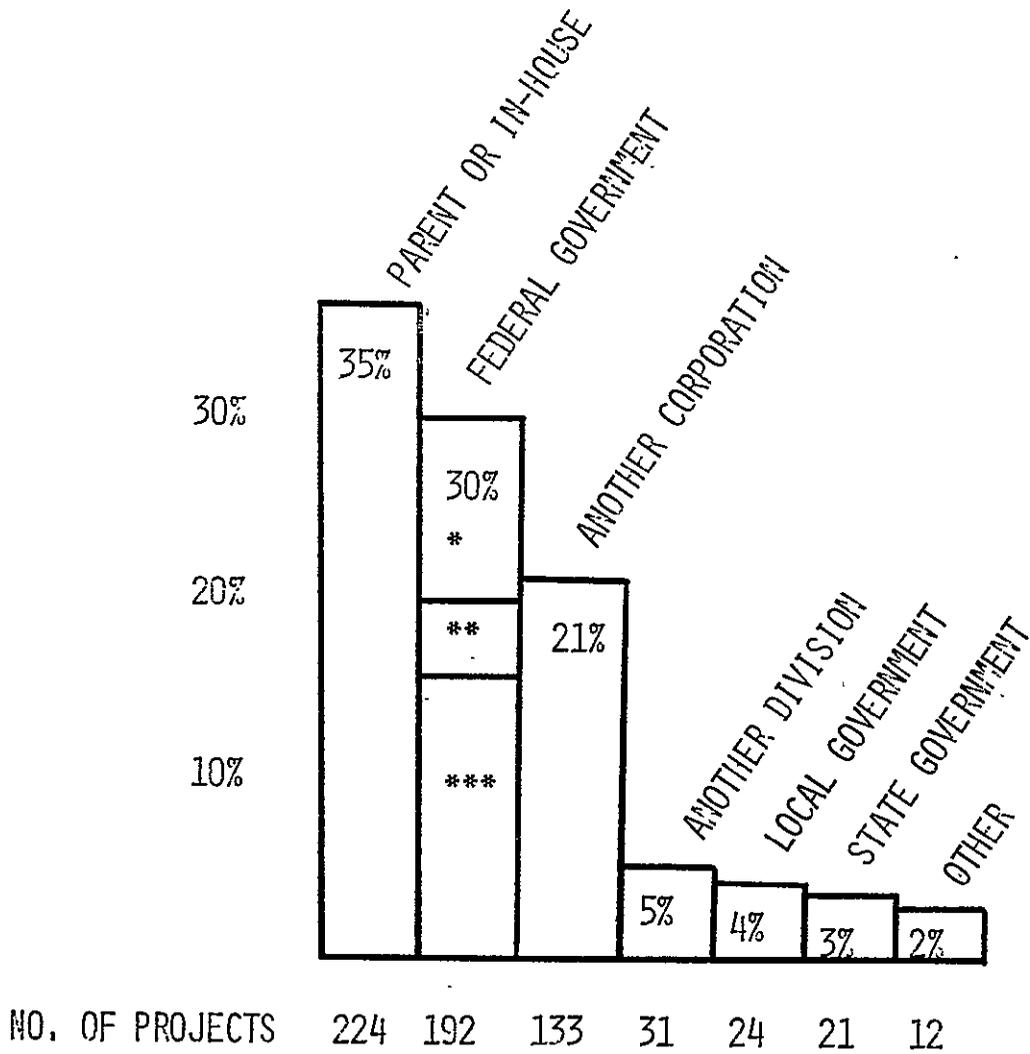


FIGURE 3.07  
 CLIENTS/SOURCES  
 OF FUNDS  
 N=637



\*OTHER 11%  
 \*\*SPACE 4%  
 \*\*\*DEFENSE 15%

FIGURE 3.08  
COMPETITIVE ENVIRONMENTS  
N=631

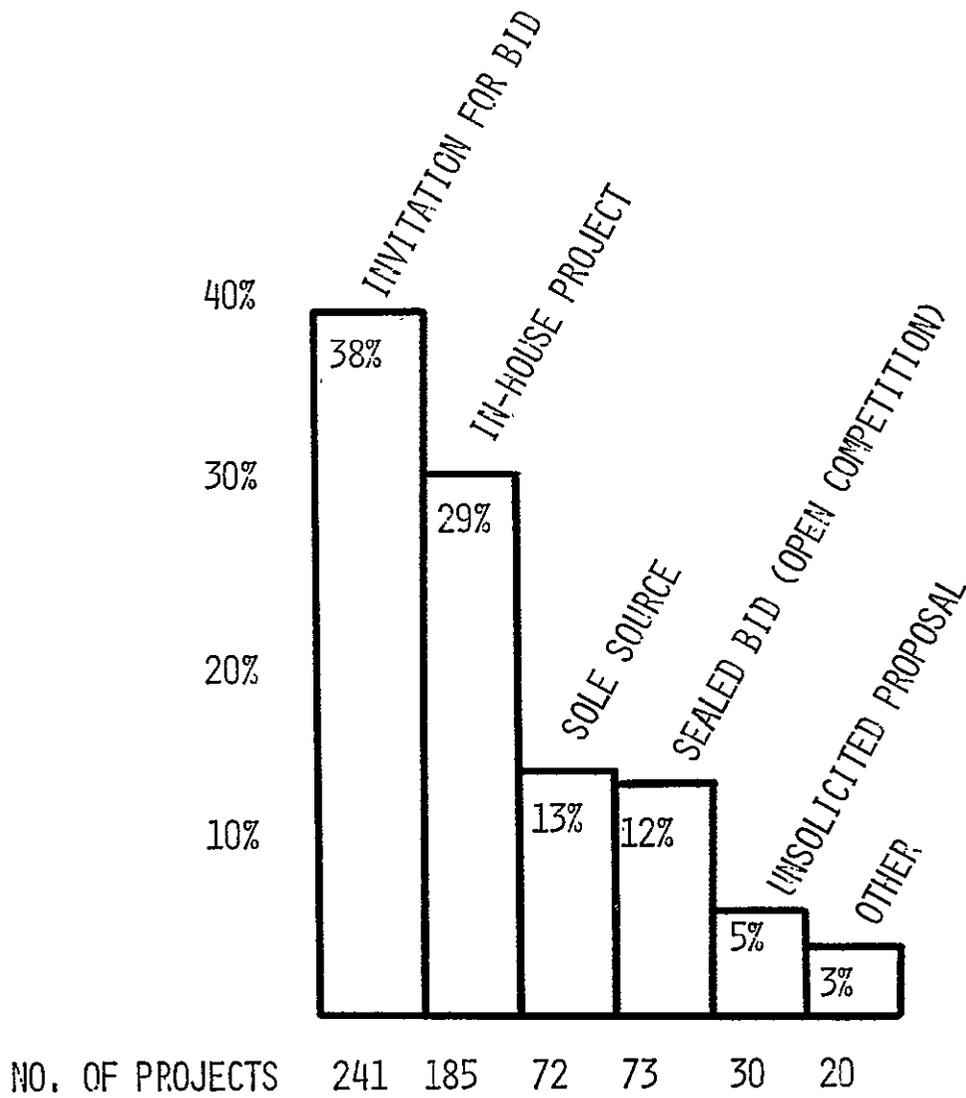


FIGURE 3.09  
ORGANIZATION STRUCTURES OF  
PROJECT TEAMS  
N=637

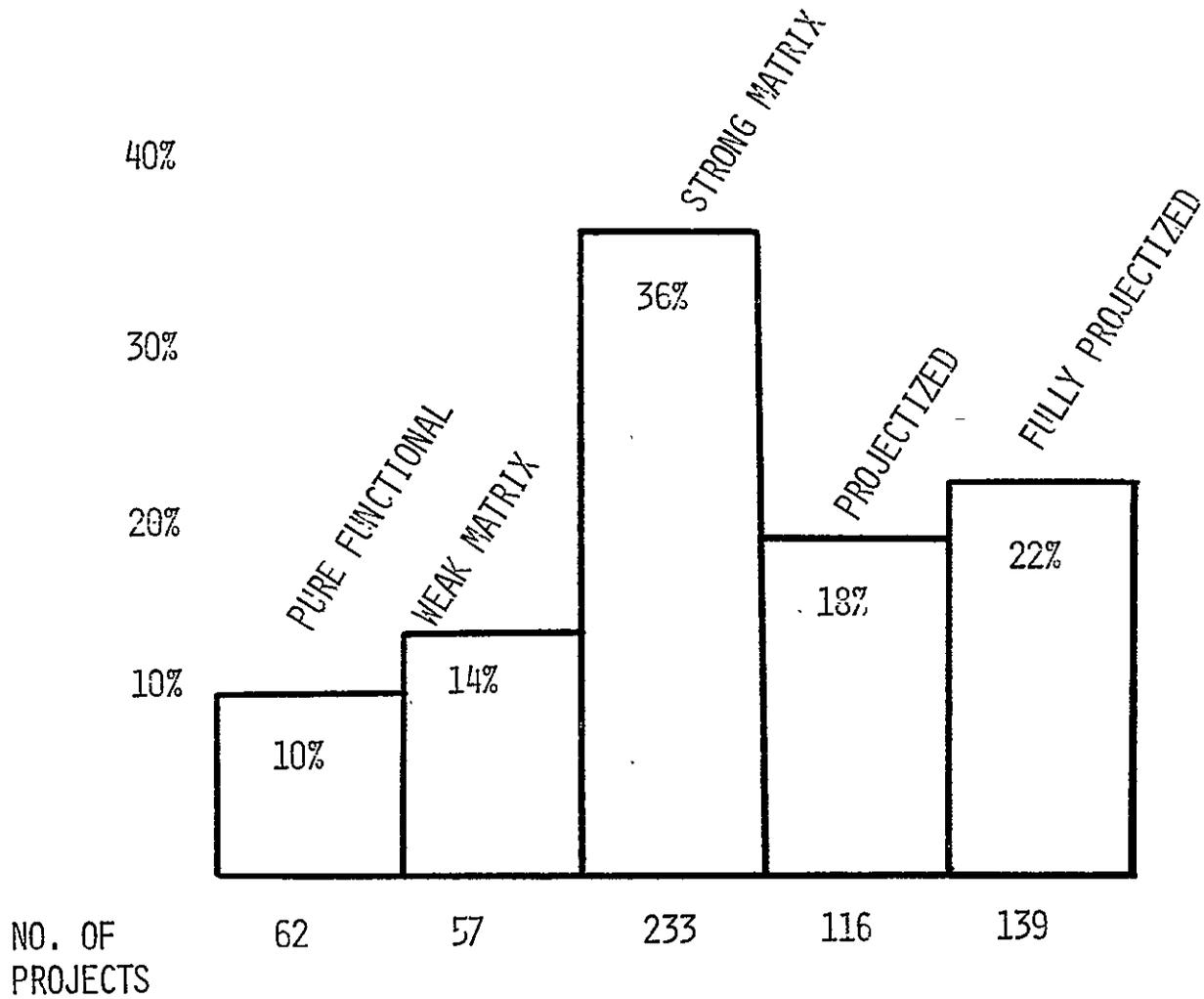


FIGURE 3.10  
LENGTH OF PROJECTS

N=618

	UP TO 1 YEAR	1-2 YEARS	2-3 YEARS	OVER 3-YEARS
CONSTRUCTION	51	108	64	45
NON-CONSTRUCTION (NO. OF PROJECTS)	102	116	63	69

FIGURE 3.11

ANALYTIC APPROACH

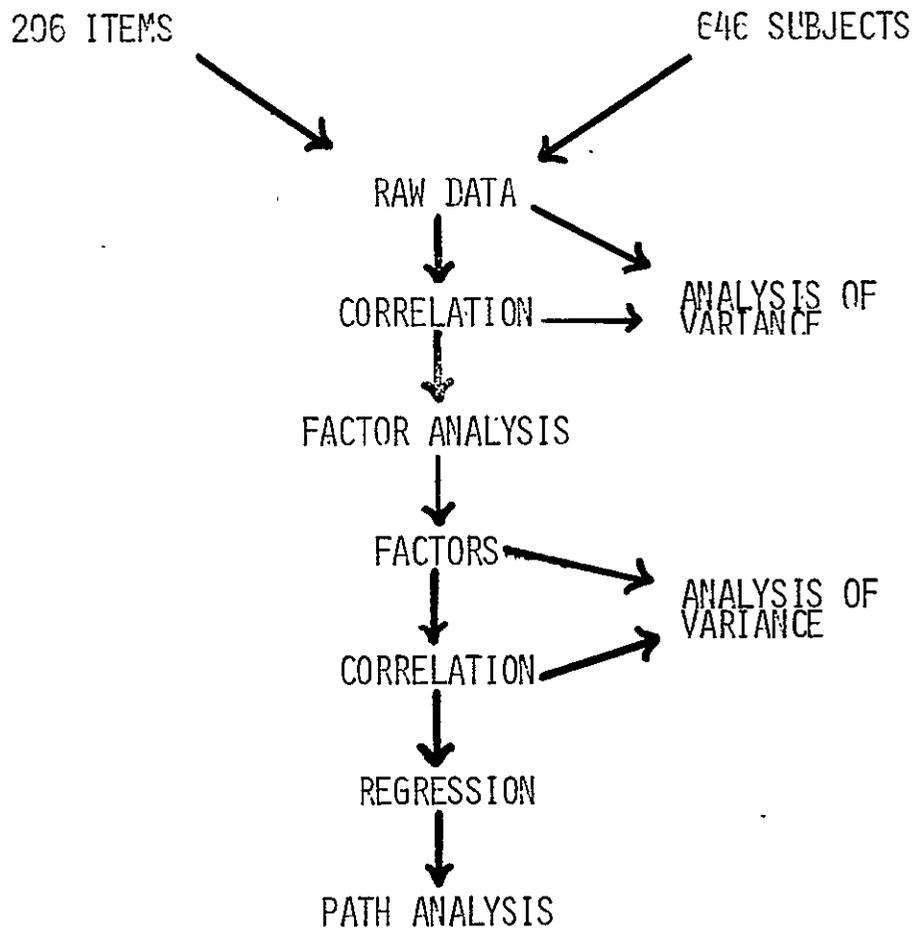


FIGURE 3.12

TECHNIQUES OF ANALYSIS

Analysis of Variance

Test for differences among groups

$$(V_n | V_{m=j}) \neq (V_n | V_m \neq j)$$

Correlation

Tests for surface relationships between two variables

$$V_n = f(V_m)$$

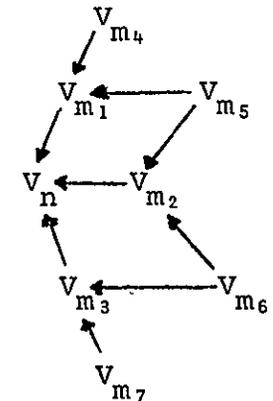
Multiple Regression

Tests for causal relationships among many variables

$$V_n = f(V_i | i=1, m)$$

Path Analysis

Specifies direct contributions and relationships among all variables



Factor Analysis

Identifies underlying dimensions, simplifies variables

$$(V_i | i=1, m) \in F_j$$

## IV. ANALYSIS

### 4.1 Analysis of Items

The analysis was performed in three successive steps. First, the raw data represented by the 206 individual response items were analyzed, with emphasis on identifying relationships between individual items and project success. Second, the 206 items were reduced to 32 underlying dimensions by means of factor analysis. Finally, relationships between project success and the factors were analyzed, with consideration given to interrelationships between the factors and to the effects on success of multiple factors in combination.

The two sections immediately following, Sections 4.11 and 4.12 show the results of the first step, the relationships between project success and the individual response items. These sections are followed by a description of the factor analysis and the results obtained from the factored data in Sections 4.2 and 4.3.

#### 4.11 Correlation

The purpose of our analysis at this stage is to reach preliminary findings concerning the relationship of project characteristics with project success. To achieve this purpose, product-moment correlations were performed on the project characteristic variables with six success items. These correlations would indicate surface relationships of the project characteristics with the success items.

Success was measured by six items on the questionnaire:

- 1) "All things considered, the project was a success;"
- 2) "In general, how satisfied were the following groups with the outcome of the project:"
  - a. parent organization
  - b. client organization
  - c. ultimate users
  - d. project team;
- 3) the extent to which the end result "fulfilled the technical performance mission or function."

It was noted that the overall subjective item -- "All things considered, the project was a success" -- presented a fair overall measure of success. This is shown by the very strong correlations of this item with the others, as shown in Table 4.1.

Therefore, for summary purposes it was felt that the single overall subjective measure would be an adequate index of success. (Correlates of each success item are detailed in Appendix C).

Considering the above, it was found that the following project management characteristics strongly affect success ( $p < .001$ ) in the directions indicated.

<u>Item Description</u>	<u>r</u>
o Project team sense of mission	+.406
o Project team spirit	+.371
o Project team goal commitment	+.347

TABLE 4.1

CORRELATIONS OF SUCCESS ITEMS WITH THE OVERALL  
 SUBJECTIVE ITEM, "ALL THINGS CONSIDERED, THE  
 PROJECT WAS A SUCCESS"

2a	satisfaction - parent	$r_{\geq}.654$	$p<.001$
2b	satisfaction - client	$r_{\geq}.611$	$p<.001$
2c	satisfaction - user	$r_{\geq}.518$	$p<.001$
2d	satisfaction - project team	$r_{\geq}.646$	$p<.001$
3	technical performance	$r_{\geq}.559$	$p<.001$

o Original cost estimates too optimistic	- .346
o Project team capability	+ .342
o Difficulty meeting project schedules	- .336
o Back-up strategies were available	+ .332
o Difficulty obtaining funding to completion	- .327
o Project Manager's satisfaction with planning and control	+ .314
o Unity between project manager and contributing department managers	+ .313
o Difficulty staying within original budget	- .311
o Unity between project manager and client contact	+ .309
o Unity between project manager and public officials	+ .309
o Unity between parent contributing departments	+ .305
o Difficulty coordinating with client organization	- .301

Although the relationships are not as strong ( $r < .3$ ), it was found that the following project management characteristics tend to affect success ( $p < .001$ ) in the directions indicated.

o Parent enthusiasm	+ .297
o Unrealistic project schedules	- .296
o Lack of rapport with client organization	- .294
o Team's satisfaction with organization structure	+ .293
o Progress reports were over-optimistic	- .283
o Project Manager's technical skills	+ .283
o Project team participation in major problem solving	+ .282
o Decision delays hampered project	- .279
o Difficulty closing out project	- .278

o Procedures for changes were inadequate	-.275
o Difficulty maintaining rapport with parent organization	-.274
o Project Manager had insufficient authority	-.271
o Project team participation in decision-making	+.266
o Unity between project manager and his superior	+.262
o Extent of parent new-capabilities buildup	+.261
o Favorability of media coverage	+.254
o Project Manager human skills	+.253
o Difficulty coordinating among team members	-.252
o Schedule overrun	-.249
o Difficulty freezing design	-.247
o Difficulty keeping competent team people	-.244
o Excessive politics involved in award	-.244
o Cost estimates intentionally underestimated	-.242
o Value of status, progress reports	+.239
o Project Manager administrative skills	+.236
o Value of work breakdown structures	+.224
o Project too encumbered by legal restrictions	-.223
o Too many government agencies involved	-.221
o Value of Bar, Gantt, Milestone charts	+.220
o Project Manager's influence in selecting team personnel	+.220
o Project team's job insecurity	-.208
o Difficulty in defining goals	-.207
o Need for new forms of government - industry cooperation	-.207
o Project Manager's influence in authorizing subcontractors	+.201

Although the relationships are not as strong ( $r < .2$ ), it was found that the following project management characteristics are associated with success ( $p < .001$ ).

o Project Manager's influence in selecting subcontractors	+ .195
o Project was more complex than initially conceived	- .192
o Difficulty in meeting technical requirements	- .189
o Government overcontrol	- .189
o Importance to parent - technical performance	+ .188
o Importance to project manager - technical performance	+ .187
o Project decisions made at higher than appropriate levels	- .183
o Project Manager's influence in authorizing overtime	+ .182
o Extent of parent enthusiasm	+ .181
o Importance to project manager - schedule	+ .179
o Difficulty in coordinating with parent organization	+ .178
o Adequacy of project physical facilities	+ .174
o Project Manager's influence in relaxing specifications	+ .169
o Value of network systems	+ .164
o Project Manager's influence in giving merit raises	+ .156
o Team members hampered by unrelated assignments	- .156
o Public became too involved	- .155
o Government red-tape caused delays	- .153
o Importance to parent - schedule	+ .144
o Volume of paper work was excessive	- .144

o Too much pressure from parent top management	-.142
o Importance to project manager - budget	+.139
o Project team participation in setting budgets	+.134
o Extent of project structure revision	-.134
o Importance to client - technical performance	+.134

#### 4.12 Analysis of Variance

The purpose of this portion of the analysis was to distinguish between those factors which improve success and those which cause failure. To achieve this purpose, the data were analyzed in two ways.

In the previous section, product-moment correlations were performed on the project characteristics with six success items. These correlations indicate linear relationships of the project characteristics with the success items.

In this section, "F-test" analysis of variance was performed on the project characteristics with success items categorized by degree. This analysis allows the identification of non-linear relationships -- particularly association with either success or failure.

As in Section 4.11, it was felt that the single overall subjective measure would be an adequate index of success for summary purposes.

Considering the above, it was found that the presence of the following project management characteristics strongly affect the failure of projects; however, the absence of these characteristics does not insure success.

- o insufficient use of status/progress reports
- o use of superficial status/progress reports
- o inadequate project manager administrative skills
- o inadequate project manager human skills
- o inadequate project manager technical skills
- o insufficient project manager influence
- o insufficient project manager authority
- o insufficient client influence
- o poor coordination with client
- o lack of rapport with client
- o client disinterest in budget criteria
- o lack of project team participation in decision-making
- o lack of project team participation in major problem-solving
- o excessive structuring with the project team
- o job insecurity within the project team
- o lack of team spirit and sense of mission within the project team
- o parent organization stable, non-dynamic, lacking strategic change
- o poor coordination with parent organization
- o lack of rapport with parent organization
- o poor relations with parent organization
- o new "type" of project
- o project more complex than the parent has completed previously

- o initial under-funding
- o inability to freeze design early
- o inability to close-out the effort
- o unrealistic project schedules
- o inadequate change procedures
- o poor relations with public officials
- o unfavorable public opinion

While the above were found to be associated with project failure, the following were found to be associated with success. That is, the following were found to be necessary, but not sufficient conditions for success.

- o frequent feedback from the parent organization
- o frequent feedback from the client
- o judicious use of networking techniques
- o availability of backup strategies
- o organization structure suited to the project team
- o adequate control procedures, especially for dealing with changes
- o project team participation in setting schedules and budgets
- o flexible parent organization
- o parent commitment to established schedules
- o parent enthusiasm
- o parent commitment to established budget
- o parent commitment to technical performance goals
- o parent desire to build up internal capabilities
- o project manager commitment to established schedules
- o project manager commitment to established budget

- o project manager commitment to technical performance goals
- o client commitment to established schedules
- o client commitment to established budget
- o client commitment to technical performance goals
- o enthusiastic public support
- o lack of legal encumbrances
- o lack of excessive government red tape
- o minimized number of public/government agencies involved

In addition to those factors which affect success or failure, some were found to be linearly related to both success and failure. That is, the presence of the following characteristics tend to improve the probability of success while their absence leads toward failure.

- o goal commitment of project team
- o accurate initial cost estimates
- o adequate project team capability
- o adequate funding to completion
- o adequate planning and control techniques
- o minimal start-up difficulties
- o task (vs. social) orientation
- o absence of bureaucracy
- o on-site project manager
- o clearly established success criteria

It was noted that cost and schedule overruns were not primary determinants of "overall failure" as might be expected. It was, therefore, decided to further investigate

those factors which affect cost and schedule overruns directly.

Cost overruns were highly correlated with the size of the project and the difficulty of meeting technical specifications. However, schedule difficulties and resulting schedule overruns were the primary causal factors leading to cost overruns. It was found that schedule overruns were, in turn, caused by the following:

- o cost underestimates
- o use of "buy-in" strategies
- o lack of alternative backup strategies
- o lack of project-team goal commitment
- o functional rather than projectized, project organization
- o lack of project team participation in setting schedules
- o lack of team spirit, sense of mission
- o inadequate control procedures
- o insufficient use of networking techniques
- o insufficient use of progress/status reports
- o over-optimistic status reports
- o decision delays
- o inadequate change procedures
- o insufficient project manager authority and influence
- o lack of commitment to budget and schedule
- o overall lack of similar experience

#### 4.2 Factor Analysis

Due to the large number of variables included in the study,

the technique of factor analysis was used to reduce the data to a smaller set of underlying dimensions. An additional benefit of the factor analysis technique is that it allows us to see what the major dimensions are that comprise the world of project management.

Four separate factor analyses were conducted. First a factor analysis was performed on all of the 206 variables. Then three separate factor analyses were done on variables which were considered to be within each of three a priori categories. The three a priori categories were first, "givens", or aspects of project environment or nature of the project over which management had little or no control. The second category was designated as "process" variables, items referring to aspects of the on-going management of the project and to things, people and events over which project management did have control. The final category consisted of variables that had to do with results and outcomes of the project. These three analyses yielded in a few instances factors which had clearer meanings than those obtained in the overall analysis. Generally, however, the factors emerging from the three separate analyses were redundant with those from the overall analysis. Between a redundant pair of factors, we retained for further study the one which had the clearer meaning or the heavier factor loadings.

A noteworthy result of the factor analysis was the large number of factors produced. This shows the multi-dimensional complexity of the project management "world".

In this section, the factors are described, with some effort made to show the implications of each factor. The listings below show the content of each of the factors and -- anticipating following sections -- includes commentary concerning each factor, its relationship to project success and its association with other factors.

Using orthogonal varimax rotation techniques, 32 meaningful factors were identified. These factors were interpreted by those variables included. Inclusion criteria was, for the most part, loading greater than .400. As the factors represent the underlying dimensions of the project characteristics it was thought desirable to investigate the relationships of the remaining factors with all other factors. Correlation analysis was used for this purpose to limit the relationships to those of prime importance, criteria established included a significance level of .001,  $r \geq .5$ , and  $r \geq .3$ . Causality was deduced from total interactive relationships.

Each of the factors is described below. Included with the description of each factor is a discussion of its important interrelationships with other factors.

Legal-Political Environment (Factor 2) -- This factor's strongly negative relationship to project success shows that projects encumbered by excessive governmental red tape, public participation and legal restrictions have very limited potential for success. The inclusion of the item, "Too many governmental agencies involved" in this factor indicates that from a strategy standpoint, projects which must be coordinated

through a number of agencies appear to have inherent obstacles which block success. Included items were:

107*	Too many government agencies involved	+ .742**
102	Government red tape caused delays	+ .741
124	Government overcontrol	+ .737
101	Project too encumbered by legal restrictions	+ .680
106	Public became too involved	+ .658
126	New forms of government - industry cooperation needed	+ .617
108	Too much politics involved in award	+ .590
110	Volume of paperwork was excessive	+ .556

Project Manager's Authority and Influence (Factor 3) --

This factor was strongly related to effective coordination during the project, and to ultimate project success. Factors acting as major determinants of project manager authority and influence were clarity of success criteria, internal criteria, client authority and influence, and size of the project team. The composition of this factor serves to emphasize the importance of both authority and influence, in combination, as determinants of project success. Included items were:

44	Project Manager's authority to authorize sub-contractors	+ .712
48	Project Manager's authority to select sub-contractors	+ .710
42	Project Manager's authority to authorize overtime	+ .709

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\*Item identification number  
\*\*Rotated Factor loading

49	Project Manager's influence in selecting sub-contractors	+ .673
45	Project Manager's influence in authorizing subcontractors to exceed budgets or schedules	+ .645
46	Project Manager's authority to select team personnel	+ .637
47	Project Manager's influence in selecting team personnel	+ .597
43	Project Manager's influence in authorizing overtime	+ .593
40	Project Manager's authority to relax specifications	+ .584
51	Project Manager's influence in giving merit raises	+ .542
50	Project Manager's authority to give merit raises	+ .526
41	Project Manager's influence in relaxing specifications	+ .520

Strategic Change in Parent (Factor 4) -- This factor was comprised of five items having to do with major modifications in strategy within the parent organization during the past five years. The factor bore a positive relationship to project success and was also associated with the establishment of internal success criteria as well as the establishment of clear criteria. Included items were:

167	Major modification in parent's R&D direction	+ .755
166	Major modification in parent's dollar R&D	+ .699
164	Major modification in parent's market	+ .668
163	Major modification in parent's product mix	+ .651
165	Major modification in parent's manufacturing process.	+ .582

Success Criteria Clarity and Consensus (Factor 5) -- This factor was strongly associated with project success. Clearly established success criteria tended to be characteristic of large projects, projects with legal-political difficulties and projects where there had been significant strategic changes in the parent organization, in short, projects in which a high degree of uncertainty prevailed.

The combination of items which loaded on this factor indicates that when importance is attached to one of the three factors -- budget, schedule or technical performance -- it tends to be attached to all three, otherwise these would have broken out as separate factors. The factor also indicates a general tendency for project manager, parent and client to agree on the importance of these three aspects of performance. Obviously, the loadings are not so high as to indicate that these tendencies always obtain, but the composition of the factor does suggest that the effective establishment of success criteria is a systemic phenomenon -- the parts need to reinforce each other. Included items were:

136	Importance to project manager - budget	+.678
135	Importance to project manager - schedule	+.676
128	Importance to parent - budget	+.671
127	Importance to parent - schedule	+.631
132	Importance to client - schedule	+.630
133	Importance to client - budget	+.562
134	Importance to client - technical performance	+.526

129	Importance to parent - technical performance	+ .512
137	Importance to project manager - technical performance	+ .455

Task (vs. Social) Orientation -- Primary (Factor 7) --

This factor measures the extent to which conflicts that arose during the project tended to be resolved by emphasizing mission goals vs. by emphasizing social, or "people" considerations. The composition of this factor indicates that respondents tended to see this as an "either-or" choice, a sub-optimal viewpoint, it would seem, in light of the large body of research findings which indicate that problems are most effectively resolved by reference to both task and social considerations. The factor was not strongly related to project success, further supporting those prior research findings which show the "either-or" approach to be less than optimal. The "task-oriented" mode of conflict resolution did tend to be related to minimization of cost and schedule overrun, but it was also associated with initial over-optimism concerning schedule and costs. The "task mode" tended to be employed more on complex projects and less on relatively routine projects. Included items were:

186	Primary Conflict Resolution Mode within parent was goal oriented	+ .618
202	Primary Conflict Resolution Mode team - client was goal oriented	+ .614
198	Primary Conflict Resolution Mode team - parent was goal oriented	+ .605
190	Primary Conflict Resolution Mode within client was goal oriented	+ .573

187	Primary Conflict Resolution Mode within parent was socially oriented	-.534
199	Primary Conflict Resolution Mode team - parent was socially oriented	-.534
203	Primary Conflict Resolution Mode team - client was socially oriented	-.503
194	Primary Conflict Resolution Mode team - client was goal oriented	+ .472
191	Primary Conflict Resolution Mode within client was socially oriented	-.432

Size of Project (Factor 8) -- Size of project was unrelated to project success. Large project size tended strongly to be associated with competitive and budgetary pressure, a high degree of client authority and influence, and clearly established success criteria. The fact that project size was unrelated to success may indicate that projects can be either too large or too small. Included items were:

149	Total cost of project	+ .779
147	Length of project	+ .768
148	Scheduled length of project	+ .767
150	Original total budget	+ .764

Systems Approaches (Factor 9) -- This factor indicates the extent to which effective use was made of systems approaches, since items relating not only to use, but also to value, were included in the factor. This factor was a strong determinant of project success and was also very strongly associated with adequacy of structure and control, effective coordination and

and relations, and minimization of cost and schedule overruns. Included items were:

13	Value of work breakdown structures	+ .650
12	Extent work breakdown structures were used	+ .634
14	Extent systems management concepts were used	+ .633
15	Value of systems management concepts	+ .535
18	Extent status and progress reports were used	+ .435

Initial Over-Optimism and Conceptual Difficulty

(Factor 10) -- This factor measures the extent to which the project was more complex and difficult than it was originally thought to be at the outset. The phenomenon of over-optimistic budget and schedule expectations and promises is unfortunately not rare. This factor showed a strong negative relationship with project success. Over-optimism was particularly likely to occur in the case of projects conducted with highly bureaucratic parent organizations and on projects which at some stage encountered legal or political difficulties. Items included were:

80	Difficulty meeting project schedules	+ .663
81	Difficulty staying within original budget	+ .642
103	Original cost estimates too optimistic	+ .553
79	Difficulty meeting technical requirements	+ .543
123	Project was more complex than initially conceived	+ .539
178	Schedule overrun	+ .490
87	Difficulty freezing design	+ .477

114	Unrealistic schedules	+ .472
111	Project was different than most	+ .442

Bureaucracy (Factor 11) -- "Bureaucratic" structures as measured by this factor, were characterized by high ratios of managers and staff to total employees in the parent organization and remoteness of the project manager from the project site. This factor was not strongly correlated with project success, or with other factors affecting success.

Included items were:

185	Parent managers to total employees (%)	+ .905
184	Parent staff personnel to total (%)	+ .809
152	Travel time - project manager to team	+ .683

Client Contact's Authority and Influence (Factor 12)

Client contact authority and influence tended to be greater on large size projects than on smaller projects and tended to be a determinant of project manager authority and influence. The factor was not strongly associated with project success or lack thereof. Included items were:

56	Client contact's authority to authorize overruns	+ .744
57	Client contact's influence in authorizing overruns	+ .744
54	Client contact's authority to approve subcontractors	+ .699
52	Client contact's authority to relax specifications	+ .662
55	Client contact's influence in approving subcontractors	+ .615

53	Client contact's influence in relaxing specifications	+ .511
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Internal Criteria (Factor 13) -- This factor refers to the extent to which internal benefits, such as improved capabilities and follow-on work, were considered important by the parent organization and the project manager. This factor was a strong determinant of project success and tended to result in internal capabilities buildup. Internal criteria were an especially strong concern on complex projects conducted within growing parent organizations that were experiencing changes in organizational strategy. Included items were:

139	Importance to project manager - improve parent capabilities	+ .679
131	Importance to parent - improve internal capabilities	+ .627
138	Importance to project manager - obtain follow-on	+ .556
130	Importance to parent - obtain follow-on	+ .488
95	Extent of parent capabilities buildup	+ .469

Size of Project Team (Factor 14) -- The items in this factor suggest that the factor measures size as well as administrative and technical sophistication of the project team. Not surprisingly, large project teams were associated with large projects and with the use of advanced control techniques (Factor 49). Included items were:

179	Total project team personnel	+ .899
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157	Number of administrative team	+ .843
156	Number of technical team members	+ .840
158	Number of "other" team members	+ .731

Social (Vs. Task) Orientation -- Secondary (Factor 15)

This factor was formed by items that asked the respondents to describe the secondary, or "back-up" mode of conflict resolution employed during the project. As was true of Factor 7, the loadings on this factor show that respondents tended to see attention to task or people consideration as an "either-or" choice when resolving disagreements. Though this factor did not show very strong relationships with other factors, there was some tendency for the social back-up orientation to be invoked where public relations difficulties and coordination difficulties were encountered, and on projects which were public in nature. The factor also tended to be associated with perceived adequacy of structure and control. There was a moderate tendency for this factor to be associated with Factor 7, the use of task-oriented methods as a primary conflict resolution mode ( $r=.22, p<.001$ ). This suggests that in many cases, the use of both task and social modes of resolving conflict helped project personnel to establish effective structures and controls despite the presence of certain difficulties. Included items were:

201	Secondary Conflict Resolution Mode, team-parent was socially oriented	+ .540
189	Secondary Conflict Resolution Mode, within parent was socially oriented	+ .456

188	Secondary Conflict Resolution Mode within parent was goal oriented	-.425
200	Secondary Conflict Resolution Mode, team-parent was goal oriented	-.409
204	Secondary Conflict Resolution Mode, team-client was goal oriented	-.409

Private (vs. Public) Project (Factor 16) -- The nature of a project as private sector or public sector tended to be associated with project success, as will be shown later in our path analysis. Private projects tended to be more successful than public projects. Included items were:

2	Client or source of funding	+.674
4	Public vs. private project	+.609
168	% parent budget to R&D	-.526
162	Parent industry	-.515
17	Value of operations research	-.419

Perceived Success of Project (R)\* (Factor 17) -- This factor is the "project success" variable referred to throughout this section as well as elsewhere in this report. It is interesting to note that the item, "technical performance, adequacy of end result", loaded strongly onto this factor, while items relating to cost overrun and schedule overrun did not. In other words, cost and schedule criteria were not so closely associated with success that they became part of the factor itself. Included items were:

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\*(R) indicates that this factor is reversed scored. A low factor score represents a high degree of perceived project success.

141	Satisfaction with outcome - client	-.734
140	Satisfaction with outcome - parent	-.701
143	Satisfaction with outcome - project team	-.683
105	Project a success	-.678
142	Satisfaction with outcome - end users	-.670
146	Technical performance, adequacy of end product	-.588

Project Manager's Spatial Distance (Factor 18) -- The project manager's geographic remoteness from the client and the project site was only weakly related to project failure, but did tend to lead to less than adequate organizational structure and control on the project, cost and schedule overruns and difficulty in coordinating with the client. Included items were:

154	Travel time -- project manager to client	+ .601
155	Travel time -- project manager to project site	+ .587

Parent Size (Factor 20) -- Parent organization size was associated with project success, though not strongly. The larger the parent organization, the greater the tendency for the project to experience start-up difficulties, but the less the likelihood of budgetary pressures. Project team members tended to participate in decision-making more within large parent organizations than in small ones, large size perhaps tending to force decision-making down to lower levels. Included items were:

174	Total parent employees	+ .751
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176	Total parent staff employees	+ .712
177	Total parent dollar sales	+ .673
175	Total parent line managers	+ .660

Project Team Decision Participation (R) (Factor 21) --

Project team participation in decision-making was very strongly related to project success. Decision participation by the project team was more likely to occur on projects which emphasized follow-on and internal build-up of capability.

It was less likely to occur on projects where over-optimistic budget and schedule forecasts had been made at the outset.

Included items were:

38	Project team participation in setting schedules	- .607
36	Project team participation in decision-making	- .585
39	Project team participation in setting budgets	- .542
35	Project team decision involvement	- .452
37	Project team participation in major problem solving	- .425

Parent 5-Year Growth (Factor 25) -- Recent growth in the

parent organization was not substantially associated with project success or with any of the other factors. Apparently, rapid growth can imply either a stimulant or a detriment to project success. Included items were:

172	Parent 5-year growth -- employees	+ .868
169	Parent 5-year growth -- sales	+ .854
170	Parent 5-year growth -- assets	+ .801
173	Parent 5-year growth -- customers	+ .693
171	Parent 5-year growth -- products	+ .631

Public Relations Environment (Factor 27) -- This factor encompassed difficulty in maintaining good relations with the public, with neighbors on the project site and with local government; as well as controversy concerning environmental impact of the project. This factor was strongly related to Factor 2, Legal Political Environment, and tended to be associated with lack of project success, though not to an extremely strong degree. Included items were:

92	Difficulty maintaining relations with public	.861
90	Difficulty maintaining relations with neighbors on site	.826
91	Difficulty maintaining relations with local government	.731
99	Extent of environmental impact controversy	.462

Competitive and Budgetary Pressure (Factor 31) -- This factor appears to be a measure of the extent to which a given project operated under budgetary pressure as a result of its having to be priced especially competitively. These characteristics tended to be associated with large projects conducted within large, relatively bureaucratic parent organizations. Included items were:

6	Nature of contract or agreement	+.682
5	Competitive Environment	-.604
128	Importance to parent - budget	+.569
136	Importance to project manager - budget	+.556
133	Importance to client - budget	+.497

Ease of Coordination (Factor 32) -- This factor is a measure of the extent to which coordination within the project team and within the parent organization was easy or difficult to achieve. Projects which were easy to coordinate were much more likely to be successful than those which were not, but the relationship between this factor and project success tended to disappear when actual coordination (Factor 42) was taken into account. In other words, coordination actually attained was what counted, and it could be attained, and often was, despite the existence of obstacles. Included items were:

85	Difficulty coordinating with parent organization	-.726
88	Difficulty maintaining rapport with parent organization	-.723
61	Unity between parent contributing departments (R)	-.679
86	Difficulty coordinating among team members	-.597
82	Difficulty keeping competent team members	-.437
76	Difficulty defining goals	-.419

Difficulty Coordinating With Client (Factor 34) -- This factor bore a strong negative relationship to project success and tended to be the result of project complexity, initial over-optimism, public relations difficulties and spatial distance of the project manager from his team. The emergence of this factor as a separate dimension in the factor analysis shows that difficulty in coordinating with the client is not the same thing as failure to coordinate with the client. If it were, these items would have loaded on Factor 42, Coordi-

nation and Relations. The data thus indicate that the difficulty is one which can be coped with and overcome. Included items were:

84	Difficulty coordinating with client organization	+ .790
89	Difficulty maintaining rapport with client organization	+ .728

Project Uniqueness, Importance and Public Exposure (R)

(Factor 36) -- This factor was correlated with several other factors that had to do with difficulties in the external environment as well as the technical demands of the project. It also tended to be associated with over-optimism and with the desire to use the project as a means toward developing the internal capabilities of the parent. As will be shown in Section 4.33, this factor was found to be correlated with project success when various factors relating to the management of the project were held constant. This indicates that, other things being equal, uniqueness, perceived importance, and public exposure are forces that tend to lead to project success, but these cannot substitute for effective management.

Included items were:

98	Extent of public enthusiasm	- .600
26	Project larger in scale than most	- .477
24	Initial importance of state-of-art advancement	- .458
111	Project was different than most	- .448
25	Parent experience with similar project scope	+ .438
100	Favorability of media coverage	- .416

Start-Up Difficulties (R) (Factor 39) -- As might be expected, projects with start-up difficulties tended to be associated with legal-political difficulties and with large parent organizations. Start-up difficulties bore a weak, though statistically significant relationship to lack of project success, and were strongly related to coordination difficulty within the parent organization and the project team. Included items were:

77	Difficulty obtaining initial parent approval	-.647
78	Difficulty obtaining client funding	-.400

Perceived Project Complexity (R) (Factor 40) -- The two items that loaded on this factor, taken together, indicate that projects tended to be seen as more complex by respondents who worked in highly structured organizations, and seen as less complex by those who worked in a more unstructured organizational setting. Thus, the factor is a measure of perceived high complexity and high parent structure, versus perceived low complexity and low parent structure. Interestingly, neither project size nor parent size were correlated significantly with this factor. This factor was not related to project success, but was related to project team decision participation, high project complexity and organizational structure tending to be associated with less decision participation on the part of the project team. Included items were:

116	Type of project becoming more complex	-.559
58	Degree of parent structure (R)	+.370

"Buy-In" Strategy (R) (Factor 41) -- "Buy-in" strategy, as shown by the items comprising this factor, refers to a top management decision to intentionally understate costs and price in order to win the contract in the face of severe competition. This approach was associated to a moderate degree with lack of project success and was very strongly associated with the legal-political environment. The correlation with the legal-political environment indicates that most projects that were characterized as buy-ins were government projects. Included items were:

109	"Cut throat" competition	.532
112	Cost estimates intentionally underestimated	-.510
104	Excessive pressure from parent management	-.430

Coordination and Relations (Factor 42) -- This factor indicates that the respondents saw favorable relationships between people as being closely related to effective planning and coordination of the effort. While many of the items in this factor connote team spirit and interpersonal rapport (the "unity" items, "informal relations" and "human skills"), others have to do with effective planning and control (the "progress reports," "procedures for changes" and "back-up strategies items", for example). The factor loadings show that interpersonal skill is part and parcel with managerial coordination and control. This factor was one of the strongest determinants of project success. Included items were:

62	Unity between project manager and contributing department managers (R)	-.695
113	Project team spirit	+.683
31	Project team sense of mission	+.651

62

32	Project team goal commitment	+ .611
30	Project team capability	+ .596
65	Unity between project manager and public officials (R)	- .583
63	Unity between project manager and client contact (R)	- .572
64	Unity between project manager and his superior (R)	- .564
29	Project Manager's human skills	+ .561
118	Progress reports were over-optimistic	- .544
28	Project Manager's administrative skills	+ .519
121	Team members informal relations supportive	+ .502
115	Project Manager had insufficient authority	- .496
125	Procedures for changes were inadequate	- .490
94	Project team job insecurity	- .473
36	Project team participation in decision-making	+ .469
37	Project team participation in major problem-solving	+ .458
96	Parent enthusiasm	+ .434
120	Back-up strategies were available	+ .426

Networking Techniques (Factor 49) -- Included items

were:

11	Value of network systems were used	+ .604
10	Extent network systems were used	+ .561

Cost and Schedule Overrun (Factor 52) -- While cost and schedule overrun tended to be associated with lack of project success, many projects in the study were considered successful

in spite of overruns. As a result, this factor does not appear as important to success as are a number of other factors. Among the major determinants of cost and schedule overrun were absence of specific control techniques and lack of project team participation in decision-making. Included items were:

151	% actual cost to budget	+ .891
178	Schedule overrun	+ .577

Adequacy of Project Structure and Control (Factor 53) --

This factor was also very strongly associated with project success, indicating the importance of the organizational aspects of project management. Adequate project structure and control tended to be seen by respondents as resulting from the employment of specific control techniques, such as PERT, systems analysis, etc. Very complex projects and projects on which the project manager's location was distant from the project site tended to be rated high on adequacy of project structure and control. Though the tendency was far from universal, it appeared that management attention tended to be given to those projects that needed it the most. Included items were:

145	Project Manager's satisfaction with planning and control	.825
144	Team's satisfaction with organization structure	.806

Internal Capabilities Build-up (R) (Factor 54) -- This factor, which was moderately related to project success, simply indicates that new parent organization capabilities are more

likely to be developed as a result of large projects than small projects. Included items were:

95	Extent of parent capabilities build-up	-.643
150	Original total budget	-.540
149	Total cost of project	-.510

#### 4.3 Analysis of Factors

Four types of analysis were performed using the factored data. Correlation analysis and analysis of variance were used to identify relationships between project success and individual factors taken one at a time. Multiple regression was employed to test the ability of several factors in combination to predict success. Finally, a path analysis was developed in order to reveal important interrelationships between factors and to identify factors which had significant indirect effects on project success.

##### 4.31 Correlation Using Factored Data

With 32 factors being considered, there were 1260 meaningful correlations which were performed. Since the major thrust of this study was to investigate project effectiveness, those correlations of central concern were those involved with success. Of the 32 factors, Factor 17 provides an independent measure of project success. This factor called "Perceived Success of the Project", was comprised of the following individual questionnaire items:

<u>Item</u>	<u>Factor Loading</u>
Satisfaction with outcome - client	.734

o Satisfaction with outcome - parent	.701
o Satisfaction with outcome - project team	.683
o Project was a success	.678
o Satisfaction with outcome - end users	.670
o Technical adequacy of end result	.588

To examine the surface relationships of the factors with success, the correlations of Factor 17 and the remaining factors were considered.

Using product-moment correlation, it was found that the following factors strongly affect success in the directions indicated:

<u>Factor</u>	<u>Correlation with Perceived Success Of Project Factor</u>
o Coordination and relations	+ .88
o Adequacy of structure and control	+ .81
o Initial over-optimism and conceptual difficulty	- .69
o Difficulty coordinating with client	- .69
o Project team decision participation	+ .67
o Ease of coordination	+ .66
o Project Manager's authority and influence	+ .55
o Success criteria clarity and consensus	+ .62
o Internal criteria	+ .60
o Systems approaches	+ .56
o Legal-political environment	- .56

The following factors tended to affect success in the directions indicated:

o Cost and schedule overrun	- .44
o Buy-in strategy	- .42
o Public relations environment	- .38
o Internal capabilities buildup	+ .34
o Strategic change in parent	+ .30
o Parent size	+ .28
o Start-up difficulties	- .24
o Task (vs. social) orientation -- primary	- .22

The following factors are associated with success:

o Bureaucracy	- .19
o Perceived Project Complexity	+ .18
o Client contact's authority and influence	+ .15
o Social (vs. task) orientation -- secondary	- .14
o Parent 5-year growth	+ .14
o Project Manager's spatial distance	- .13
o Size of project team	+ .11
o Private (vs. public) project	+ .11
o Project uniqueness, importance and public exposure	- .11

#### 4.32 Analysis of Variance Using Factored Data

The purpose of this portion of the analysis was to distinguish between those factors which improve success and those which cause failure. To achieve this purpose, the factored data were analyzed in two ways.

In the previous section product-moment correlations were performed on the factors identified. These correlations

indicate linear relationships of the factors with the overall success factor.

In this section "F-test" analysis of variance was performed on the factors with the success factor categorized by degree. This analysis allowed the identification of non-linear relationships -- particularly those associated only with failure.

Using "F-test" analysis of variance, it was found that the following factors strongly affect the failure of projects; however, the absence of these characteristics does not insure success (listed in order of importance).

- o absence of project management planning and control techniques
- o poor client relations
- o poor overall coordination
- o inherent project complexity
- o absence of project team participation
- o insufficient project manager authority and influence
- o ill-defined success criteria
- o external bureaucratic-political difficulties
- o buy-in strategy
- o poor public relations
- o static or undynamic parent organization
- o initial start-up difficulties
- o over-management by client
- o rigid parent organization

#### 4.33 Multiple Regression Using Factored Data

In the preceding sections we have made numerous references

to the relationship or association of the various factors with project success. In each case the kind of association we have been indicating is that of simple correlation, the extent to which variation in anyone given factor tends to be associated with variation in the perceived success factor, with no consideration given to the effects of any of the other factors. Simple correlation analysis leaves unanswered the question of whether several of the factors, taken together in combination, would explain a larger portion of the variance in the success factor than would any one factor by itself. Since it is our contention that project success results not from any one factor alone, but from a combination of many factors, a further test of the data, beyond simple correlation analysis, is necessary.

Table 4.2 shows the results of one such test. Here are shown the results of a stepwise multiple regression analysis in which Factor 17, the Perceived Success of Project factor, was the dependent variable and all of the other factors were independent variables. The independent variable with the highest partial correlation at the conclusion of each step was the variable entered into the equation in the next step. This form of analysis yields a list of those factors which each make significant independent contributions toward explaining project success, after allowance has been made for the effects of the other factors.

Table 4.2 shows that strongest seven of the determining factors explained 91% of the variance in the success factor.

TABLE 4.2

Multiple Regression Results: All Factors  
as Determinants of Factor 17, Perceived  
Success of Project

<u>Strongest Determining Factors</u>	<u>Standardized Regression Coefficient</u>	<u>Signifi- cance</u>	<u>Cumula- tive R<sup>2</sup></u>
42* Coordination and Relations	+ .347	p < .001	.773
53 Adequacy of Project Structure and Control	+ .187	p < .001	.830
36 Project Uniqueness, Importance and Public Exposure	+ .145	p < .001	.877
5 Success Criteria Clarity and Consensus	+ .254	p < .001	.886
31 Competitive and Budgetary Pressure	- .153	p < .001	.897
10 Initial Over optimism and Conceptual Difficulty	- .215	p < .001	.905
54 Internal Capabilities Buildup	+ .084	p < .001	.911

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\*Factor Identification Number

This very large percentage of explained variance is attributable partly to the strong determining effect of Coordination and Relations on project success. However, it is also attributable to the fact that six other factors made significant contributions toward explaining success even after the effects of Coordination and Relations had been held constant. This analysis supports well, therefore, the proposition that project success is multiply caused rather than singly caused. Coordination and Relations, though very important, is not the sole determinant of project success.

Table 4.2 re-emphasizes the importance of the initial phases of project planning. Success Criteria Clarity and Consensus and avoidance of Initial Over-Optimism were the two heaviest weighted factors in the regression equation, after Coordination and Relations.

It is interesting to note that two factors which had insignificant simple correlations with success did emerge as significant determinants of success when other factors were held constant. One of these was Factor 36, Project Uniqueness, Importance and Public Exposure. The analysis shows that unique and highly publicized projects tend to be more successful than others, but that this aspect of the project is not as critically important to its success as are the ways in which the project is managed. Factor 31, Competitive and Budgetary Pressure was another which had shown no relationship to success under simple correlation analysis, but showed a significant negative relationship with success in the

multiple regression equation. This result is saying that, all other things being equal, competitive and budgetary pressure tend to work against success.

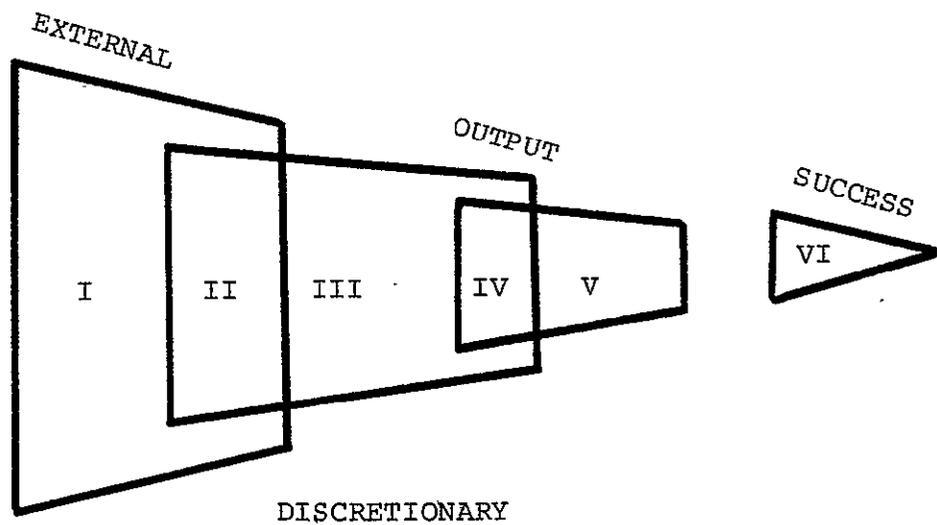
With the exception of Factor 36, all seven of the factors shown in Table 4.2 had to do with project management effectiveness and were things which management had the potential ability to influence. This analysis points forcefully to the importance of project management as a determinant of project success by suggesting that relatively less controllable factors such as the legal-political environment, the on-going nature of the parent organization, and the behavior of the client, are not likely to be things that act as fatal obstacles to a well-managed project, nor will they make a success of a poorly managed project. This is not to say that factors relating to the environment, the client and the parent organization are unimportant. Indeed, these factors can act as either facilitators or obstacles to effective project management, as will be clearly shown in the path analysis section of this report. Nonetheless, the regression analysis shows that on most projects, the determinants of project success are within the control of those who are managing and making decisions about the project.

#### 4.4 Path Analysis

Analysis of the factors and factor correlations indicate that three major groupings or partitions are reasonable:

- 1) factors which are external to the project;
- 2) those which are discretionary; and
- 3) those which represent output characteristics

Further, analysis indicates that these groupings are not mutually exclusive, and many factors are shown to belong to more than one group. For example, client/influence appears to be a "given" or external factor as it relates to control techniques utilized, but it is also a discretionary factor in relation to the bureaucracy factor. Such situations require overlapping classifications which result in six subsets:



Using the preceding paradigm the factors were classified in the following manner:

- I. EXTERNAL factors are those over which there is little or no control; typically these describe pre-existent conditions.
- o Legal Political Environment (2)\*
  - o Strategic Change in Parent (4)
  - o Size of Project (8)
  - o Bureaucracy (11)
  - o Private (vs. Public) Project (16)
  - o Parent Size (20)
  - o Parent 5-Year Growth (25)
  - o Project Uniqueness, Importance and Exposure(R) (36)
  - o Perceived Project Complexity (R) (40)
- II. PROCESS/EXTERNAL factors are external or predetermined to the specific project effort, but discretionary in the larger system.
- o Success Criteria Clarity and Concensus (5)
  - o Initial Over-optimism and Conceptual Difficulty (10)
  - o Client Contact's Authority and Influence (12)
  - o Internal Criteria (13)
  - o Size of Project Team (14)
  - o Public Relations Environment (27)
  - o Competitive and Budgetary Pressure (31)
  - o Start-up Difficulties (R) (39)
  - o Buy-in Strategy (R) (41)

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\*Factor Identification Number

III. PROCESS factors are essentially discretionary specific to the effort.

- o Project Manager's Authority and Influence (3)\*
- o Task (vs. Social) Orientation -- Primary (7)
- o Systems Approaches (9)
- o Social (vs. Task) Orientation -- Secondary (15)
- o Project Manager's Spatial Distance (18)
- o Project Team Decision Participation (R) (21)
- o Networking Techniques (49)

IV. OUTPUT/PROCESS factors represent both end-product and facilitating characteristics.

- o Ease of Coordination (32)
- o Difficulty Coordinating With Client (34)
- o Coordination and Relations (42)

V. OUTPUT factors are end-products of the specific project effort, they are consequent to the process.

- o Cost and Schedule Overrun (52)
- o Adequacy of Project Structure and Control (53)
- o Internal Capabilities Buildup (R) (54)

VI. The SUCCESS factor assesses the project output.

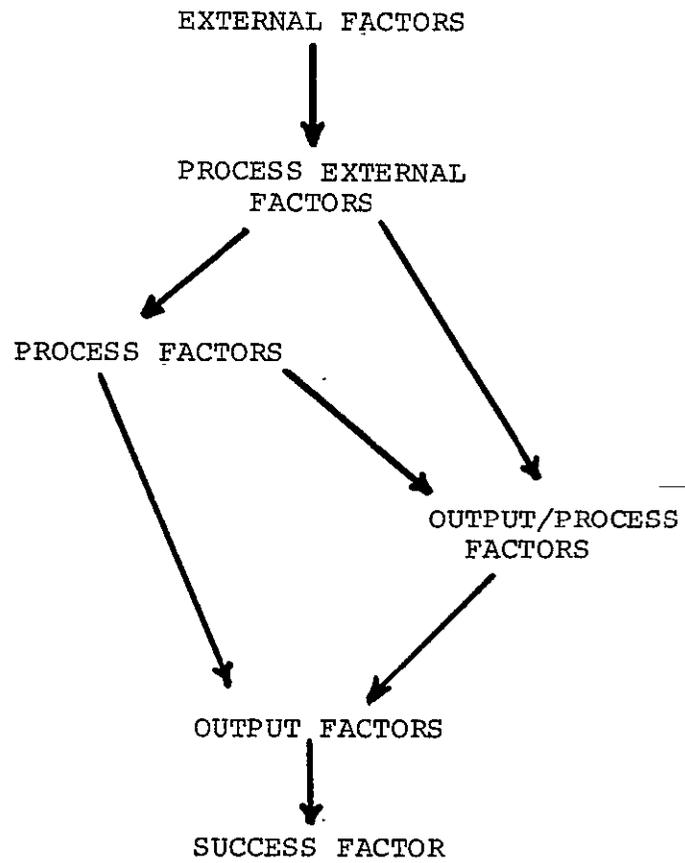
- o Perceived Success of Project (R) (17)

Speculative causal analysis yields a model descriptive of these group interrelationships, see Figure 4.1.

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\*Factor Identification Number

FIGURE 4.1  
HYPOTHESIZED CAUSAL MODEL



Given the six factor groupings and the causal model, an approach comparable to path analysis was employed as a final analytic step to aide in interpretation of the relationships among all factors as determinants of project success.

It was found that Factor 17, Success, was directly determined ( $R^2=.880$ ) by:

o Cost and Schedule Overrun	(52)*	(.081)**
o Adequacy of Project Structure and Control	(53)	(.256)
o Internal Capabilities Buildup (R)	(54)	(.110)
o Ease of Coordination	(32)	(.089)
o Difficulty Coordinating With Client	(34)	(.275)
o Coordinations and Relations	(42)	(.533)

As summarized in Tables 4.3 - 4.6, it was found that OUTPUT factors were determined by OUTPUT PROCESS AND PROCESS factors; OUTPUT PROCESS factors were determined by PROCESS factors and PROCESS EXTERNAL factors; and PROCESS factors were determined by PROCESS EXTERNAL factors which were, in turn, determined by EXTERNAL factors.

Based on the path coefficients derived in the previous table total path coefficients were determined for all factors as they relate to success, Factor 17. Total path coefficients indicate the relative importance of each factor as a determinant of success -- even though the influence may be indirect. These coefficients are summarized in Table 4.7.

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\*Factor Identification Number

\*\*Direct path coefficient (standardized regression coefficient), indicating the relative determinant value of the factor.

Analysis of the total path coefficients points out the importance of the factors as determinants of success. Particularly the most important include:

o Legal Political Environment	(2) *
o Initial Over-optimism and Conceptual Difficulty	(10)
o Coordination and Relations	(42)
o Internal Criteria	(13)
o Project Team Decision Participation (R)	(21)
o Success Criteria Clarity and Concensus	(5)
o Difficulty Coordinating With Client	(34)
o Adequacy of Structure and Control	(53)

Although some of the remaining factors show relatively weak contributions to success, the importance of these factors should not be underestimated as they most often significantly impact upon others of greater importance. Such cannot, therefore, be casually dismissed.

The results of the path analysis are summarized in Figure 4.3.

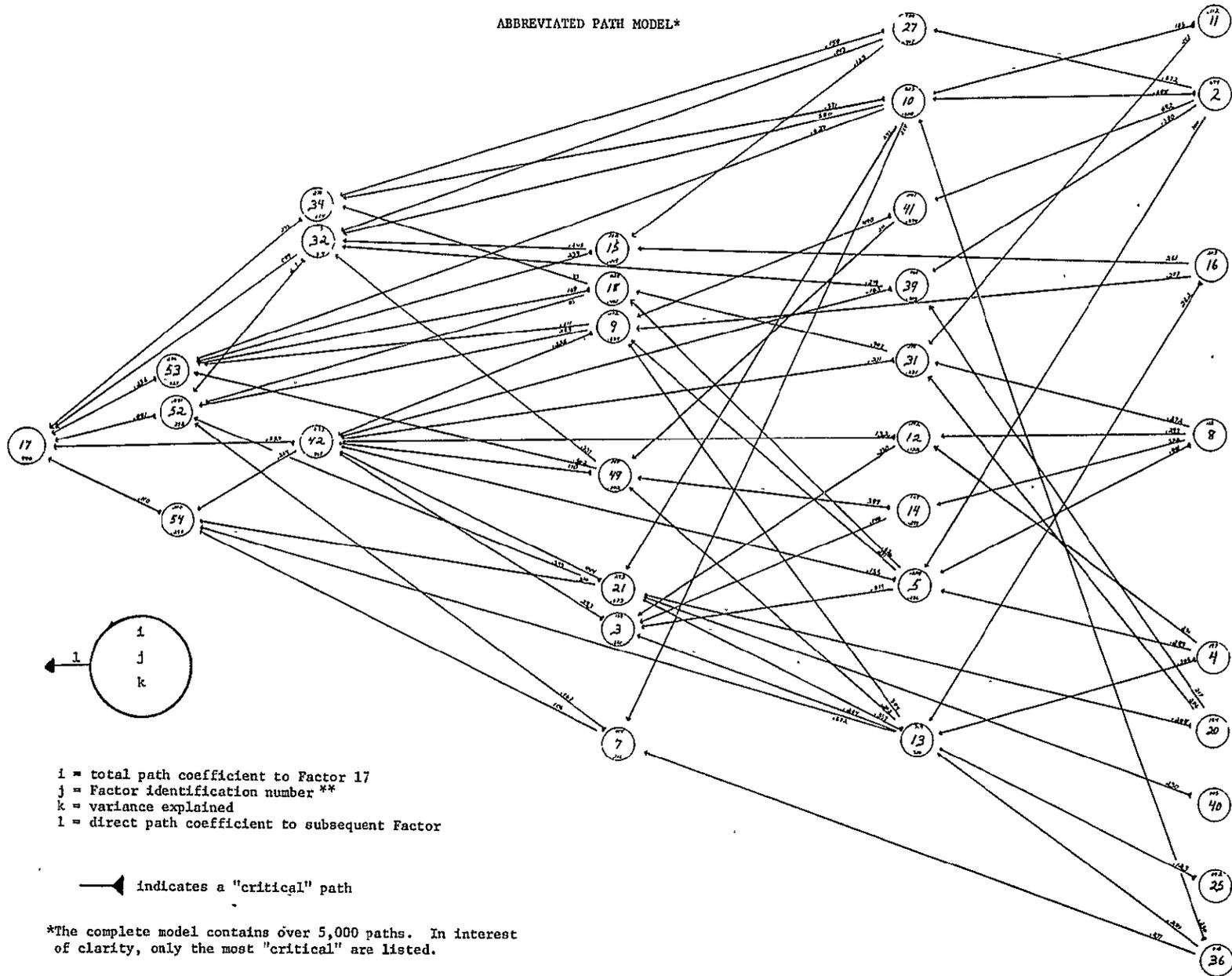
Beyond providing a summary of the path analysis, the path model represented in Figure 4.3 has further value in at least two other dimensions.

First, the path model illustrates a complex set of inter-relationships among factors, indicating those which directly affect, as well as those which indirectly affect, success.

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\*Factor Identification Number

FIGURE 4.3  
ABBREVIATED PATH MODEL\*



i = total path coefficient to Factor 17  
 j = Factor identification number \*\*  
 k = variance explained  
 l = direct path coefficient to subsequent Factor

← indicates a "critical" path

\*The complete model contains over 5,000 paths. In interest of clarity, only the most "critical" are listed.

\*\*see pages following for factor identifications

FIGURE 4.3, continued  
FACTOR LABELS

- 17 Perceived Success of Project (R)
  
- 52 Cost and Schedule Overrun
- 53 Adequacy of Project Structure and Control
- 54 Internal Capabilities Buildup (R)
  
- 32 Ease of Coordination
- 34 Difficulty Coordinating With Client
- 42 Coordination and Relations
  
- 3 Project Manager's Authority and Influence
- 7 Task (vs. Social) Orientation -- Primary
- 9 Systems Approaches
- 15 Social (vs. Task) Orientation -- Secondary
- 18 Project Manager's Spatial Distance
- 21 Project Team Decision Participation (R)
- 49 Networking Techniques

- 5 Success Criteria Clarity and Concensus
- 10 Initial Over-optimism and Conceptual Difficulty
- 12 Client Contact's Authority and Influence
- 13 Internal Criteria

- 14 Size of Project Team
- 27 Public Relations Environment
- 31 Competitive and Budgetary Pressure
- 39 Start-up Difficulties (R)
- 41 Buy-in Strategy (R)
  
- 2 Legal Political Environment
- 4 Strategic Change in Parent
- 8 Size of Project
- 11 Bureaucracy
- 16 Private (vs. Public) Project
- 20 Parent Size
- 25 Parent 5-Year Growth
- 36 Project Uniqueness, Importance and Public Exposure (R)
- 40 Perceived Project Complexity (R)

This is particularly important in clarifying relationships proposed on the basis of uni-dimensional analysis. Further, it points out important factors not able to be identified by less complex analytic techniques.

Second, the path model readily identifies guidelines to follow given particular states of particular factors. For example, if the Legal-Political Environment is excessively oppressive, the path diagram points to the need to place increased emphasis on initial conceptualization (Factor 10), public relations (Factor 27), and (Factor 5) clearly established criteria.

TABLE 4.3

PATH COEFFICIENTS OF  
OUTPUT FACTORS DETERMINED BY  
OUTPUT/PROCESS AND PROCESS FACTORS

<u>OUTPUT PROCESS AND PROCESS FACTORS</u>		<u>OUTPUT FACTORS</u>		
		52*	53	54(R)
32*	Ease of Coordination	.207	-.155	ns
42	Coordination and Relations	.181	-.135	-.264
3	Project Manager's Authority and Influence	ns	.125	ns
7	Task (vs. Social) Orientation -- Primary	-.167	ns	.106
9	Systems Approaches	-.293	.311	.127
15	Social (vs. Task) Orientation -- Secondary	.172	.239	.059
18	Project Manager's Spatial Distance	.115	-.169	.061
21	Project Team Decision Participation (R)	.243	-.322	-.210
49	Networking Techniques	.265	-.302	ns
10	Initial Over-Optimism and Conceptual Difficulty	.681	-.627	-.142
12	Client Contact's Authority and Influence	.049	-.186	.093
13	Internal Criteria	ns	.228	-.572

\*Factor Identification Number

TABLE 4.4

PATH COEFFICIENTS OF  
OUTPUT/PROCESS FACTORS DETERMINED BY  
PROCESS AND PROCESS/EXTERNAL FACTOR

PROCESS AND PROCESS/EXTERNAL FACTORS	OUTPUT/PROCESS FACTORS		
	32*	34	42
3* Project Manager's Authority and Influence	.123	-.074	.233
7 Task (vs. Social) Orientation -- Primary	.071	ns	ns
9 Systems Approaches	ns	.138	.226
15 Social (vs. Task) Orientation -- Secondary	-.245	ns	-.108
18 Project Manager's Spatial Distance	ns	-.115	ns
21 Project Team Decision Participation (R)	-.155	ns	-.444
49 Networking Techniques	-.237	ns	-.170
5 Success Criteria Clarity and Concensus	ns	-.176	.155
10 Initial Over-optimism and Conceptual Difficulty	-.580	.591	-.294
12 Client Contact's Authority and Influence	-.190	.155	-.132
13 Internal Criteria	.055	-.139	ns
14 Size of Project Team	ns	ns	ns
27 Public Relations Environment	-.143	.158	ns
31 Competitive and Budgetary Pressure	ns	.219	-.211
39 Start-up Difficulties (R)	.279	-.101	.103

\*Factor Identification Number

TABLE 4.5

PATH COEFFICIENTS OF  
PROCESS FACTORS DETERMINED BY  
PROCESS/EXTERNAL AND EXTERNAL FACTORS

PROCESS EXTERNAL AND EXTERNAL FACTORS	PROCESS FACTORS						
	3	7	9	15	18	21	49
5* Success Criteria Clarity and Consensus	.319	.095	.281	ns	-.627	-.142	ns
10 Initial Over-optimism and Conceptual Difficulty	-.188	.264	-.100	ns	ns	.241	-.201
12 Client Contact's Authority & Influence	.230	ns	ns	-.191	.076	ns	-.089
13 Internal Criteria	.264	-.115	.304	ns	.244	-.357	.262
14 Size of Project Team	.140	.105	ns	-.071	ns	ns	.389
27 Public Relations Environment	.119	ns	ns	.123	ns	ns	.090
31 Competitive and Budgetary Pressure	-.166	ns	ns	ns	.908	-.196	ns
39 Start-up Difficulties (R)	ns	-.152	ns	.074	ns	ns	-.126
41 Buy-in Strategy (R)	ns	ns	-.490	ns	-.162	.164	ns
2 Legal Political Environment	-.101	-.186	-.318	ns	-.145	.129	-.079
4 Strategic Change in Parent	ns	-.064	.085	-.096	.105	ns	.245
8 Size of Project	ns	.167	.274	-.107	.187	-.160	ns
11 Bureaucracy	-.077	ns	-.103	.088	ns	ns	ns
16 Private (vs. Public) Project	ns	ns	-.277	-.261	ns	ns	ns
20 Parent Size	ns	-.180	.185	-.106	.157	-.205	-.085
25 Parent 5-Year Growth	ns	ns	ns	.084	ns	ns	-.088
36 Project Uniqueness, Im- portance and Public Exposure (R)	ns	-.271	ns	ns	.125	.082	ns
40 Perceived Project Complexity (R)	.086	ns	ns	ns	ns	-.230	ns

\*Factor Identification Number

TABLE 4.6

PATH COEFFICIENTS OF  
PROCESS/EXTERNAL FACTORS DETERMINED BY  
EXTERNAL FACTORS

	5*	10	12	13	14	27	31	39	41
2* Legal Political Environment	-.300	.688	-.078	-.218	-.203	.672	.150	-.580	-.692
4 Strategic Change in Parent	.285	-.123	.231	.305	.032	.043	-.004	.101	.105
8 Size of Project	.401	-.080	.293	.067	.532	.123	-.372	-.031	.043
11 Bureaucracy	-.178	.105	-.079	-.075	-.068	.069	-.207	.065	-.041
16 Private (vs. Public) Project	.019	.131	.077	-.262	-.106	.197	-.070	.140	-.174
20 Parent Size	-.001	.019	-.093	.021	-.120	.073	-.286	-.217	.138
25 Parent 5-Year Growth	.067	-.055	.030	.123	-.056	ns	.074	-.066	.042
36 Project Uniqueness, Importance and Public Exposure (R)	.070	-.250	-.029	-.281	-.144	-.072	.323	-.170	.051
40 Perceived Project Complexity (R)	.129	-.029	.146	-.069	.081	.140	.199	-.105	.101

\*Factor Identification Number

TABLE 4.7

TOTAL PATH COEFFICIENTS  
FOR FACTOR 17, "SUCCESS"  
 $R^2 = .880$

## FACTOR

52	Cost and Schedule Overrun	.081
53	Adequacy of Project Structure and Control	.256
54	Internal Capabilities Buildup (R)	.110
32	Ease of Coordination	.145
34	Difficulty Coordinating With Client	.275
42	Coordination and Relations	.513
3	Project Manager's Authority and Influence	.159
7	Task (vs. Social) Orientation -- Primary	.008
9	Systems Approaches	.172
15	Social (vs. Task) Orientation -- Secondary	.019
18	Project Manager's Spatial Distance	.028
21	Project Team Decision Participation (R)	.293
49	Networking Techniques	.158
5	Success Criteria Clarity and Concensus	.288
10	Initial Over-optimism and Conceptual Difficulty	.523
12	Client Contact's Authority and Influence	.102
13	Internal Criteria	.309
14	Size of Project Team	.047
27	Public Relations Environment	.020
31	Competitive and Budgetary Pressure	.175
39	Start-up Difficulties (R)	.060

41	Buy-in Strategy (R)	.041
2	Legal Political Environment	.694
4	Strategic Change in Parent	.197
8	Size of Project	.115
11	Bureaucracy	.112
16	Private (vs. Public) Project	.203
20	Parent Size	.104
25	Parent 5-Year Growth	.092
36	Project Uniqueness, Importance and Public Exposure (R)	.015
40	Perceived Project Complexity (R)	.005

## V. CONCLUSIONS

### 5.1 Analysis

To achieve the purpose of the study the data were analyzed in seven ways. These analyses were conducted in two major partitions: the first utilizing raw data, the second utilizing factored data. With the raw data, variance, correlation, and factor analysis techniques were used. One of the results of a factor analysis is a set of factor scores. With these factor scores, variance, correlation, regression, and path analysis techniques were used.

#### 5.11 Correlation

Product-moment correlation was performed on the project characteristic variables with six indices of success. These correlations indicate surface relationships of the project characteristics with the success items.

It was found that the following project management characteristics strongly affect success ( $r > .3$ ,  $p < .001$ ) in the direction indicated.

#### Item Description

- o Project team sense of mission (+)
- o Project team spirit (+)
- o Project team goal commitment (+)
- o Original cost estimates too optimistic (-)
- o Project team capability (+)
- o Difficulty meeting project schedules (-)
- o Back-up strategies were available (+)
- o Difficulty in obtaining funding to completion (-)
- o Project Manager's satisfaction with planning and control (+)

- o Unity between project manager and contributing department managers (+)
- o Difficulty staying within original budget (-)
- o Unity between project manager and client contact (+)
- o Unity between project manager and public officials (+)
- o Unity between parent contributing departments (+)
- o Difficulty coordinating with client organization (-)

Although the relationships are not as strong ( $.2 \leq r \leq .3$ ), it was found that the following project management characteristics tend to affect success ( $p < .001$ ) in the directions indicated.

- o Parent enthusiasm (+)
- o Unrealistic project schedules (-)
- o Lack of rapport with client organization (-)
- o Team's satisfaction with organization structure (+)
- o Progress reports were over-optimistic (-)
- o Project Manager's technical skills (+)
- o Project team participation in major problem solving (+)
- o Decision delays hampered project (-)
- o Difficulty closing out project (-)
- o Procedures for changes were inadequate (-)
- o Difficulty maintaining rapport with parent organization (-)
- o Project Manager had insufficient authority (-)
- o Project team participation in decision making (+)
- o Unity between project manager and his superior (+)
- o Extent of parent new capabilities buildup (+)
- o Favorability of media coverage (+)
- o Project Manager's human skills (+)
- o Difficulty in coordinating among team members (-)
- o Schedule overrun (-)
- o Difficulty freezing design (-)
- o Difficulty keeping competent team people (-)
- o Excessive politics involved in award (-)
- o Cost estimates intentionally underestimated (-)
- o Value of status, progress reports (+)
- o Project Manager's administrative skills (+)
- o Value of work breakdown structures (+)
- o Project too encumbered by legal restrictions (-)
- o Too many government agencies involved (-)
- o Value of Bar, Gantt, Milestone charts (+)
- o Project Manager's influence in selecting team personnel (+)
- o Project team's job insecurity (-)
- o Difficulty in defining goals (-)
- o Need new forms of government - industry cooperation (-)
- o Project Manager's influence in authorizing subcontractors (+)

Although the relationships are not as strong ( $r < .2$ ), it was found that the following project management characteristics are associated with success ( $p < .001$ ).

- o Project Manager's influence in selecting subcontractors (+)
- o Project was more complex than initially conceived (-)
- o Difficulty in meeting technical requirements (-)
- o Government overcontrol (-)
- o Importance to parent - technical performance (+)
- o Importance to project manager - technical performance (+)
- o Project decisions made at higher than appropriate levels (-)
- o Project Manager's influence in authorizing overtime (+)
- o Extent of parent enthusiasm (+)
- o Importance to project manager - schedule (+)
- o Difficulty in coordinating with parent organization (+)
- o Adequacy of project physical facilities (+)
- o Project Manager's influence in relaxing specifications (+)
- o Value of network systems (+)
- o Project Manager's influence in giving merit raises (+)
- o Team members hampered by unrelated assignments (-)
- o Public became too involved (-)
- o Government red-tape caused delays (-)
- o Importance to parent - schedule (+)
- o Volume of paper work was excessive. (-)
- o Too much pressure from parent top management (-)
- o Importance to project manager - budget (+)
- o Project team participation in setting budgets (+)
- o Extent of project structure revision (-)
- o Importance to client - technical performance (+)

### 5.12 Analysis of Variance

While correlation analysis is a useful way of discovering that a relationship exists between two variables, it has the disadvantage that it assumes the relationship to be continuous and linear across the full range of both variables being considered. Analysis of variance was used in order to discover which variables were associated with project failure but not with success, which were associated with success but not with failure, and which were associated with both success and failure -- linear and continuous.

Considering the above, it was found that the presence of the following project management characteristics strongly affect the failure of projects; however, the absence of these characteristics does not insure success.

- o insufficient use of status/progress reports
- o use of superficial status/progress reports
- o inadequate project manager administrative skills
- o inadequate project manager human skills
- o inadequate project manager technical skills
- o insufficient project manager influence
- o insufficient project manager authority
- o insufficient client influence
- o poor coordination with client
- o lack of rapport with client
- o client disinterest in budget criteria
- o lack of project team participation in decision-making
- o lack of project team participation in major problem-solving
- o excessive structuring of project team
- o job insecurity within the project team
- o lack of team spirit and sense of mission within the project team
- o parent organization stable, non-dynamic, lacking strategic change
- o poor coordination with parent organization
- o lack of rapport with parent organization
- o new "type" of project
- o project more complex than the parent has completed previously
- o initial under-funding
- o inability to freeze design early
- o inability to close-out the effort
- o unrealistic project schedules
- o inadequate change procedures
- o poor relations with public officials
- o unfavorable public opinion

While the above were found to be associated with project failure, the following were found to be associated with success. That is, the following were found to be necessary, but not sufficient conditions for success.

- o frequent feedback from the parent organization
- o frequent feedback from the client

- o judicious use of networking techniques
- o availability of backup strategies
- o organization structure suited to the project team
- o adequate control procedures, especially for dealing with changes
- o project team participation in setting schedules and budgets
- o flexible parent organization
- o parent commitment to established schedules
- o parent enthusiasm
- o parent commitment to technical performance goals
- o parent desire to build up internal capabilities
- o project manager commitment to established schedules
- o project manager commitment to established budget
- o project manager commitment to technical performance goals
- o client commitment to established schedules
- o client commitment to established budget
- o client commitment to technical performance goals
- o enthusiastic public support
- o lack of legal encumbrances.
- o lack of excessive government red-tape
- o minimized number of public/government agencies involved

In addition to those factors which affect success or failure, some were found to be linearly related to both success and failure. That is, the presence of the following characteristics tend to improve the probability of success while their absence leads toward failure.

- o goal commitment of project team
- o accurate initial cost estimates
- o adequate project team capability
- o adequate funding to completion
- o adequate planning and control techniques
- o minimal start-up difficulties
- o task (vs. social) orientation
- o absence of bureaucracy
- o on-site project manager
- o clearly established success criteria

### 5.13 Factor Analysis

Due to the large number of variables included in the

study, the technique of factor analysis was used to reduce the data to a smaller set of underlying dimensions. An additional benefit of the factor analysis technique is that it allows us to see what the major dimensions are that comprise the world of project management.

A noteworthy result of the factor analysis was the large number of factors produced. This illustrates the multi-dimensional complexity of the project management "world". The factors or underlying dimensions identified include:

- o Legal political environment
- o Project Manager's authority and influence
- o Strategic change in parent
- o Success criteria clarity and consensus
- o Task (vs. social) orientation -- primary
- o Size of project
- o Systems approaches
- o Initial over-optimism and conceptual difficulty
- o Bureaucracy
- o Client contact's authority and influence
- o Internal criteria
- o Size of project team
- o Social (vs. task) orientation -- secondary
- o Private (vs. public) project
- o Perceived success of project (R)
- o Project Manager's spatial distance
- o Parent size
- o Project team decision participation
- o Parent 5-year growth
- o Public relations environment
- o Competitive and budgetary pressure
- o Ease of coordination
- o Difficulty coordinating with client
- o Project uniqueness, importance and public exposure (R)
- o Start-up difficulties (R)
- o Perceived project complexity
- o Buy-in strategy (R)
- o Coordination and relations
- o Networking techniques
- o Cost and schedule overrun
- o Adequacy of project structure and control
- o Internal capabilities buildup (R)

#### 5.14 Correlation Using Factored Data

Of the 32 factors identified, Factor 17 provides an independent measure of project success. To examine the surface relationships of the factors with success, the correlations of Factor 17 and the remaining factors were considered.

Using product-moment correlation, it was found that the following factors strongly affect success in the directions indicated:

- o Coordination and relations (+)
- o Adequacy of structure and control (+)
- o Project difficulty and complexity (-)
- o Difficulty coordinating with client (-)
- o Project team decision participation (+)
- o Coordination difficulty (-)
- o Project manager authority and influence (+)
- o Clearly established success criteria (+)
- o Project difficulty (-)
- o Internal criteria (+)
- o Control techniques (+)
- o Legal-political difficulties (-)

Although the relationships were not as strong, the following factors were associated with success in the directions indicated.

- o Bureaucracy (-)
- o Parent organization flexibility (+)
- o Client contact's authority and influence (-)
- o Social (vs. task) orientation -- secondary (+)
- o Parent 5-year growth (+)
- o Project Manager's spatial distance (-)
- o Size of project team (-)
- o Private (vs. public) project (+)
- o Routine-type project (+)

#### 5.15 Analysis of Variance Using Factored Data

"F-test" analysis of variance was performed on the factors

with the success factor categorized by degree. This analysis allowed the identification of non-linear relationships -- particularly those associated only with failure.

Using "F-test" analysis of variance, it was found that the following factors strongly affect the failure of projects; however, the absence of these characteristics does not insure success (listed in order of importance).

- o absence of project management planning and control techniques
- o poor client relations
- o poor overall coordination
- o inherent project complexity
- o absence of project team participation
- o insufficient project manager authority and influence
- o ill-defined success criteria
- o external bureaucratic-political difficulties
- o buy-in strategy
- o poor public relations
- o static or undynamic parent organization
- o initial start-up difficulties
- o over-management by client
- o rigid parent organization

#### 5.16 Regression Using Factored Data

Up to this point we have made numerous references to the relationship or association of the various project characteristics and factors with project success. In each instance we have been describing "simple" relationships, that is, the extent to which variation in any one given characteristic or factor tends to be associated with variation in success, with no consideration given to the effects of any of the other characteristics or factors. Simple relationships leave unanswered the question of whether several variables, taken in

combination, would explain a larger portion of the variance in success than would any one variable by itself. Since we contend that project success results not from any one cause alone, but from a combination of causes, a further test of the data was necessary.

Multiple regression analysis provided this test. In this analysis, the "perceived success of project" factor was used as the dependent variable, and the other 31 factors were independent variables.

The analysis revealed that the seven strongest of the independent variables, taken together, explained 91% of the variation in the success factor. These seven factors, in order of importance and with the direction of their effect indicated, were the following:

- o Coordination and relations (+)
- o Adequacy of project structure and control (+)
- o Project uniqueness, importance and public exposure (+)
- o Success criteria clarity and consensus (+)
- o Competitive and budgetary pressure (-)
- o Initial over-optimism and conceptual difficulty (-)
- o Internal capabilities buildup (+)

This analysis clearly supported the proposition that project success is multiply caused rather than singly caused. Furthermore, most of the factors listed above were things which management had the potential ability to influence. This result points forcefully to the importance of project management as a determinant of success by suggesting that relatively less controllable factors such as the legal-political environment, the on-going nature of the parent organization, and the

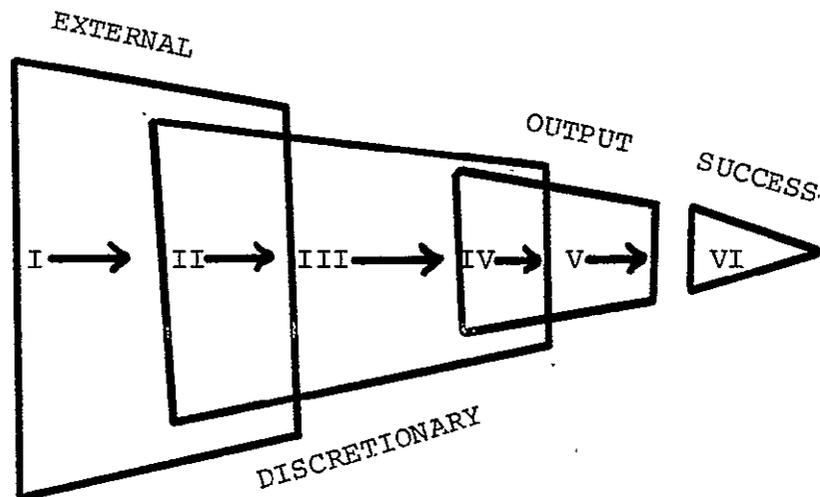
behavior of the client, need not act as fatal obstacles to the success of a well-managed project, nor will they make a success of a poorly managed project. The regression analysis shows that on most projects, the determinants of project success are within the control of those who are managing and making decisions about the project.

### 5.17 Path Analysis

Study of the above analyses suggest that the variables considered in this study can be classified as being either:

- I. EXTERNAL
- II. PROCESS/EXTERNAL
- III. PROCESS
- IV. OUTPUT/PROCESS
- V. OUTPUT
- VI. SUCCESS

Their relationships may be illustrated as follows:



Considering the preceding paradigm, path analysis was used to study the interrelationships of the identified factors. The result of the path analysis is a path model which illustrates the complex set of interrelationships among factors -- indicating those which directly affect, as well as those which indirectly affect success.

The path model developed, as shown in Figure 5.1, does much in achieving the stated purpose of the study -- "to determine the interactions of numerous project considerations with particular reference to project performance"

## 5.2 Conclusion

The various statistical analyses described above yield immediate conclusions regarding determinants of project success. More important, however, are conclusions based upon these analyses when considered collectively. When so considered, more general and perhaps more important conclusions can be formulated. In Chapter I the following conclusions are developed:

- 5.21 Project Management is a complex mechanism containing numerous variables of significance to project success. There is no simple approach to insure project effectiveness. Many factors contribute to project success.
- 5.22 To achieve the potential success of a project it is necessary to both a) encourage positive determinants, and simultaneously b) discourage negative determinants.
- 5.23 The usefulness of project management techniques lie in their judicious use. The limitations of techniques used must be recognized and considered. Appropriate techniques must be used in concert.

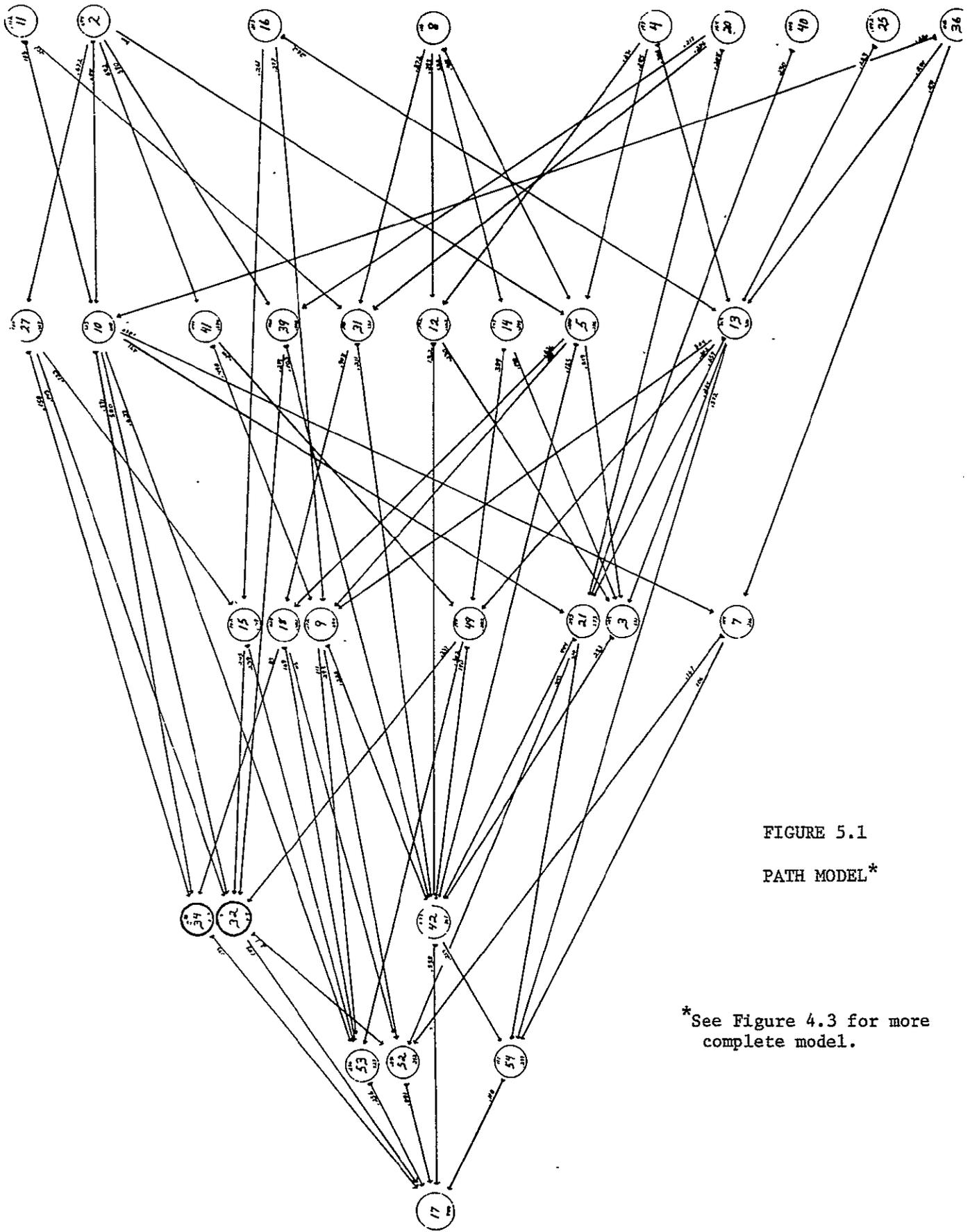


FIGURE 5.1  
 PATH MODEL\*

\*See Figure 4.3 for more complete model.

- 5.24 Project Management is itself a complex system, and only when so considered can optimal managerial techniques be developed and utilized effectively.
- 5.25 The factors affecting the success of projects include factors over which little or no management control is possible, discretionary factors which can be controlled either within the project effort itself or in the larger system, and end products which serve as the basis for the determination of degree of success.
- 5.26 Many determinants of success are established prior to the time period during which a project is conducted. As a result, the potential success of a project is partially established prior to its undertaking.
- 5.27 Many determinants of success or lack of success are established by parties external to the project team. As a result, the potential success of a project is partially established by agents external to the project team. The influence of the project manager and project team is therefore limited to factors which they can control.
- 5.28 Adverse environmental or "given" conditions do not necessarily affect project success directly, but often may be seen as affecting success through their influence on other intervening conditions and management processes. An adverse environmental or given condition can therefore be avoided or overcome through astute identification of those factors which it tends to affect directly, and through effective management action on those factors.
- 5.29 The major variables which affect the success of projects include:

Project Manager

- o commitment to project goals
- o authority and influence
- o task orientation
- o administrative skill
- o human skill
- o technical skill
- o early and continued involvement
- o participation in goal setting and criteria specification

Project Team

- o capabilities
- o commitment to goals
- o participation in
  - goal setting
  - setting budgets and schedules
  - major decision-making
  - problem solving
- o early and continued involvement
- o "sense of mission"
- o structural flexibility

Parent Organization

- o coordinative efforts
- o structural flexibility
- o effective strategic planning
- o rapport maintenance
- o adaptability to change
- o past experience
- o external buffering
- o prompt and accurate communications
- o enthusiasm
- o project contributes to parent capabilities

Client Organization

- o coordinative efforts
- o rapport maintenance
- o establishment of reasonable and
  - specific goals and criteria
- o change procedures
- o prompt and accurate communication
- o commitment
- o lack of red-tape
- o prompt decision-making
- o influence and authority of contact

Managerial Techniques

- o judicious, and adequate but not excessive use of planning, control, and communication systems.

Pre-Conditions

- o clearly established specifications and design

- o realistic schedules
- o realistic cost estimates
- o avoidance of buy-ins
- o avoidance of over-optimism
- o conceptual clarity
- o favorable interface with legal-political environment

### 5.3 Implications

Based upon the conclusions derived and the various analyses it is apparent that the Client, Parent, and Project Organizations can influence the success of project efforts. The results of this study have specific implications for each of these organizations, as summarized in Figure 5.2.

#### 5.3.1 Client Organization

To create positive determinants of success and to diminish negative determinants it is considered that the Client Organization and/or Principal Client Contact should:

- o Encourage openness and honesty from the start from all participants.
- o Create an atmosphere that encourages healthy, but not cutthroat, competition or "liars" contests.
- o Plan for adequate funding to complete the entire project.
- o Develop clear understandings of the relative importance of cost, schedule, and technical performance goals.
- o Seek to minimize direct public participation and involvement.
- o Develop short and informal lines of communication and flat organizational structures.
- o Delegate sufficient authority to the principal client contact and let him promptly approve or reject important project decisions.
- o Reject "buy-ins."

FIGURE 5.2

STRATEGY GUIDELINES

	Conceptual Phase (Before the Invitations for Bid)	Bid, Proposal, Contract Definition, and Negotiation Phase (Before Contract Award or go-ahead)	Implementation Phase (After Contract Award or go-ahead)
The Client Organization and/or Principal Client Contact	Encourage openness and honesty from the start from all participants.		Develop close, but not meddling, working relationships with project participants.
	<p>Create an atmosphere that encourages healthy, but not cutthroat, competition or "liars' contests." Plan for adequate funding to complete the entire project.</p> <p>Develop clear understandings of the relative importance of cost, schedule, and technical performance goals.</p> <p>Seek to minimize public participation and involvement. Develop short and informal lines of communication and flat organizational structures</p> <p>Delegate sufficient authority to the principal client contact and let him promptly approve or reject important project decisions.</p>	<p>Reject "buy-ins." Make prompt decisions regarding contract award or go-ahead.</p>	<p>Avoid arms-length relationships.</p> <p>Do not insist upon excessive reporting schemes.</p> <p>Make prompt decisions regarding changes.</p>
The Parent Organization and/or Principal Parent Contact	<p>Select, at an early point, a project manager with a proven track record of technical skills, human skills, and administrative skills (in that order) to lead the project team.</p> <p>Develop clear and workable guidelines for your project manager.</p> <p>Delegate sufficient authority to your project manager and let him make important decisions in conjunction with his key project team members.</p>	<p>Do not exert excessive pressure on the project manager to win the contract.</p> <p>Do not slash or balloon the project team's cost estimates.</p> <p>Avoid "buy-ins."</p>	<p>Develop close, but not meddling, working relationships with the principal client contact and the project manager.</p>
	<p>Demonstrate enthusiasm for and commitment to the project and the project team.</p> <p>Develop and maintain short and informal lines of communication with the project manager</p>		
The Project Manager and/or the Project Team	<p>Insist upon the right to select your own key project team members</p> <p>Select key project team members with proven track records in their area of expertise.</p> <p>Develop commitment and a sense of mission from the outset among project team members.</p> <p>Seek sufficient authority and a projectized form of organizational structure.</p> <p>Coordinate frequently and constantly reinforce good relationships with the client, the parent, and your team.</p> <p>Seek to enhance the public's image of the project.</p>	<p>Call upon key project team members to assist in decision-making and problem solving.</p> <p>Develop realistic cost, schedule, and technical performance estimates and goals.</p> <p>Develop back-up strategies and systems in anticipation of potential problems.</p> <p>Develop an appropriate, yet flexible and flat, project team-organization structure.</p> <p>Seek to maximize your influence over people and key decisions even though your formal authority may not be sufficient.</p>	<p>Employ a workable and candid set of project planning and control tools.</p> <p>Avoid pre-occupation with, or over-reliance upon, one type of project control tool.</p> <p>Constantly stress the importance of meeting cost, schedule and technical performance goals.</p> <p>Generally, give highest priority to achieving the technical performance mission or function to be performed by the project end-item.</p> <p>Keep changes under control.</p> <p>Seek to find ways of assuring the job security of effective project team members.</p> <p>Plan for an orderly phase-out of the project</p>

- o Make prompt decisions regarding contract award or go-ahead.
- o Develop close, but not meddling, working relationships with project participants.
- o Avoid arms-length relationships.
- o Do not insist upon excessive reporting schemes.
- o Make prompt decisions regarding changes.

### 5.32 Parent Organization

To create positive determinants of success and to diminish negative determinants it is considered that the Parent Organization and/or Principal Parent contact should:

- o Select, at an early point, a project manager with proven track record of technical skills, human skills, and administrative skills (in that order) to lead the project team.
- o Develop clear and workable guidelines for the project manager.
- o Delegate sufficient authority to the project manager and let him make important decisions in conjunction with his key project team members.
- o Demonstrate enthusiasm for and commitment to the project and the project team.
- o Develop and maintain short and informal lines of communication with the project manager.
- o Do not exert excessive pressure on the project manager to win the contract.
- o Do not slash or balloon the project team's cost estimates.
- o Avoid "buy-ins".
- o Develop close, but not meddling, working relationships with the principal client contact and the project manager.

### 5.33 Project Manager

To create positive determinants of success and to diminish negative determinants it is considered that the Project Manager and/or Project Team should:

- o Insist upon the right to select own key project team members.
- o Select key project team members with proven track records in their area of expertise.
- o Develop commitment and a sense of mission from the outset among project team members.
- o Seek sufficient authority and a projectized form of organizational structure.
- o Coordinate frequently and constantly reinforce good relationships with the client, the parent, and the team.
- o Seek to enhance the public's image of the project.
- o Call upon key project team members to assist in decision-making and problem solving.
- o Develop realistic cost, schedule, and technical performance estimates and goals.
- o Develop back-up strategies and systems in anticipation of potential problems.
- o Develop an appropriate, yet flexible and flat, project team organization structure.
- o Seek to maximize influence over people and key decisions even though formal authority may not be sufficient.
- o Employ a workable and candid set of project planning and control tools.
- o Avoid pre-occupation with, or over-reliance upon, one type of project control tool.
- o Constantly stress the importance of meeting cost, schedule and technical performance goals.
- o Generally, give highest priority to achieving the technical performance mission or function to be performed by the project end-item.

- o Keep changes under control.
- o Seek to find ways of assuring the job security of effective project team members.
- o Plan for an orderly phase-out of the project.

#### 5.34 Future Research

The primary purpose of this research was to investigate the determinants of project success in non-NASA projects. While many determinants of project mission success were identified, a somewhat unsettling finding was that effective cost performance was not uniformly associated with mission success. In fact, the data revealed that mission-successful projects more often than not show a cost overrun, often a very substantial one. Questionnaire data provided by respondents during the study (most of whom were project managers) showed, furthermore, that project success tends strongly to be defined as adequacy of technical performance and not as adequacy of cost performance. Factor analysis of the data revealed that technical performance and cost performance were independent factors, with only technical performance being strongly and positively related to overall project success.

Although the study covered a wide range of project types, ranging from construction projects to software development, the phenomenon uncovered, namely the low priority given to cost performance, is one of particular note for those managers who are becoming increasingly concerned about finding ways of improving cost performance without downgrading

confidence in mission success.

While it tended to be true that cost overruns were associated with mission-successful projects, this was not universally the case. The large existing data bank, containing quantified descriptions of more than 670 projects, includes many projects which were both mission-successful and cost-control effective. It appears reasonable, therefore, that future research be conducted to determine those organizational factors and managerial actions that differentiate projects which are both cost and mission effective from those that are not.

To further the understanding of factors leading to combined cost-mission effectiveness of project management, and to facilitate the transfer of this knowledge into improved practices, future research should be conducted with the following kinds of questions in mind:

1. What mix of organizational and management factors leads to mission success on projects where costs are effectively controlled? What is the relative importance of each of these factors and what important interrelationships exist between these factors?
2. What factors most commonly lead to cost overrun and upon what do these factors, in turn, depend? Which of these factors are most readily subject to management control? In what ways can the "givens" (relatively uncontrollable factors which tend to

have adverse effects on costs) be dealt with effectively? What organization designs and management strategies were employed on projects which did not show cost overruns despite adverse circumstances?

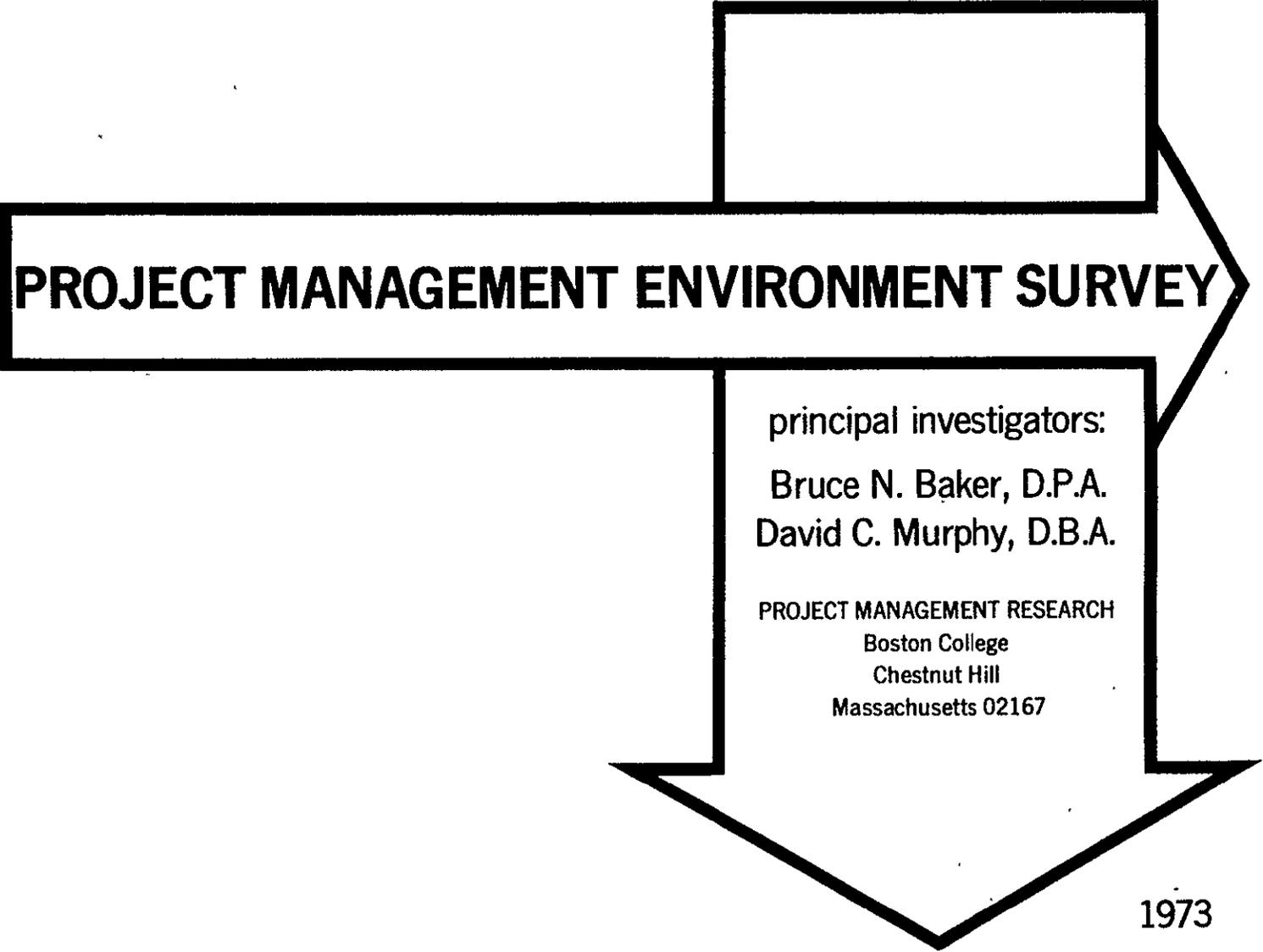
3. What are the differences in organizational and management profiles among projects which have each of the four outcome patterns, A, B, C and D shown below?

		Mission Success	
		High	Low
Cost Control	High	A	C
	Effectiveness	Low	B

A comparison of outcome patterns A, B and C will be of particular importance to future research efforts, since the aim would be to distinguish project management techniques which lead to combined cost and mission success from those which lead to mission success at the expense of cost overrun on the one hand, and cost performance at the expense of mission success on the other.

Research conducted by methods designed to answer the above questions and to reveal determinants and interrelationships which were not anticipated by the present analysis will yield a revised model having direct policy and action implications for the management of both NASA and non-NASA programs and projects.

APPENDIX A  
QUESTIONNAIRE



**PROJECT MANAGEMENT ENVIRONMENT SURVEY**

principal investigators:  
Bruce N. Baker, D.P.A.  
David C. Murphy, D.B.A.

PROJECT MANAGEMENT RESEARCH  
Boston College  
Chestnut Hill  
Massachusetts 02167

1973

## PROJECT MANAGEMENT ENVIRONMENT SURVEY

The questions in this survey are directed toward your experience on *one unique project* which has been completed within the past five years. Please select a project with which you were very familiar. The questions are designed to be answered by Project Managers, Project Team members, or someone else who was intimately familiar with a specific project.

If a question is not applicable to the project you have selected, or if you cannot answer a question for any reason, skip it, or cross it out. The important aspect of this survey is to have *everyone* respond to as many questions as possible.

The answers and results of the survey will be treated such that anonymity is preserved as to the source of the information. If you wish to receive the results of the survey, please write your name and address on the enclosed card. The card is designed so that you can include it in the envelope with your completed questionnaires; or if you prefer, you can mail it separately. In either case, your name or the name of your organization will not be associated with your questionnaire responses.

The questions are designed to permit rapid responses. In most cases, you can merely check the appropriate box, or place a vertical slash mark

at the most appropriate point. In cases where quantitative data is requested, exact answers are *not* necessary, knowledgeable *estimates and approximations will suffice*. If any question is not clear, please answer it in the best way you can.

If you wish to elaborate or clarify your response, write in the margins or use the comments page at the back of the survey booklet. After answering the specific questions in the survey, if you think anything has been omitted, or if there is any special thing about the project, management environment to which you have directed your answers, please write these on the comments page or enclose additional sheets.

*Your response is needed.* If you have any questions or problems, please call collect to

Dr. Bruce N. Baker  
or  
Dr. David C. Murphy  
(617) 969-0100,  
Extension 812 or 2479

**PLEASE NOTE THE FOLLOWING DEFINITIONS FOR THE PURPOSE OF THIS SURVEY**

**PROJECT TEAM** refers to all project personnel *within* the Parent Organization, whether or not they are under the Project Manager

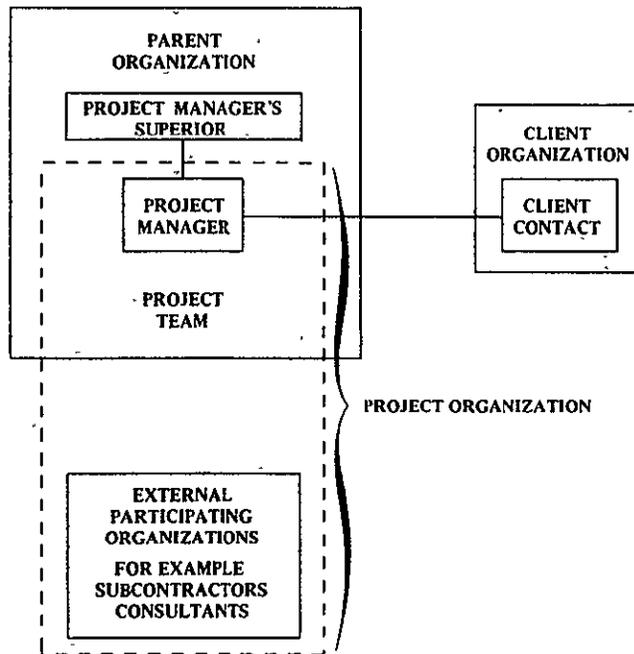
**PROJECT ORGANIZATION** refers to the Project Team *plus* all subcontractors and other external organizations working on the Project

**PARENT ORGANIZATION** refers to all personnel in the hierarchical structure above the level of the Project Manager but within the same overall organization.

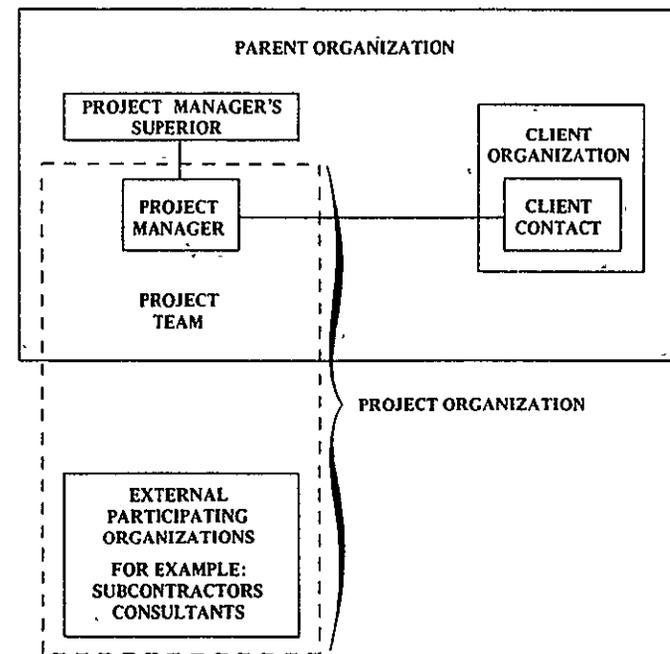
**CLIENT ORGANIZATION** refers to the principal organization or individual which sponsored, approved, and funded the Project For internally funded projects, the Client Organization may be a subset of the Parent Organization or the Parent and Client Organizations may be one and the same

Two typical arrangements of these organizations are depicted below Many other arrangements are possible

**EXTERNAL CLIENT ARRANGEMENT**



**INTERNAL CLIENT ARRANGEMENT**



Which of the following best describes the project activity or end product, the client or source of funds, your individual role, the nature of the project, the competitive environment, and the nature of the contract or agreement

For each of the following please check the box which best applies

- Project Activity or End Product**
- A Construction Project
  - A Hardware, Equipment, or Appliance Development
  - A Food, Drug, or Soft Goods Development
  - A New or Improved Process or Software Development
  - A Service or Test
  - A Study
  - Other \_\_\_\_\_ (please specify)
- Client/Source of Funds**
- Federal Government—Defense
  - Federal Government—Space
  - Federal Government—Other
  - State Government
  - Local Government
  - Your Parent Organization or In-House Funds
  - Another Division of the Parent Organization
  - Another Corporation or Individual Client
  - Other \_\_\_\_\_ (please specify)

- Your Individual Role**
- If on Project Team**
- Project Manager
  - Manager on Project Team
  - Project Team—Technical
  - Project Team—Administrative
  - Other \_\_\_\_\_ (please specify)
- If in Parent Organization**
- Project Manager's Superior
  - Manager in Parent Organization
  - Other \_\_\_\_\_ (please specify)
- If in Client Organization:**
- Owner or Top Executive Officer
  - Principal Client Contact or Client's Project Manager
  - Contact in Client Organization—Technical
  - Contact in Client Organization—Administrative
  - Other \_\_\_\_\_ (please specify)
- If in any other organization**
- \_\_\_\_\_ (please specify)

- Nature of the Project**
- Essentially, was the overall Project:
- Public in Nature
  - Private in Nature
- Competitive Environment**
- Sole Source
  - Invitation for Bid—Limited Competition
  - Sealed Bid—Open Competition
  - Unsolicited Proposal
  - In-House Project
  - Other \_\_\_\_\_ (please specify)
- Nature of Contract or Agreement**
- Fixed Price type Contract—Without Incentives or Penalties
  - Fixed Price type Contract—With Incentives or Penalties
  - Cost Reimbursement Type Contract (e.g., cost-plus-fixed-fee, or cost-plus-incentive-fee)
  - Cost-Sharing Type Contract
  - In-House Work Order or Budgetary Allocation
  - Other \_\_\_\_\_ (please specify)

Which of the following terms best describes the organizational structure of the Project Team as it existed during the peak activity period of the Project?

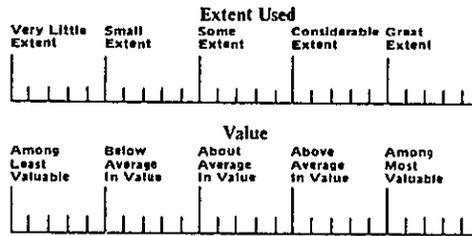
- Pure Functional—Project Manager**, if any, was merely the focal point for *communications*; he had no authority to direct people other than by persuasion or reporting to his own superior
- Weak Matrix—Project Manager** was the focal point for *controls*; he did not actively direct the work of others.
- Strong Matrix or Partially Projectized—Project Manager** was the focal point for *directions and controls*; he may have had some engineering and control personnel reporting to him on a line basis, while remainder of the Project Team was located administratively in other departments.
- Projectized—Project Manager** had most of the essential elements of the Project Team under him
- Fully Projectized—Project Manager** had *almost all* of the employees who were on the Project Team under him

Listed below are some of the more common tools and techniques associated with Project Management. If a particular tool or technique was not used, skip the corresponding question. For each one used, please indicate on the respective scales.

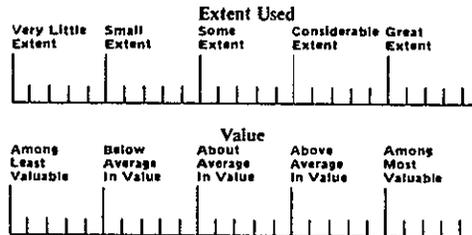
-the extent to which the tool or technique was *used* in managing the project, and

-the *value* of the tool or technique in contributing to the attainment of the goals of the Project

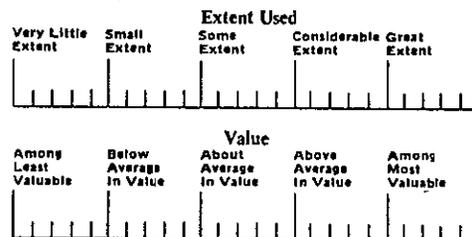
Bar charts, Gantt charts, or milestone charts.



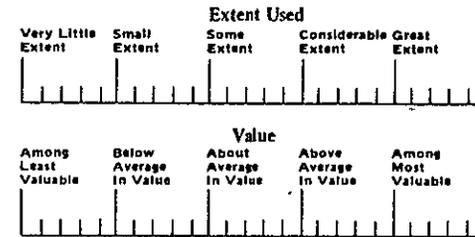
Network systems for schedule and/or cost control (e.g., PERT, CPM, PERT/COST, etc.)



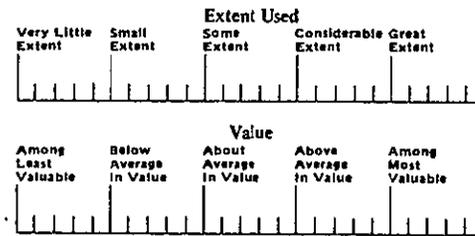
Work breakdown structure concepts and procedures (e.g., work package matrices).



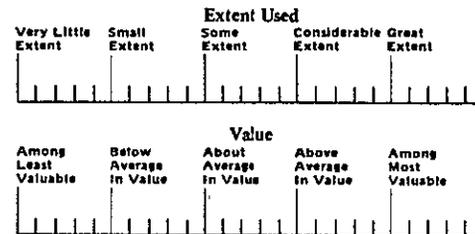
Systems management concepts and procedures (e.g., systems analysis, life cycle planning, systems engineering, configuration management, etc.).



Operations research techniques (e.g., linear programming, simulation, etc.).



Status and/or progress reports.



How frequently were status and/or progress reports prepared?

From the Project to the Parent Organization

Weekly  Monthly  Quarterly  Semi-Annually  Annually

Other \_\_\_\_\_  
(please specify)

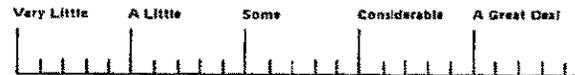
From the Project to the Client Organization\*

Weekly  Monthly  Quarterly  Semi-Annually  Annually

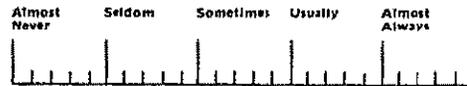
Other \_\_\_\_\_  
(please specify)

When the effort was initiated, to what extent was it considered necessary to advance the state-of-the-art to meet the objectives of the project?

Advance in State-of-the-Art

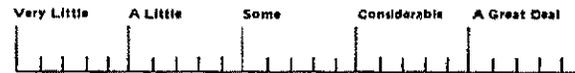


After formal reports were submitted to the Parent Organization, how often did the Project Team receive feedback from the Parent Organization?



When this project was initiated, how much experience did the Parent Organization have with projects of similar scope?

Experience with Scope of Project



After formal reports were submitted to the Client Organization, how often did the Project Team receive feedback from the Client Organization?

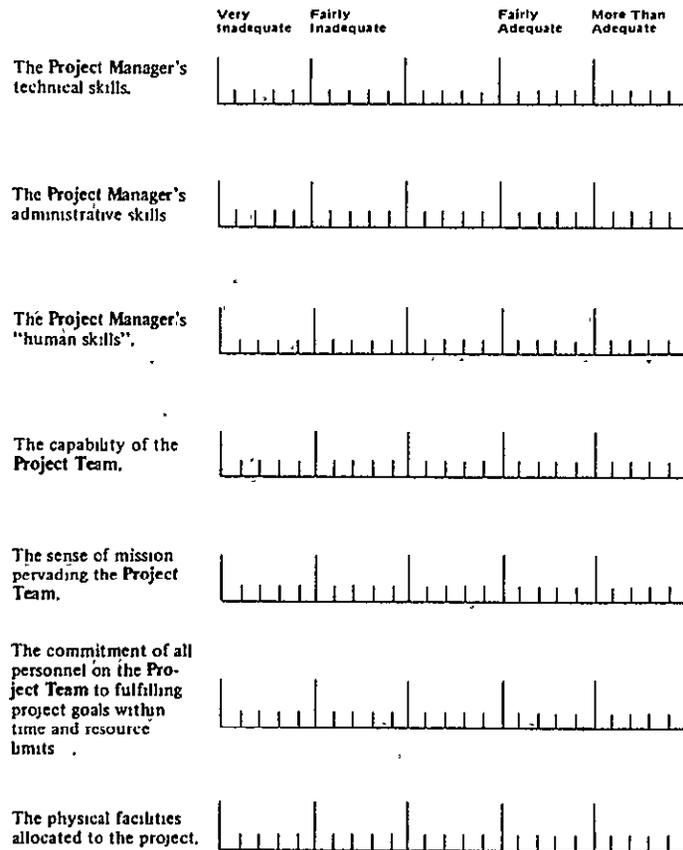


Was this project effort smaller or larger in scale than most projects with which the Parent Organization has been involved?

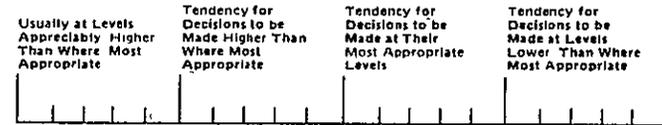


\*Please note that there is *always* a Client Organization. Please answer all the Client questions, even though the Client is internal to the Parent Organization.

Listed below are a number of conditions, skills, services, etc that may have contributed directly to the effective performance of the Project Team. Please rate the adequacy of each of these conditions, skills, and services during the life of the project with respect to effective performance.



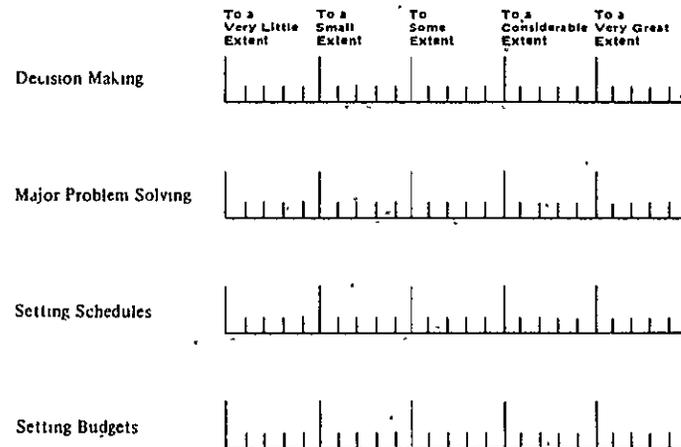
Were project-related decisions made at the most appropriate level within the overall organization?



The bulk of project-related decisions were made

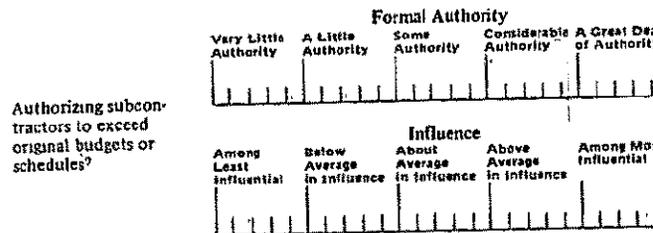
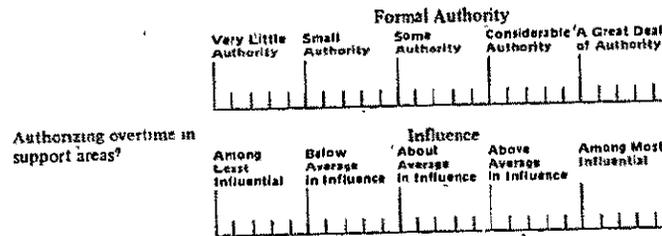
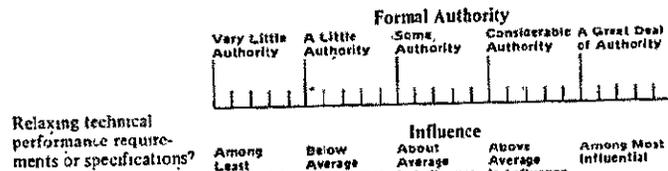


To what extent did the key Project Team members participate in the following processes?

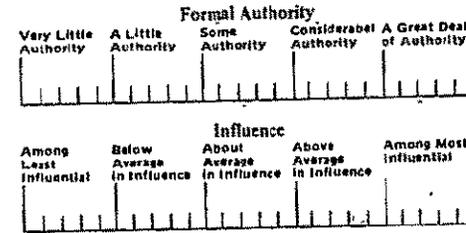


A Project Manager's *formal authority* can differ from his *influence*. Even if the Project Manager did not possess the formal authority to make certain decisions, he may have been among the most influential contributors to these decisions. Conversely, a Project Manager could have had considerable formal authority, but he could be among the least influential contributors to the decision process.

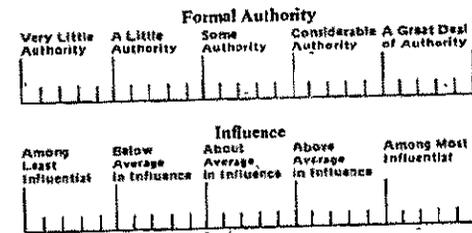
How much formal authority and influence did the Project Manager have over each of the following decisions?



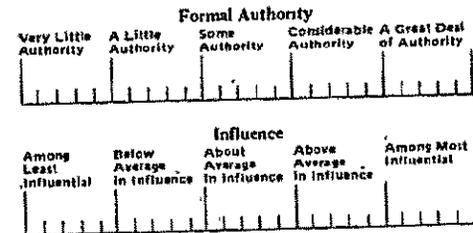
Selecting key Project Team personnel?



Selecting subcontractors?



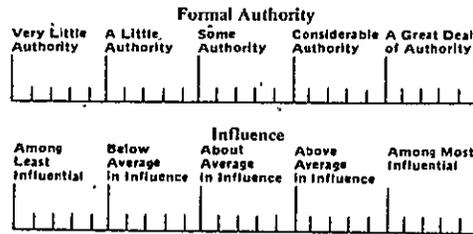
Determining merit raises for Project Team personnel?



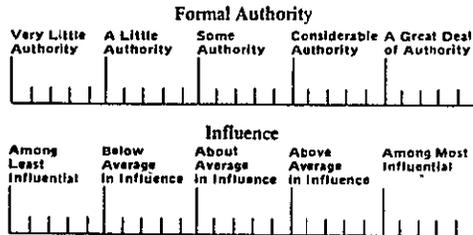
A Client Contact's *formal authority* can differ from his *influence*. Even if the Client Contact did not possess the formal authority to make certain decisions, he may have been among the most influential contributors to these decisions. Conversely, a Client Contact could have had considerable formal authority, but he could be among the least influential contributors to the decision process.

How much formal authority and influence did the principal Client Contact have over,

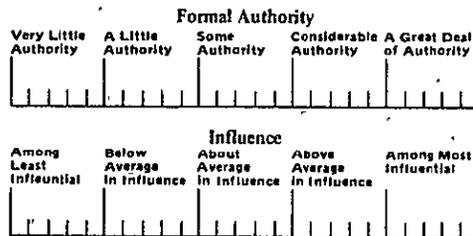
Relaxing technical performance requirements or specifications?



Approving sub-contractors?

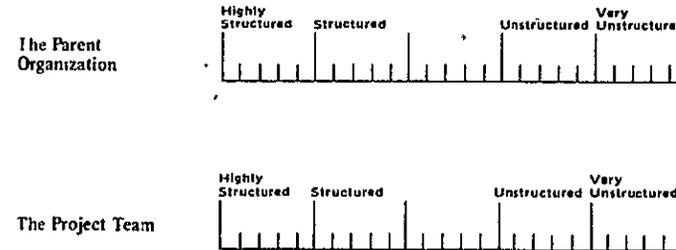


Authorizing budget overruns?



Organizations and departments differ in their degree of structure. Some are highly structured, with clearly defined roles and reporting relationships. Others are very unstructured, with ambiguous roles and few hierarchical levels.

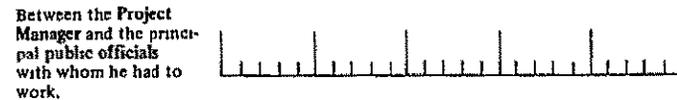
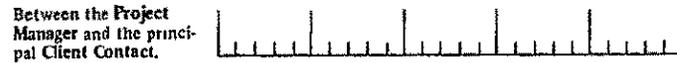
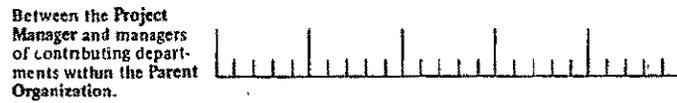
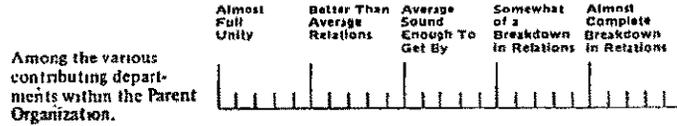
To what degree are the following organizations structured?



In terms of degree of structure, how different from each other were the groups or departments in the Parent Organization which were directly involved in this project?



What point on the scale best describes the relations between or among the different organizations or individuals associated with the project?



Different groups and organizations handle conflicts and disagreements in various ways. Using the code letters given below, please indicate your impression of the *most frequent* and the *next most frequent* way in which conflicts were handled during the project within the groups indicated in the right-hand column.

Code Letter

- S — Smoothing over differences by working to maintain harmony.
- F — Forceful decision-making by the most senior or most powerful person or persons involved.
- C — Compromise. Finding a middle ground which "splits the difference" between contending factions.
- O — Open Confrontation of the aspects and causes of disagreement by those involved until consensus was reached.
- W — Withdrawal from conflicts. Conflicts and disagreements tended not to be expressed.

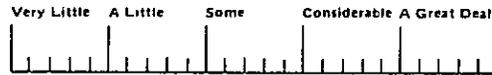
Most Frequent Method Used	Next Most Frequent Method Used	Location of Conflict
_____	_____	<i>Within</i> the Parent Organization in general.
_____	_____	<i>Within</i> the Client Organization in general.
_____	_____	<i>Within</i> the Project Team.
_____	_____	<i>Between</i> the Project Team and the Parent Organization
_____	_____	<i>Between</i> the Project Team and the Client Organization

Please indicate the degree of difficulty experienced by the Project Team with respect to the following

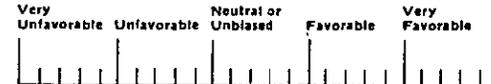
	Very Little Difficulty	A Little Difficulty	Some Difficulty	Considerable Difficulty	A Great Deal of Difficulty
Defining the goals of the project in clear, measurable terms	[Scale]				
Obtaining the necessary Parent Organization approvals to initiate the project.	[Scale]				
Obtaining the necessary Client Organization funding approvals to begin the project effort.	[Scale]				
Meeting the technical requirements of the project.	[Scale]				
Meeting the project schedules.	[Scale]				
Staying within the original project budget.	[Scale]				
Obtaining and keeping competent people on the Project Team.	[Scale]				
Obtaining sufficient funding to complete the project.	[Scale]				

	Very Little Difficulty	A Little Difficulty	Some Difficulty	Considerable Difficulty	A Great Deal of Difficulty
Coordinating with the Client Organization.	[Scale]				
Coordinating with the Parent Organization.	[Scale]				
Coordinating among Project Team members.	[Scale]				
Freezing the design on schedule.	[Scale]				
Maintaining rapport with the Parent Organization.	[Scale]				
Maintaining rapport with the Client Organization.	[Scale]				
Maintaining good relations with neighbors in the general area of the project site.	[Scale]				
Maintaining good relations with local government officials.	[Scale]				
Maintaining good relations with the general public.	[Scale]				
Closing out the project effort.	[Scale]				

How much job insecurity was generally attributed to participation on this Project Team?



If any articles regarding the project appeared in newspapers or magazines (not house organs), was the coverage generally favorable or unfavorable?



To what extent did this project result in a build-up of new capabilities for future use by the Parent Organization?



How much do you agree or disagree with each of the following statements?

To what extent was top management of the Parent Organization consistently enthusiastic about, and committed to, the project?



The project was too encumbered by legal restrictions



To what extent was the organizational structure of the project revised throughout the life of the project?



Governmental "red tape" caused many delays.



To what extent was that portion of the general public, which was familiar with the project, enthusiastic about it?



The original cost estimates were much too optimistic.



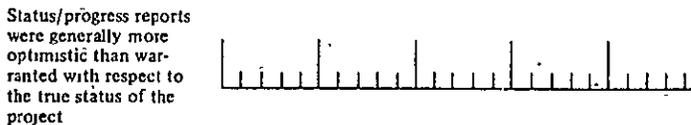
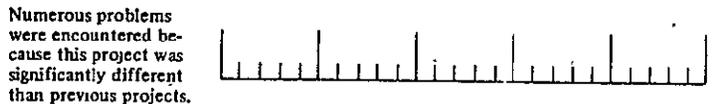
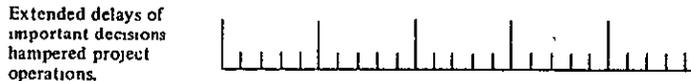
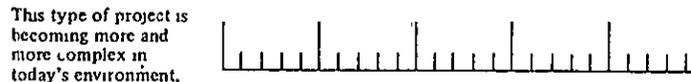
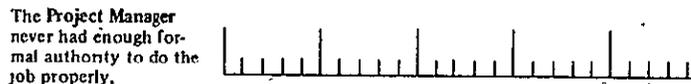
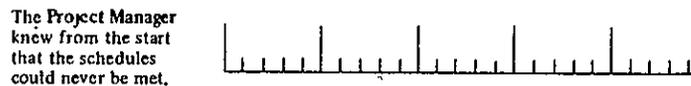
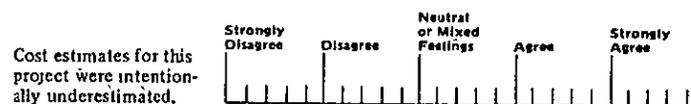
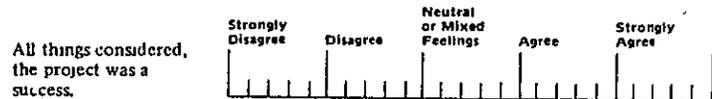
To what extent did controversy arise as to the environmental impact of the project?



Top management of the Parent Organization put too much "pressure" on the project



How much do you agree or disagree with each of the following statements?



How much do you agree or disagree with each of the following statements?

Project Team members were often hampered by work assignments not related to the project.

Strongly Disagree    Disagree    Neutral or Mixed Feelings    Agree    Strongly Agree

Alternative back-up strategies and systems were generally available in case significant problems were encountered on the project.

Personal and informal relations of key Project Team members supported the formal project effort.

The Project Manager consistently exhibited a "get the job done" philosophy.

The project turned out to be much more complex than initially conceived.

The government exerts too much control over this type of project.

The procedures for controlling and implementing changes were inadequate.

New forms of cooperation between government and industry are necessary for this type of project in the future.

Please indicate how important each of the following criteria was to the PARENT ORGANIZATION:

Meeting the scheduled completion date.

Below Average in Importance    Above Average in Importance    Among Most Important    Of Critical Importance    Most Critical Criterion

Staying within the budget.

Achieving the specified technical performance goals.

Obtaining follow-on work.

Improving the capability of the Parent Organization to perform this type of project.

Please indicate how important each of the following criteria was to the CLIENT ORGANIZATION:\*

Meeting the scheduled completion date.

Below Average in Importance    Above Average in Importance    Among Most Important    Of Critical Importance    Most Critical Criterion

Staying within the budget.

Achieving the specified technical performance goals.

\*Please answer this section even though the Client Organization is internal to the Parent Organization.

Please indicate how important each of the following criteria was to the **PROJECT MANAGER**:

	Below Average in Importance	Above Average in Importance	Among Most Important	Of Critical Importance	Most Critical Criterion
Meeting the scheduled completion date.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Staying within the budget.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Achieving the specified technical performance goals.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Obtaining follow-on work.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Improving the capability of the Parent Organization to perform this type of project.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

In general, how satisfied were the following groups with the outcome of the project?

	Very Dissatisfied	Fairly Dissatisfied	Neutral or Mixed Feelings	Fairly Satisfied	Very Satisfied
The Parent Organization.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The Client Organization.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The ultimate users, recipients, or clientele (e.g., the tenants of a building, users of equipment, or recipients of a service).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The Project Team.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

During the project's peak activity period, how satisfied were the Project Team members with the organizational structure of the Project?

Very Dissatisfied	Fairly Dissatisfied	Neutral or Mixed Feelings	Fairly Satisfied	Very Satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

How satisfied was the Project Manager with the project planning and control system?

Very Dissatisfied	Fairly Dissatisfied	Neutral or Mixed Feelings	Fairly Satisfied	Very Satisfied
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Did the end result of the project adequately fulfill the technical performance mission or function to be performed?

Very Inadequately	Fairly Inadequately	Fairly Adequately	Very Adequately
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Approximately how long did the project last? \_\_\_\_\_ (months)

Approximately how long was the original scheduled time duration for the project? \_\_\_\_\_ (months)

What was the approximate total cost of the project? \$ \_\_\_\_\_

What was the approximate original total budget for the project? \$ \_\_\_\_\_

If you did not answer the two preceding questions concerning costs because of the confidential nature of the information, please calculate the percentage budget overrun for this project, using the following formula.

$$\frac{\text{Final Total Expenditures}}{\text{Original Total Budget}}$$

Please indicate the *total* travel time required (include all walking, driving, flying) from the Project Manager's principal office until in the presence of:

The bulk of the Project Team. \_\_\_\_\_ minutes  
or \_\_\_\_\_ hours

The Project Manager's Superior in the Parent Organization \_\_\_\_\_ minutes  
or \_\_\_\_\_ hours

The principal Client Contact. \_\_\_\_\_ minutes  
or \_\_\_\_\_ hours

The project site. \_\_\_\_\_ minutes  
or \_\_\_\_\_ hours

For the peak project period, please estimate.

Number of *technical* Project Team personnel \_\_\_\_\_

Number of *administrative* Project Team personnel. \_\_\_\_\_

Number of *other* Project Team personnel. \_\_\_\_\_

What percentage of the total budget of the Parent Organization was allocated to the project during its "peak" activity period? \_\_\_\_\_ %

What percentage of the total project budget was allocated to external organizations (e.g., subcontractors, consultants, etc.)? \_\_\_\_\_ %

How many times was the principal Project Manager replaced? \_\_\_\_\_

Please indicate that industry with which the Parent Organization is primarily associated.

Agriculture, Forestry, Fisheries

Mining

Construction

General Building Contractors

Heavy Construction Contractors

Special Trade Contractors

Manufacturing

Durable

Nondurable

Transportation and Public Utilities

Wholesale and/or Retail Trade

Finance, Insurance, Real Estate

Services

Government\*

Federal

State

Local

Other \_\_\_\_\_  
(please specify)

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During the past five years, to what extent have there been *major modifications* in the following areas of the *Parent Organization*?

	To a Very Little Extent	To a Small Extent	To Some Extent	To a Considerable Extent	To a Very Great Extent
Products (or services) sold.	[Scale]				
Marketing (or distribution) techniques.	[Scale]				
Processing, constructing, or manufacturing methods.	[Scale]				
Dollar amount of R&D effort.	[Scale]				
Direction of R&D effort.	[Scale]				

Approximately what percentage of the *Parent Organization's* annual budget is allocated to Research and Development activities? \_\_\_\_\_%

By approximately what percentage has the *Parent Organization* grown (+ or -) in the past five years?

Sales	_____ %
Assets	_____ %
Products	_____ %
Employees	_____ %
Direct Customers	_____ %

Please estimate the following information concerning the *Parent Organization* for 1972:

Total number of employees	_____
Total number of line managerial employees	_____
Total number of staff employees	_____
Total dollar sales	\$ _____

THANK YOU VERY MUCH.

Please enclose your completed questionnaires in the accompanying envelope and mail to:

Dr. Bruce N Baker  
 Project Management Research  
 P.O. Box A155  
 Campus Mail Room  
 Boston College  
 Chestnut Hill, MA 02167

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APPENDIX B

ITEM LISTING

- 1 Project Activity or End Product
- 2 Client or Source of Funding
- 3 Respondent's Role
- 4 Public vs. Private Project
- 5 Competitive Environment
- 6 Nature of Contract or Agreement
- 7 Project Team Organization
- 8 Extent Bar, Gantt, and Milestone Charts Were Used
- 9 Value of Bar, Gantt, and Milestone Charts Were Used
- 10 Extent Network Systems Were Used
- 11 Value of Network Systems Were Used
- 12 Extent Work Breakdown Structures Were Used
- 13 Value of Work Breakdown Structures
- 14 Extent Systems Management Concepts Were Used
- 15 Value of Systems Management Concepts Were Used
- 16 Extent Operations Research Techniques Were Used
- 17 Value of Operations Research Techniques
- 18 Extent Status and Progress Reports Were Used
- 19 Value of Status and Progress Reports Were Used
- 20 Report Frequency -- To Parent
- 21 Report Frequency -- To Client
- 22 Feedback Frequency -- From Parent
- 23 Feedback Frequency -- From Client

- 24 Initial Importance of State-of-Art Advancement
- 25 Parent Experience With Similar Project Scope
- 26 Project Larger In Scale Than Most
- 27 Project Manager's Technical Skills
- 28 Project Manager's Administrative Skills
- 29 Project Manager's Human Skills
- 30 Project Team Capability
- 31 Project Team Sense of Mission
- 32 Project Team Goal Commitment
- 33 Project Facilities -- Adequacy
- 34 Project Decisions at Appropriate Level
- 35 Project Team Decision Involvement
- 36 Project Team Participation in Decision-Making
- 37 Project Team Participation in Major Problem-Solving
- 38 Project Team Participation in Setting Schedules
- 39 Project Team Participation in Setting Budgets
- 40 Project Manager's Authority to Relax Specifications
- 41 Project Manager's Influence in Relaxing Specifications
- 42 Project Manager's Authority to Authorize Overtime
- 43 Project Manager's Influence in Authorizing Overtime
- 44 Project Manager's Authority to Authorize Subcontractors
- 45 Project Manager's Influence in Authorizing Subcontractors
- 46 Project Manager's Authority to Select Team Personnel
- 47 Project Manager's Influence in Selecting Team Personnel
- 48 Project Manager's Authority to Select Subcontractors
- 49 Project Manager's Influence in Selecting Subcontractors
- 50 Project Manager's Authority to Give Merit Raises

- 51 Project Manager's Influence in Giving Merit Raises
- 52 Client Contact's Authority to Relax Specifications
- 53 Client Contact's Influence in Relaxing Specifications
- 54 Client Contact's Authority to Approve Subcontractors
- 55 Client Contact's Influence in Approving Subcontractors
- 56 Client Contact's Authority to Authorize Overruns
- 57 Client Contact's Influence in Authorizing Overruns
- 58 Degree of Parent Structure
- 59 Degree of Project Structure
- 60 Difference in Degree of Structure of Parent Departments
- 61 Unity Between Parent Contributing Departments (R)
- 62 Unity Between Project Manager and Contributing Department Manager
- 63 Unity Between Project Manager and Client Contact (R)
- 64 Unity Between Project Manager and His Superior
- 65 Unity Between Project Manager and Public Officials (R)
- 66-75 (These items served as raw data for computing derived variables 186-205)
- 76 Difficulty Defining Goals
- 77 Difficulty Obtaining Initial Parent Approvals
- 78 Difficulty Obtaining Client Funding
- 79 Difficulty Meeting Technical Requirements
- 80 Difficulty Meeting Project Schedules
- 81 Difficulty Staying Within Original Budget
- 82 Difficulty Keeping Competent Team Members
- 83 Difficulty Obtaining Funding to Completion
- 84 Difficulty Coordinating With Client Organization
- 85 Difficulty Coordinating With Parent Organization

- 86 Difficulty Coordinating Among Team Members
- 87 Difficulty Freezing Design
- 88 Difficulty Maintaining Rapport With Parent Organization
- 89 Difficulty Maintaining Rapport With Client Organization
- 90 Difficulty Maintaining Relations With Neighbors on Site
- 91 Difficulty Maintaining Relations With Local Government
- 92 Difficulty Maintaining Relations With Public
- 93 Difficulty Closing-Out Project
- 94 Project Team Job Insecurity
- 95 Extent of Parent Capabilities Build-up
- 96 Parent Enthusiasm
- 97 Extent Project Organization Structure Revised
- 98 Extent Project Public Enthusiasm
- 99 Extent of Environmental Impact Controversy
- 100 Favorability of Media Coverage
- 101 Project Too Encumbered By Legal Restrictions
- 102 Government Red Tape Caused Delays
- 103 Original Cost Estimates Too Optimistic
- 104 Excessive Pressure From Parent Management
- 105 Project Was A Success
- 106 Public Became Too Involved
- 107 Too Many Government Agencies Involved
- 108 Too Much Politics Involved In Award
- 109 "Cut Throat" Competition
- 110 Volume of Paperwork Was Excessive
- 111 Project Was Different Than Most
- 112 Cost Estimates Intentionally Underestimated

- 113 Project Team Spirit
- 114 Unrealistic Schedules
- 115 Project Manager Had Insufficient Authority
- 116 This Type of Project Becoming More Complex
- 117 Delays In Important Decisions
- 118 Progress Reports Were Over-Optimistic
- 119 Project Members Hampered By Unrelated Assignments
- 120 Back-up Strategies Were Available
- 121 Team Members Informal Relations Supportive
- 122 Project Manager Had "Get-The-Job-Done" Philosophy
- 123 Project Was More Complex Than Initially Conveived
- 124 Government Over Control
- 125 Procedures For Change Were Inadequate
- 126 New Forms of Government - Industry Cooperation Needed
- 127 Importance to Parent -- Schedule
- 128 Importance to Parent -- Budget
- 129 Importance to Parent -- Technical Performance
- 130 Importance to Parent -- Obtain Follow-on
- 131 Importance to Parent -- Improve Internal Capabilities
- 132 Importance to Client -- Schedule
- 133 Importance to Client -- Budget
- 134 Importance to Client -- Technical Performance
- 135 Importance to Project Manager -- Schedule
- 136 Importance to Project Manager -- Budget
- 137 Importance to Project Manager -- Technical Performance
- 138 Importance to Project Manager -- Obtain Follow-on
- 139 Importance to Project Manager -- Improve Parent Capabilities

- 140 Satisfaction With Outcome -- Parent
- 141 Satisfaction With Outcome -- Client
- 142 Satisfaction With Outcome -- End Users
- 143 Satisfaction With Outcome -- Project Team
- 144 Team's Satisfaction With Organization Structure
- 145 Project Manager's Satisfaction With Planning and Control
- 146 Technical Performance Adequacy of End Product
- 147 Length of Project
- 148 Scheduled Length of Project
- 149 Total Cost of Project
- 150 Original Total Budget
- 151 % Actual Cost to Budget
- 152 Travel Time -- Project Manager To Team
- 153 Travel Time
- 154 Travel Time -- Project Manager To Client
- 155 Travel Time -- Project Manager To Project Site
- 156 Number of Technical Team Members
- 157 Number of Administrative Team Members
- 158 Number of "Other" Team Members
- 159 Peak % Parent Budget Allocated To Project
- 160 % Project Budget Allocated To Subcontractors
- 161 Number of Times Project Manager Replaced
- 162 Parent Industry
- 163 Major Modification In Parent's Product Mix
- 164 Major Modification In Parent's Market
- 165 Major Modification In Parent's Manufacturing Process
- 166 Major Modification In Parent's Dollar R&D
- 167 Major Modification In Parent's R&D Direction

168 % Parent Budget to R&D  
169 Parent 5-Year Growth -- Sales  
170 Parent 5-Year Growth -- Assets  
171 Parent 5-Year Growth -- Products  
172 Parent 5-Year Growth -- Employees  
173 Parent 5-Year Growth -- Customers  
174 Total Parent Employees  
175 Total Parent Line Managers  
176 Total Parent Staff Employees  
177 Total Parent Dollar Sales  
178\* Schedule Overrun  
179\* Total Project Team Personnel  
180\* Technical-To-Total Team Personnel (%)  
181\* Administrative-To-Total Team Personnel (%)  
182\* "Other"-To-Total Team Personnel (%)  
183\* Parent Line Managers To Total Personnel (%)  
184\* Parent Staff Personnel To Total (%)  
185\* Parent Managers To Total Employees (%)  
186\* Primary Conflict Resolution Style Within Parent Was  
Goal Oriented  
187\* Primary Conflict Resolution Style Within Parent Was  
Socially Oriented  
188\* Secondary Conflict Resolution Style Within Parent Was  
Goal Oriented  
189\* Secondary Conflict Resolution Style Within Parent Was  
Socially Oriented  
190\* Primary Conflict Resolution Style Within Client Was  
Goal Oriented  
191\* Primary Conflict Resolution Style Within Client Was  
Socially Oriented

- 192\* Secondary Conflict Resolution Style Within Client Was Goal Oriented
- 193\* Secondary Conflict Resolution Style Within Client Was Socially Oriented
- 194\* Primary Conflict Resolution Style Within Team Was Goal Oriented
- 195\* Primary Conflict Resolution Style Within Team Was Socially Oriented
- 196\* Secondary Conflict Resolution Style Within Team Was Goal Oriented
- 197\* Secondary Conflict Resolution Style Within Team Was Socially Oriented
- 198\* Primary Conflict Resolution Style, Team-Parent, Was Goal Oriented
- 199\* Primary Conflict Resolution Style, Team-Parent, Was Socially Oriented
- 200\* Secondary Conflict Resolution Style, Team-Parent, Was Goal Oriented
- 201\* Secondary Conflict Resolution Style, Team-Parent, Was Socially Oriented
- 202\* Primary Conflict Resolution Style, Team-Client, Was Goal Oriented
- 203\* Primary Conflict Resolution Style, Team-Client, Was Socially Oriented
- 204\* Secondary Conflict Resolution Style, Team-Client, Was Goal Oriented
- 205\* Secondary Conflict Resolution Style, Team-Client, Was Socially Oriented
- 206\* Multifunded Project

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\*These items were derived from combinations of the reported 177 items.

## APPENDIX C

## ITEM CORRELATION MATRIX

	VAR (105)	VAR (140)	VAR (141)	VAR (142)	VAR (143)	VAR (146)
VAR(1)	0.006	0.006	0.030	-0.067	-0.003	-0.069
VAR(2)	-0.019	-0.028	-0.029	-0.020	-0.064	0.008
VAR(3)	-0.008	-0.051	-0.039	-0.003	-0.036	0.002
VAR(4)	-0.061	-0.072	-0.085*	-0.035	-0.071	-0.046
VAR(5)	0.065	0.017	0.016	0.012	0.060	-0.029
VAR(6)	0.023	0.017	-0.024	-0.019	0.007	-0.033
VAR(7)	0.107**	0.080*	0.057	0.020	0.061	0.013
VAR(8)	0.037	0.035	0.007	-0.016	0.025	0.015
VAR(9)	0.220***	0.235***	0.175***	0.137**	0.208***	0.148***
VAR(10)	0.057	0.072	0.040	0.079	0.069	0.056
VAR(11)	0.164***	0.236***	0.178***	0.090	0.209***	0.106*
VAR(12)	0.091*	0.069	0.053	0.002	0.076	0.081*
VAR(13)	0.224***	0.207***	0.187***	0.084	0.222***	0.252***
VAR(14)	0.096*	0.087*	0.045	0.058	0.100*	0.090*
VAR(15)	0.142**	0.097	0.103	0.078	0.150**	0.196***
VAR(16)	0.081*	0.021	0.024	0.025	0.028	0.034
VAR(17)	0.035	-0.010	-0.006	0.022	0.033	0.070
VAR(18)	0.083*	0.122**	0.108**	0.076	0.078	0.075
VAR(19)	0.239***	0.213***	0.200***	0.165***	0.163***	0.227***
VAR(20)	0.000	0.022	0.010	-0.019	0.039	-0.064
VAR(21)	-0.007	-0.023	-0.063	-0.063	0.023	-0.035
VAR(22)	0.129**	0.195***	0.141***	0.179***	0.166***	0.173***
VAR(23)	0.119**	0.148***	0.113**	0.103*	0.098*	0.111**
VAR(24)	0.118**	0.098*	0.084*	0.050	0.071	0.081*
VAR(25)	0.033	0.052	0.041	0.083	0.029	0.063
VAR(26)	0.046	0.004	-0.019	-0.005	-0.003	0.012
VAR(27)	0.283***	0.279***	0.261***	0.210***	0.232***	0.296***
VAR(28)	0.236***	0.310***	0.259***	0.200***	0.230***	0.195***
VAR(29)	0.253***	0.304***	0.258***	0.228***	0.288***	0.170***
VAR(30)	0.342***	0.327***	0.310***	0.285***	0.370***	0.314***
VAR(31)	0.406***	0.413***	0.376***	0.323***	0.458***	0.336***
VAR(32)	0.347***	0.369***	0.315***	0.271***	0.413***	0.304***
VAR(33)	0.174***	0.164***	0.110**	0.097*	0.142***	0.149***
VAR(34)	0.183***	0.202***	0.206***	0.159***	0.190***	0.176***
VAR(35)	0.177***	0.134***	0.144***	0.172***	0.171***	0.121**
VAR(36)	0.266***	0.271***	0.238***	0.214***	0.257***	0.163***
VAR(37)	0.282***	0.230***	0.246***	0.208***	0.242***	0.160***
VAR(38)	0.125**	0.104*	0.119**	0.110*	0.137***	0.082*
VAR(39)	0.134***	0.154***	0.153***	0.155***	0.183***	0.137***
VAR(40)	0.070	0.054	0.054	0.015	0.077	0.075
VAR(41)	0.169***	0.156***	0.105*	0.072	0.141***	0.139***
VAR(42)	0.074	0.100*	0.041	0.106*	0.046	0.097*
VAR(43)	0.182***	0.162***	0.114**	0.148***	0.183***	0.212***
VAR(44)	0.089*	0.054	0.081	0.131**	0.103*	0.124**
VAR(45)	0.201***	0.142**	0.172***	0.185***	0.169***	0.180***
VAR(46)	0.126**	0.141***	0.144***	0.111*	0.153***	0.117**
VAR(47)	0.220***	0.219***	0.179***	0.149***	0.203***	0.178***
VAR(48)	0.070	0.045	0.059	0.070	0.043	0.167***
VAR(49)	0.195***	0.146***	0.173***	0.185***	0.131**	0.237***
VAR(50)	0.021	0.081	0.079	0.108*	0.080	0.023

\*p&lt;.05

\*\*p&lt;.01

\*\*\*p&lt;.001

	VAR (105)	VAR (140)	VAR (141)	VAR (142)	VAR (143)	VAR (146)
VAR(51)	0.156***	0.209***	0.172***	0.175***	0.197***	0.099*
VAR(52)	0.074	0.069	0.073	0.075	0.044	0.065
VAR(53)	-0.012	0.002	0.068	0.062	-0.002	0.035
VAR(54)	-0.070	-0.072	-0.081	-0.030	-0.114*	-0.045
VAR(55)	-0.031	-0.030	-0.009	-0.016	-0.086	-0.063
VAR(56)	0.043	0.047	0.049	-0.003	0.018	0.058
VAR(57)	0.097*	0.068	0.098*	0.075	-0.011	0.079
VAR(58)	-0.131**	-0.084*	-0.075	-0.046	-0.092*	-0.025
VAR(59)	-0.095*	-0.089*	-0.064	-0.069	-0.075	-0.111**
VAR(60)	0.012	-0.034	-0.001	0.006	-0.025	0.002
VAR(61)	-0.305***	-0.309***	-0.277***	-0.228***	-0.315***	-0.255***
VAR(62)	-0.313***	-0.317***	-0.272***	-0.287***	-0.349***	-0.210***
VAR(63)	-0.309***	-0.340***	-0.382***	-0.297***	-0.320***	-0.257***
VAR(64)	-0.262***	-0.343***	-0.215***	-0.144***	-0.277***	-0.146***
VAR(65)	-0.309***	-0.348***	-0.292***	-0.249***	-0.299***	-0.248***
VAR(76)	-0.207***	-0.185***	-0.205***	-0.167***	-0.177***	-0.180***
VAR(77)	-0.039	-0.062	0.003	-0.060	-0.033	-0.097*
VAR(78)	-0.056	-0.081	-0.061	-0.031	-0.111**	-0.124**
VAR(79)	-0.189***	-0.197***	-0.199***	-0.184***	-0.158***	-0.204***
VAR(80)	-0.336***	-0.368***	-0.307***	-0.224***	-0.300***	-0.201***
VAR(81)	-0.311***	-0.381***	-0.309***	-0.206***	-0.304***	-0.164***
VAR(82)	-0.244***	-0.256***	-0.219***	-0.167***	-0.254***	-0.158***
VAR(83)	-0.327***	-0.330***	-0.262***	-0.162***	-0.311***	-0.273***
VAR(84)	-0.301***	-0.324***	-0.354***	-0.333***	-0.337***	-0.205***
VAR(85)	-0.178***	-0.232***	-0.171***	-0.148***	-0.230***	-0.143***
VAR(86)	-0.252***	-0.242***	-0.237***	-0.216***	-0.317***	-0.097*
VAR(87)	-0.247***	-0.255***	-0.267***	-0.219***	-0.240***	-0.149***
VAR(88)	-0.274***	-0.295***	-0.199***	-0.216***	-0.287***	-0.196***
VAR(89)	-0.294***	-0.352***	-0.396***	-0.345***	-0.353***	-0.204***
VAR(90)	-0.104*	-0.111*	-0.109*	-0.178***	-0.124**	-0.078
VAR(91)	-0.102**	-0.116**	-0.109**	-0.127**	-0.065	-0.051
VAR(92)	-0.040	-0.053	-0.055	-0.222***	-0.006	-0.055
VAR(93)	-0.278***	-0.268***	-0.241***	-0.229***	-0.231***	-0.130**
VAR(94)	-0.208***	-0.232***	-0.184***	-0.183***	-0.199***	-0.113**
VAR(95)	0.261***	0.228***	0.197***	0.152***	0.205***	0.162***
VAR(96)	0.297***	0.386***	0.225***	0.233***	0.322***	0.244***
VAR(97)	-0.134***	-0.136***	-0.168***	-0.079	-0.176***	-0.094*
VAR(98)	0.181***	0.140**	0.128*	0.158**	0.127*	0.194***
VAR(99)	-0.074	-0.099*	-0.114*	-0.166***	-0.143**	-0.060
VAR(100)	0.254***	0.225***	0.206***	0.208***	0.236***	0.196***
VAR(101)	-0.223***	-0.198***	-0.158***	-0.137**	-0.205***	-0.112**
VAR(102)	-0.153***	-0.144**	-0.158***	-0.175***	-0.203***	-0.120**
VAR(103)	-0.346***	-0.337***	-0.260***	-0.143**	-0.283***	-0.165***
VAR(104)	-0.142**	-0.122**	-0.122**	-0.110*	-0.112**	-0.061
VAR(105)	1.000	0.654***	0.611***	0.518***	0.646***	0.559***
VAR(106)	-0.155**	-0.142**	-0.150**	-0.110*	-0.163***	-0.159**
VAR(107)	-0.221***	-0.208***	-0.180***	-0.182***	-0.213***	-0.128**
VAR(108)	-0.244***	-0.166***	-0.150**	-0.135**	-0.181***	-0.203***
VAR(109)	-0.118**	-0.118*	-0.059	0.010	-0.114*	-0.011
VAR(110)	-0.142***	-0.112**	-0.127**	-0.086	-0.141***	-0.103*

	VAR (105)	VAR (140)	VAR (141)	VAR (142)	VAR (143)	VAR (146)
VAR(111)	-0.124**	-0.167***	-0.186***	-0.110*	-0.179***	-0.082*
VAR(112)	-0.242***	-0.238***	-0.244***	-0.153***	-0.232***	-0.116**
VAR(113)	-0.371***	-0.361***	-0.322***	-0.267***	-0.407***	-0.230***
VAR(114)	-0.296***	-0.289***	-0.260***	-0.158***	-0.265***	-0.170***
VAR(115)	-0.271***	-0.279***	-0.232***	-0.198***	-0.280***	-0.207***
VAR(116)	-0.062	-0.082*	-0.037	-0.051	-0.051	-0.001
VAR(117)	-0.279***	-0.283***	-0.283***	-0.192***	-0.320***	-0.212***
VAR(118)	-0.283***	-0.312***	-0.260***	-0.216***	-0.271***	-0.208***
VAR(119)	-0.156***	-0.130**	-0.091*	-0.119**	-0.163***	-0.173***
VAR(120)	0.332***	0.327***	0.320***	0.305***	0.299***	0.261***
VAR(121)	0.349***	0.313***	0.247***	0.252***	0.349***	0.259***
VAR(122)	0.258***	0.286***	0.285***	0.234***	0.283***	0.238***
VAR(123)	-0.192***	-0.187***	-0.167***	-0.077	-0.166***	-0.145***
VAR(124)	-0.189***	-0.144**	-0.166***	-0.176***	-0.164***	-0.104*
VAR(125)	-0.275***	-0.262***	-0.278***	-0.261***	-0.263***	-0.227***
VAR(126)	-0.207***	-0.152**	-0.142**	-0.169**	-0.175***	-0.116*
VAR(127)	0.144***	0.210***	0.178***	0.166***	0.214***	0.208***
VAR(128)	0.081*	0.072	0.123**	0.085	0.071	0.139***
VAR(129)	0.188***	0.226***	0.210***	0.186***	0.223***	0.263***
VAR(130)	0.048	0.098*	0.093*	0.153***	0.019	0.069
VAR(131)	0.131**	0.162***	0.136**	0.161***	0.122**	0.079
VAR(132)	0.105**	0.161***	0.150***	0.200***	0.204***	0.215***
VAR(133)	0.112**	0.120**	0.106**	0.108*	0.073	0.102*
VAR(134)	0.134***	0.190***	0.218***	0.217***	0.204***	0.249***
VAR(135)	0.179***	0.265***	0.237***	0.214***	0.276***	0.243***
VAR(136)	0.139***	0.153***	0.174***	0.198***	0.127**	0.167***
VAR(137)	0.187***	0.225***	0.255***	0.240***	0.253***	0.267***
VAR(138)	0.117**	0.144***	0.142***	0.204***	0.108*	0.109*
VAR(139)	0.130**	0.182***	0.152***	0.146***	0.167***	0.083*
VAR(140)	0.654***	1.000	0.751***	0.554***	0.738***	0.460***
VAR(141)	0.611***	0.751***	1.000	0.676***	0.676***	0.497***
VAR(142)	0.518***	0.554***	0.676***	1.000	0.573***	0.523***
VAR(143)	0.646***	0.738***	0.676***	0.573***	1.000	0.502***
VAR(144)	0.293***	0.348***	0.324***	0.302***	0.373***	0.236***
VAR(145)	0.314***	0.356***	0.323***	0.297***	0.327***	0.295***
VAR(146)	0.559***	0.460***	0.497***	0.523***	0.502***	1.000
VAR(147)	-0.029	-0.093*	-0.116**	-0.018	-0.050	-0.029
VAR(148)	0.038	-0.039	-0.061	-0.020	-0.028	-0.012
VAR(149)	0.054	-0.026	-0.063	-0.029	0.031	0.059
VAR(150)	0.068	0.004	-0.056	-0.037	0.049	0.075
VAR(151)	-0.144***	-0.126**	-0.106*	-0.101*	-0.099*	-0.104*
VAR(152)	0.023	-0.006	-0.028	-0.055	0.025	-0.023
VAR(153)	-0.022	-0.002	0.021	0.015	0.016	-0.053
VAR(154)	0.004	0.009	0.023	0.049	0.004	-0.028
VAR(155)	-0.028	-0.014	-0.026	0.013	-0.037	-0.057
VAR(156)	-0.010	0.006	-0.021	0.031	0.020	0.007
VAR(157)	-0.015	-0.001	-0.013	0.022	0.024	0.011
VAR(158)	0.048	0.009	0.028	0.070	0.036	0.076
VAR(159)	0.025	-0.062	-0.027	0.042	-0.030	0.029
VAR(160)	0.026	-0.022	-0.058	0.020	-0.029	0.045

	VAR (105)	VAR (140)	VAR (141)	VAR (142)	VAR (143)	VAR (146)
VAR(161)	-0.106**	-0.105*	-0.112**	0.000	-0.096*	-0.029
VAR(162)	0.051	0.090*	0.043	-0.010	0.102*	0.011
VAR(163)	0.006	0.075	0.078	0.051	0.012	0.014
VAR(164)	0.092*	0.166***	0.091*	0.044	0.081	0.075
VAR(165)	0.075	0.097*	0.096*	0.091	0.015	0.066
VAR(166)	-0.026	0.087	0.026	0.013	0.020	-0.004
VAR(167)	0.056	0.116**	0.054	0.035	0.057	0.066
VAR(168)	0.054	0.102	0.056	0.132*	0.072	0.087
VAR(169)	0.064	0.041	0.010	-0.034	0.059	0.108*
VAR(170)	0.075	0.065	0.014	0.026	0.099	0.121
VAR(171)	-0.034	0.028	-0.001	0.041	-0.013	0.042
VAR(172)	-0.025	0.029	0.032	0.030	-0.003	0.040
VAR(173)	0.042	-0.039	0.024	-0.072	0.002	0.143*
VAR(174)	0.071	0.074	0.070	0.046	0.086	-0.011
VAR(175)	0.040	0.051	0.036	0.042	0.039	-0.039
VAR(176)	-0.021	-0.055	-0.062	0.016	-0.018	-0.139*
VAR(177)	0.126*	0.080	0.090	-0.045	0.059	0.046
VAR(178)	-0.249***	-0.253***	-0.223***	-0.164***	-0.213***	-0.124**
VAR(179)	0.042	0.048	0.013	0.065	0.054	0.059
VAR(180)	0.074	0.019	-0.001	0.045	0.016	0.038
VAR(181)	-0.102*	0.012	-0.036	-0.039	-0.014	-0.089
VAR(182)	-0.022	-0.025	0.019	-0.024	-0.008	0.007
VAR(183)	0.064	-0.067	-0.063	-0.051	-0.072	0.022
VAR(184)	0.027	0.002	-0.009	-0.014	0.040	0.021
VAR(185)	0.053	-0.042	-0.048	-0.070	0.001	0.025
VAR(186)	0.053	0.021	0.066	-0.009	-0.013	0.056
VAR(187)	0.017	0.012	0.057	0.099*	0.082*	0.051
VAR(188)	-0.001	0.023	0.067	0.064	0.018	-0.011
VAR(189)	0.043	0.035	0.028	0.048	0.001	-0.003
VAR(190)	-0.003	-0.011	-0.026	-0.044	-0.010	0.009
VAR(191)	0.104*	0.082	0.077	0.101*	0.088*	0.045
VAR(192)	-0.007	0.042	0.054	0.023	0.006	0.020
VAR(193)	-0.074	-0.053	-0.068	-0.088	-0.014	-0.017
VAR(194)	0.028	-0.007	0.001	-0.042	-0.008	0.028
VAR(195)	-0.007	0.060	0.022	0.032	0.063	0.007
VAR(196)	0.034	0.055	0.038	0.017	0.062	0.003
VAR(197)	-0.013	-0.035	-0.023	-0.071	-0.051	-0.047
VAR(198)	0.015	0.006	0.013	-0.011	0.008	-0.017
VAR(199)	0.036	0.065	0.048	0.118**	0.076	0.054
VAR(200)	0.027	0.021	0.082	0.075	0.066	0.082
VAR(201)	0.017	0.016	0.008	-0.032	-0.064	-0.049
VAR(202)	-0.036	-0.060	-0.060	-0.084	-0.062	-0.032
VAR(203)	0.010	0.030	0.010	0.027	0.044	0.023
VAR(204)	0.029	-0.063	-0.079	-0.059	-0.025	0.013
VAR(205)	-0.018	0.019	0.077	0.050	0.057	0.076
VAR(206)	-0.029	-0.058	-0.045	-0.035	-0.026	0.059

APPENDIX D

FACTOR LISTING

- 1 Coordination and Relations\*
- 2 Legal Political Environment
- 3 Project Manager's Authority and Influence
- 4 Strategic Change in Parent
- 5 Success Criteria Clarity and Concensus
- 6 Parent 5-Year Growth (R) \*
- 7 Task (vs. Social) Orientation -- Primary
- 8 Size of Project
- 9 Systems Approaches
- 10 Initial Over-optimism and Conceptual Difficulty
- 11 Bureaucracy
- 12 Client Contact's Authority and Influence
- 13 Internal Criteria
- 14 Size of Project Team
- 15 Social (vs. Task) Orientation -- Secondary
- 16 Private (vs. Public) Project
- 17 Perceived Success of Project (R)
- 18 Project Manager's Spatial Distance
- 19 Public Relations Environment\*
- 20 Parent Size
- 21 Project Team Decision Participation (R)

- 22 Initial Over-optimism and Conceptual Difficulty\*
- 23 Success Criteria Clarity and Concensus\*
- 24 Parent Size\*
- 25 Parent 5-Year Growth
- 26 Private (vs. Public) Project\*
- 27 Public Relations Environment
- 28 Bureaucracy\*
- 29 Strategic Change in Parent (R)\*
- 30 Internal Criteria\*
- 31 Competitive and Budgetary Pressure
- 32 Ease of Coordination
- 33 Project Manager's Spatial Distance\*
- 34 Difficulty Coordinating With Client
- 35 Undefined\*
- 36 Project Uniqueness, Importance and Public Exposure (R)
- 37 Legal Political Environment\*
- 38 Undefined\*
- 39 Start-up Difficulties (R)
- 40 Perceived Project Complexity (R)
- 41 Buy-in Strategy (R)
- 42 Coordination and Relations
- 43 Project Manager's Authority and Influence\*
- 44 Task (vs. Social) Orientation\*
- 45 Control Techniques\*
- 46 Client Contact's Authority and Influence\*
- 47 Size of Project Team (R)\*
- 48 Undefined\*

- 49 Networking Techniques
- 50 Perceived Success of Project\*
- 51 Size of Project\*
- 52 Cost and Schedule Overrun
- 53 Adequacy of Project Structure and Control
- 54 Internal Capabilities Buildup (R)

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\*As explained in Section 4.3, these factors are redundant and were not included in further analysis.

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