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An integrative research review of the relationship between technology and structure: A meta-analytic synthesis

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AN INTEGRATIVE RESEARCH REVIEW OF THE RELATIONSHIP BETWEEN TECHNOLOGY AND STRUCTURE: A META-ANALYTIC SYNTHESIS

by

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PH.D. THESIS

This is to certify that the Ph.D. thesis of

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CHAPTER I

THE ROLE OF THEORY IN TECHNOLOGY RESEARCH

Perrow, (1967: 195) believes that technology is the defining characteristic of an organization. He contends that technology is a better basis for comparing organizations than the several other schemes in existence (e.g., social function; beneficiaries; compliance structures). The advantage of the "technological school" is that it provides a focus on something more or less analytically independent of structure and goals (Perrow, 1967). Perrow concedes that there is no general agreement in the technological school of contingency theory "as to how to define technology in any precise way, or how to measure it, . . . [however] the general outlines of a theory are present" (1986: 141).

However, Perrow argues that "organizational theory has not until recently attempted to build into its models any systematic consideration of different types of organizations" (1986: 140), and criticizes the typologies offered by researchers to date as not very informative (1986: 141). Reimann and Inzerilli suggest that before we carry out more empirical studies we need to develop a "useful, common theory of the system level relationship between technology and structure" (1979: 189-190). If the major task in science is the development of theory that can generate testable hypotheses, then a cumulative body of knowledge must be generated by empirical research. Synthesis is needed, and one more small-scale study will not provide for that need.

Technology in Organization Research

There have been two basic approaches to the study of technology in organizational research. The first was concerned with the effect of technology on the behavior of organization members, and was an outgrowth of the human relations tradition that developed after World War II. It may be viewed as a response to the rapid increase in mass production technologies during that period. The Yale Technology Project at the end of the 1940s was one of the first attempts to answer the question of how mass production technology influenced job attitudes. The measure of technology developed by Walker and Guest (1952) scaled the degree of work repetitiveness, pacing, skill requirements, number of breaks, frequency of interaction, and the size of the work group.

During that same time period the Tavistock Institute of Human Relations in England was investigating how technology affects social organization of small groups. The most well known study coming from this group involved the introduction of longwall methods in coal mining (Trist & Bamforth, 1951). Other studies investigated the effect of automation on workers in an Indian textile firm (Rice, 1958). Outside of the Tavistock Institute of Human Relations, other researchers investigated the effect of different types of technology on worker alienation (Blauner, 1964). This research and other studies led to prescriptions. Based upon their findings researchers recommended job enlargement, participative decision making, job rotation, and other practices intended to reduce turnover and absenteeism (Walker & Guest, 1952), as well as restructuring of social organization to regain group autonomy and cohesion (Blauner, 1964;

Rice, 1958; Trist & Bamforth, 1951).

The second, and more recent, approach to the study of organizational technology has focused on the question of how technology affects organization structure. Contemporary interest in technology as a determinant of organization structure has its origin in Woodward's (1958/1966) research. The publication of her landmark study ushered in the era of contingency theory in organizational research. Woodward was attempting to test the utility of classical management theory. As such she was concerned with advantages of different types of structure (functional, line, or line-staff); the degree of functional specialization; the optimal span of control and number of hierarchical levels; and the ratio of staff personnel to workers.

When Woodward and her colleagues could find no linkage between these variables and organization success, they turned to the nature of the predominant technology in each organization (Woodward, 1965). They found that when the organizations were grouped by type of technology, the most successful firms within each type scored near the median on the structural variables. Those firms that scored either above or below the median were less successful. This has become known as Woodward's "technological imperative". The research team concluded that technical methods are not only an important factor in determining organizational structure, but also in setting the tone of human relations within the firms. Size had little effect on structure and so technology was more important than size in her study. Woodward argued that there is no one best way to organize, and her study has become recognized as one of the first major empirically based challenges to classical management theory, and a pioneering work in the new contingency approach.

These results have been the subject of research and debate for three decades. As can be seen, Woodward's seminal research is not only central to the technology-structure debate, but also to the whole fabric of contingency theory which remains a dominant paradigm in organization research. Technology was the original contingency. All others (e.g., organization size, and environment) came later as alternative or adjunct contextual variables.

However, little progress has been made toward an explanation of those results. Woodward's own comments regarding her findings emphasized the need for an explanation:

> If we could find answers to such questions as why unit articles can be produced successfully only where the lines of control are short, why mass production demands the definition of duties and responsibilities, and why the chief executive in a process production firm can successfully control more subordinates than his counterparts in other types of production, we would have come a long way towards the discovery of cause and effect relationship between systems of production and the forms of organization they demand. These cause and effect relationships in turn provide us with a basis of reasoning in the field of management (Woodward, 1965: 78).

This initial call for a unifying theory has generally gone unanswered. Gerwin has argued that "in comparative research on structure and technology, too much time has been devoted to the initial pattern finding aspect and too little to the remaining theory formulation aspects" (1979a: 42).

However, there have been some attempts made to introduce theoretical explanations of the relationship between technology and structure. For example, the concepts of task routineness developed by Perrow (1967) and workflow interdependence suggested by Thompson (1967) have been used to generate testable hypotheses regarding the effect of technology on structure. However, research into the relationship between technology and structure has been directed primarily by empirical findings. Woodward's (1958/1966) study, and its serendipitous findings, has served as a general framework for subsequent research, but it does not constitute a theory of technology. The interpretation of research findings is guided by their consistency, or lack of consistency, with the findings of earlier research. The body of literature that has evolved is a patchwork of conflicting results and varied interpretations.

This condition is further exacerbated by the variety of operational measures of technology that have been used in the literature. The remainder of this chapter will focus on the origins of these various constructs of technology. The inconsistency in empirical findings will be addressed in Chapter II.

Constructs of Technology

Nearly all of the empirical research into the relationship between technology and organizational structure can trace its roots to six constructs of technology contributed by Woodward (1958/1966); Harvey (1968); Thompson (1967); Perrow (1967); Hickson, Pugh and Pheysey (1969); and Whisler (1970). This section will present a brief review of these constructs. Table I-1 lists these constructs and some related operationalizations.

Hickson et al. (1969) propose that concepts of technology have three dimensions which, together, encompass the full range of meanings that have been developed:

1. Knowledge technology refers to the characteristics of the knowledge used in the workflow. It is related primarily to Perrow's (1967) model and includes both search behavior and ability to understand the raw material.

2. Materials technology concerns characteristics of the materials in the workflow. This concept includes what Perrow refers to as the perceived uniformity and stability of the object or raw material (1967: 195). Rushing (1968) classified materials according to hardness in his study of industries. Also related is Thompson's (1967) concept of "intensive technology" in which the state of the material or object itself determines what is done to it.

3. Operations technology involves the techniques used in the workflow activity. This concept comes from Pugh et al. (1963: 310) and is closely related to serial interdependence of acts in long-linked technology (Thompson, 1967). The term "workflow" is preferred by Hickson et al. (1969) over "production" because it applies to all organizations, not just to manufacturers.

Gerwin (1981), like Perrow, conceptualizes technology on two dimensions; variety and changeability. Variety relates to the existence of different task-technology combinations at one time or over time. Gerwin (1981) further defines the dimension of variety as having two parts. The first is diversity which is related to the number of task-technology combinations at any one time. The second component of variety is explicitness which is the degree to which a given task-technology combination has a well defined hierarchy at both the organizational and the job level. Changeability, the second dimension of technology, is the rate at which the mix of task-technology combinations changes over time. Changeability is distinguished from diversity in that diversity relates to the number of task-technology combinations at any point in time, while changeability refers to the rate of change in those combinations. An organization's technology can therefore be viewed as a point in a three dimensional space as shown in Figure I-1.

Gerwin (1981) contends that there is no clear cut distinction between tasks performed and technology. Rather, there is a more or less gradual shift from ends to means. An organization must break its tasks down into sub-tasks in order to accomplish them. These sub-tasks constitute the technology. Sub-task activities at any given level of the means-end hierarchy serve as the technology (or means) for accomplishing the tasks (or ends) at the level above. Given Gerwin's view that the task determines the technology and the raw materials, it is understandable that he believes organization-level analysis, with a focus on a dominant technology and primary task, may tend to obscure the distinctive hierarchy of sub-tasks being accomplished throughout the organization. This conceptualization of task-technology combinations is not unique to Gerwin, but he is most explicit in its description. What is unique is Gerwin's strong advocacy for analysis of the task-technology combination at the job level. However, this has been little pursued in empirical research. Most research uses summary measures of technology as one or a few variables. This is what the technology-structure literature has focused upon and will be our concern here.

Workflow Continuity

Woodward (1965) classified industrial plants on the basis of their mode of production. There were four elements to her scale. First, each firm was ranked on an 8-point scale to assess the predominant mode of production. This scale ranged from <u>single simple articles</u> to <u>continuous flow</u>. Second, each firm was rated for product type on a 3-point scale: (a) stable, (b) progressive, and (c) made to order. Third, technological change was assessed based upon whether there had been any changes within the previous six months or were anticipated. Finally, the effect of technological changes on the nature of the production system was assessed (Rackham & Woodward, 1970: 20-21). Firms were grouped into 10 categories according to their technical methods. Woodward (1965) claimed that the first nine systems on her scale are listed in order of chronological development and technical complexity; the production of single units to customer specifications being the oldest and the simplest, and the continuous-flow production the most advanced and most complex. By complexity she meant "the extent to which the production process is controllable and its results predictable" (Woodward, 1958/1966: 12). Her final scale of technological complexity regrouped the 10 categories into 3 categories: (a) unit and small batch production, (b) large batch and mass production, and (c) continuous process production.

There has been some controversy over the dimensions of Woodward's scale and its underlying theoretical construct. Woodward (1965: 37) admits that her scale was a "rough and ready basis" to group organizations and she likened it to the botanist's "Flora", and later joined in the call for improved measures of the technology variable (Rackham & Woodward, 1970). Starbuck argues that what Woodward called "complexity" of technology "seems to correspond to the smoothness of production" (1965: 503). Hickson et al. (1969: 381) consider it to be a subconcept of operations technology, that is, continuity of the units of throughput (work in process). Perrow even suggests that Woodward's independent variable is not, strictly speaking, technology at all, "but is a mixture of type of production, size of production run, layout of work and type of customer order" (1967: 207). Hunt argues that the meaning of unit, batch, and mass production is quite clearly a "scale of production quantities ranging from one of a kind through few to very many" (1970: 239).

In this study we will refer to this technology construct as workflow continuity. This will include Woodward's (1965) scale of technological complexity and all versions of that scale.

Operations Variability

Harvey argues that while Woodward chose to see her scale as being arranged on an ascending scale of technical complexity, it could just as easily be "viewed as a move toward technical simplicity rather than complexity" (1968: 249). That is to say unit production can, at times, be more complex than continuous process. He argues that it is variability in the process that distinguishes unit production from continuous process production.

Harvey (1968) proposes a continuum from technical diffuseness (many changes) to technical specificity (few changes). Diffuseness was operationalized by Harvey as the number of product changes over a 10 year period. This seems to be comparable to Woodward's concept of complexity (i.e., controllability and predictability). According to Harvey, "the more technically diffuse a firm . . . the greater the degree of 'made to orderness'" (1968: 249). This conceptualization is intended to take account not only of the form of technology, as Woodward did, but also the rate of change of products. In a comparison with Woodward's three main categories unit is most diffuse, continuous process is most specific, and mass production comes under the heading of mid range. Thus diffuseness is the inverse of technological complexity. That is, technological complexity is positively associated with technological specificity.

Interdependence

The role of technology in determining organization structure has also been addressed by Thompson (1967) who claims that it is the degree of interdependence between groups at the technical core that determines organization design. Thompson claims that his model of three types of interdependence forms a Guttman-type scale ranging from pooled (i.e., no direct interdependence, but failure of any single element contributes to failure for the whole), through sequential (i.e., direct interdependence such that the outputs of one element become the inputs of another), to reciprocal (i.e., each unit provides input to all others, and receives input from all others). According to this model all organizations have pooled interdependence, but only the most complex will have reciprocal interdependence.

As the level of interdependence increases so does the burden on communication and decision making systems. As a result of this increased burden, Thompson (1967) argues that increases in the level of interdependence will lead to departmentalization in order to place reciprocally interdependent members in the same group, and sequentially interdependent positions adjacent to each other in a common group. Under conditions of pooled interdependence organizations will seek to group positions homogeneously by process in an effort to facilitate coordination. This process occurs at each level of organization and results in horizontal complexity. However, it is not always possible to confine reciprocal interdependence within groups. When this occurs groups will be linked together through a higher level group to form a simple hierarchy, leading to vertical complexity.

A related theoretical treatment of the technology-structure relationship can be found in Galbraith's (1986) information processing model. A basic proposition of this model is that task uncertainty (a hypothesized dimension of technology) increases the amount of information that must be processed between decision makers during the execution of the task. Galbraith argues that unless the organization design is adaptive to these pressures then "reduced performance standards will happen automatically" (1986: 513). In other words, unless the structure of the organization is correctly balanced to the demands for information processing, the organization will decline, thus reducing the flow of information until it matches the organization's capacity to process it.

Thompson (1967) suggests that the level of interdependence is directly related to the method of coordination that is possible. Borrowing from March and Simon (1958: 56), he states that coordination can be accomplished in three ways. First, standardization (i.e., the application of routines and rules) can be used when the situation is fairly stable and there are few exceptions to deal with, and is appropriate under conditions of pooled interdependence. Second, coordination by plan requires a lower level of stability than standardization does, and involves the use of schedules to govern the action of interdependent groups. It is appropriate in situations involving sequential interdependence. Finally, coordination by mutual adjustment (i.e., feedback) involves an ongoing exchange of new information during task accomplishment, and it is appropriate under conditions of reciprocal interdependence. It is worth noting that coordination by mutual adjustment can also be used under conditions of sequential interdependence or pooled interdependence, but coordination by mutual adjustment is a more costly method than coordination by plan or standardization.

Each of these three levels of interdependence is also associated with Thompson's (1967) typology of three types of technology found in organizations. Mediating technology links clients or customers who either are or wish to be interdependent. Examples frequently cited include investment bankers, or job placement services. The pooled interdependence of mediating technology allows coordination through standardization which assures each segment of the organization that other segments are operating in compatible ways. Long-linked technology involves serial interdependence and coordination by plan. Mass production assembly lines are the best examples. Finally intensive technology is best illustrated by the hospital emergency room. It draws upon a variety of techniques to achieve a change in the input, but the inputs determine what combination of techniques will apply. Coordination by mutual adjustment is the only viable alternative.

It can be hypothesized that as the level of interdependence increases in an organization one should observe increases in the level of task specialization (i.e., the degree to which a task is differentiated into parts). Decentralization of decision making should also increase, but this may be due more to increased organization size implicit in the move from pooled to sequential interdependence. The increased burden on coordination should also tend to reduce the span of control of management which, in turn, will result in an increase in the number of hierarchical levels.

However, as the organization moves from pooled, through sequential, to reciprocal interdependence these structural changes may display nonlinear patterns. Task specialization, for instance, will increase as the technology shifts from mediating to long-linked, but the shift from long-linked technology to intensive will require fewer specialists, and more professionals and generalists who can function independently.

The impact of interdependence on standardization and formalization is not clear. If the level of interdependence does follow a Guttman-type scale as Thompson suggests, then it can be assumed that the level of standardization and formalization that is needed under conditions of pooled interdependence will remain fairly constant through sequential and reciprocal interdependence. However, standardization and formalization may prove ineffective, or even dysfunctional, in the face of reciprocal interdependence and the necessity for mutual adjustment. It might even be expected that a decline in the level of standardized rules and formalized roles will occur. It has also been suggested that these consequences of interdependence between tasks and roles (e.g., specialization, etc.) tend to reinforce interdependence, that is, more specialization of work creates more roles which are interdependent with one another (Pennings, 1975: 828).

Task Routineness

After considering, and rejecting, alternative bases of a typology for technology Perrow argues that there are two characteristics that might apply: "Raw materials (things, symbols, or people), which are transformed into outputs through the application of energy; and tasks, or techniques of effecting that transformation" (1986: 141). Within this framework, Perrow defines technology as "the actions that an individual performs upon an object, with or without the aid of tools or mechanical devices, in order to make some change in that object" (1967: 195). He views machines and equipment as "merely tools; they are not the technology itself" (1970: 75-76). The object, or raw material, may be a living being, human or otherwise, a symbol or an inanimate object.

Perrow (1967) conceptualizes both raw materials and techniques as varying along two dimensions: (a) the degree of variability in the stimuli (i.e., number of exceptions encountered); and (b) the degree to which search procedures are analyzable (i.e., extent to which established procedures exist to deal with exceptions). Search behavior is the response to stimuli received by the individual performing a task. Little search behavior is required for familiar stimuli because the individual knows how to respond based upon past experience. The response may be to refer to standardized procedures, or even ignore the stimuli, but little energy is required. On the other extreme, if the individual must respond to unfamiliar stimuli, much energy must be devoted to analyzing it. This is what Perrow calls "unanalyzable search procedures" related to nonroutine tasks (1970: 76). These two dimensions come together to form four quadrants as in Figure I-2. Perrow considers routine (lower left cell) and nonroutine (upper right cell) to be extreme types of technology. He suggests that nonroutine firms will be characterized by unanalyzable search procedures, many exceptions, coordination through mutual adjustment (feedback), and high group interdependence. Routine firms will be characterized by analyzable search, few exceptions, coordination through plan, and low interdependence. He also suggests that nonroutine types tend to be more organic, but most firms are in the quite routine cell. It is in their best interest to be there due to the higher level of control possible.

If we substitute the term "raw material" for the term "stimuli" in the previous discussion, we can also define the raw material variable on two dimensions as shown in Figure I-3.

1. Understandability or controllability: "To understand the nature of the material means to be able to control it better and achieve more predictability and efficiency in transformation" (Perrow, 1967: 196-197).

2. Stability and variability refer to whether the material can be treated in a standardized fashion or whether continual adjustment to it is necessary. Perrow states that "organizations uniformly seek to standardize their raw material in order to minimize exceptional situations" (1967: 196-197).

This conceptualization of technology can be applied to all organization activities. "[T]he interactions of people are raw materials to be manipulated by administrators in organizations. . . . The form that this interaction takes we will call the structure of the organization" (Perrow, 1967: 195). It might be said that the interaction of individuals, which is an essential element in the process of changing materials in an organization setting, becomes the raw material for building organization structures. It is not the nature of the process that determines structure so much as it is the nature and degree of interaction required in that process.

Workflow Integration

Although Hickson and his colleagues (1969) considered technology in three facets (i.e., knowledge technology, materials technology, and operations technology), the focus of their research was operations technology which they viewed as possessing a number of subconcepts. The first three subconcepts apply to both manufacturing firms and service providers. The first refers to how automated the production equipment is (i.e., automaticity). The second subconcept of operations technology refers to the rigidity of the workflow sequence, and relates to the ability to adjust the process and provide buffers. It also contains elements of workflow interdependence. The third subconcept of operations technology relates to the means used to evaluate the operations performed (i.e., specificity of evaluation of operations). These means can be specific objective standards, subjective personal opinion, or some combination in between. Hickson et al. developed a new technology measure called workflow integration consisting of the first three subconcepts. They defined workflow integration as "the degree of automated, continuous, fixed-sequence operations in the technology" (1969: 384).

The fourth subconcept of operations technology is the continuity of work in process (i.e., production continuity) and is central to Woodward's (1958/1966) scale of unit, mass, and continuous process production. Hickson et al. (1969) consider this concept to be limited to manufacturing firms. They revised Woodward's scale into a 10-point scale of workflow continuity which they called "production continuity" (Hickson et al., 1969).

When compared to Gerwin's (1981) concept of task-technology combinations, Hickson et al.'s (1969) definition clearly separates technology from the task, which they prefer to call charter or purpose. The focus is on the techniques applied rather than the task.

Information Processing Technology

The final conceptual definition of technology relates to the impact of information processing technologies on organization structure. Whisler (1970) believes that most technologies introduced into business firms in this century have had only a localized effect on the structure of the organization, because the technology itself is limited to only a couple of specialized functions. The computer, on the other hand, deals with the universal function of information processing and should have company-wide effect (i.e., its potential impact is systems-wide).

This perspective differentiates system level structure from workflow level structure and suggests that the impact of workflow level technology will be limited to workflow level structure, while system level technology (i.e., use of computers, or technological change in the industry) will impact system level structure. Information processing technology is indexed by computerization (Blau, Falbe, McKinley & Tracy, 1976; Reimann, 1980). Information processing technology can have some relationship to the broad theoretical concepts of Thompson (1967) and Perrow (1967) discussed above, but the concepts of Woodward (1958/1966), Harvey (1968), and Hickson et al. (1969) all focus on the workflow. Information processing technology and routineness are nevertheless distinct concepts, in that information processing technology (computerization) may imply routineness, but is not identical to it.

Dimensions of Technology

Ford and Slocum (1977) believe that one common dimension underlies the numerous operationalizations of technology. That dimension appears to be task predictability, routineness or programmability. This dimension clearly appears to be captured in the

Woodward scale of technical complexity. She defined her term to mean "the extent to which the production process is controllable and its results predictable" (Woodward, 1958/1966: 12). Perrow's conceptualization of routine technology is specifically defined as having few exceptions and analyzable search procedures (Perrow, 1967), and most operationalizations address routineness (Hage & Aiken, 1969; Hall, 1962; Van de Ven & Delbecq, 1974). Harvey's (1968) measure of specificity does. For example, as the technology becomes more specific (fewer product changes) the results should be more predictable. Finally, the extent of automation, rigidity, and ability to measure output quality, included in the measure of workflow integration also seem to have implications for the dimensions of predictability, routineness, and programmability (Hickson et al., 1969).

Conclusion

Contingency theory remains the dominant paradigm in the study of organization design, and technology, as the first contingency, is one of the most extensively studied contextual variables. This represents an important body of literature in organization research. However, it is a literature that has been driven by empirical findings rather than by a unifying theory of technology.

One of the outcomes of the research interest in technology has been a proliferation of conceptual measures of technology. Empirical results obtained with these measures, and the conclusions of several literature reviews, will be addressed in Chapter II. It will be shown there that the research literature on technology and structure is in need of synthesis.

Gerwin made the following recommendation regarding the need for a balance between "pattern finding" and "theory formulation":

> Shifting the balance can be facilitated by more organized inquiries into the maze of existing empirical studies. The literature must be partitioned into a few sensible categories in order to prevent meaningless comparisons. It is probably not fruitful to assume that studies of organizations with broadly different tasks, such as manufacturing and service or profit and nonprofit, will exhibit similar structural and technological patterns. Perhaps research at organizational and component levels should be analyzed separately (Gerwin, 1979a: 49).

This recommendation will be implemented in this study through the application of the techniques of meta-analysis (Hunter, Schmidt, & Jackson, 1982). Chapter IV will discuss these techniques. The goal is to determine whether the interpretations of past research and literature reviews hold up when the results of several studies are accumulated quantitatively.

Table I-1. Technology Constructs and Operationalizations

Construct		Operationalization	
Continuity	Woodward (1958/1966)	Unit, mass, & process	Woodward (1958/1966); Zwerman (1970)
		Production continuity	Hickson, Pugh & Pheysey (1969)
		Throughput continuity	Hickson et al. (1969)
		Mass-output orientation	Khandwalla (1974)
Operations variability	Harvey (1968)	Technical specificity	Harvey (1968); Litschert (1971)
Workflow integration	Hickson et al. (1969)	Workflow integration	Hickson et al. (1969); Child & Mansfield (1972)
		Automation	Blau, Falbe, McKinley, & Tracy (1976)
Level of interdependence	Thompson (1967)	Interdependence of of workflow segments and workflow rigidity (Part of workflow integration)	Hickson et al. (1969); Ford (1975; 1981)
Task routineness	Perrow (1967)	Routineness	Hage & Aiken (1967); Lynch (1974); Glisson (1978)
		Variety	Daft & Macintosh (1981); Van de Ven & Delbecq (1974); Van de Ven & Ferry (1980)
		Difficulty	Van de Ven & Delbecq (1974); Van de Ven & Ferry (1980)
		Analyzability	Daft & Macintosh (1981)
		Predictability	Lynch (1974)
		Insufficient knowledge	Lynch (1974)
Information processing technology	Whisler (1970)	Use of computers	Blau et al. (1976); Reimann (1980)

Figure I-1. Gerwin's Conceptualization of Technology

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                 /--------\
                /        /|
               /        / |
              /--------/  |
              |        |  /
    DIVERSITY | VARIETY | /
              |        |/ CHANGEABILITY
              \--------/
             EXPLICITNESS
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Note. Adapted from Gerwin, D. 1981. Relationships between structure and technology. In P. Nystrom & W. Starbuck (Eds.), Handbook of organizational design: Vol. 2. Remodeling organizations and their environments: 3-38. Clifton, NJ: Oxford University Press.

Figure I-2. Technology Variable (Industrial Example)

SEARCH

EXCEPTIONS

Unanalyzable Problems

	Few Exceptions	Many Exceptions
Unanalyzable Problems	Craft industries (specialty glass)	Nonroutine (aerospace)
Analyzable Problems	Routine (tonnage steel mills, screw and bolts)	Engineering (heavy machinery

Analyzable Problems

Note. From Perrow, C. 1967. A framework for the comparative analysis of organizations. American Sociological Review, 32: 196.

Figure I-3. Raw Material Variables (People Changing Examples)

PERCEIVED NATURE OF RAW MATERIAL

VARIABILITY OF MATERIAL

Not Well Understood

	Perceived as uniform and stable	Perceived as nonuniform and stable
Not Well Understood	Socializing institution (e.g., some schools)	Elite psychiatric agency
Well Understood	Custodial institutions, vocational training	Programmed learning school

Well Understood

Note. From Perrow, C. 1967. A framework for the comparative analysis of organizations. American Sociological Review, 32: 198.

CHAPTER II

INCONSISTENCY IN RESEARCH FINDINGS

The origins and the importance of technology in organization theory were discussed in the previous chapter, along with a description of several conceptual definitions of technology that have appeared in the literature. The important role of empirical findings as the guiding force in technology-structure research was also emphasized. In this chapter the inconsistency in those empirical findings will be discussed, followed by a discussion of the attempts of several reviewers of the literature to reconcile that inconsistency.

Empirical Evidence

Workflow Continuity

Woodward (1958/1966) played a central role in the development of contingency theory in organization research. Her results indicated that there were clear linear and nonlinear relationships between her variable of technical complexity and several measures of structure. As the predominant technology type shifted from unit production to continuous process production, Woodward and her colleagues observed increases in the number of levels of authority, the ratio of managers and supervisors to total personnel, the ratio of indirect to direct labor, the ratio of administrative and clerical personnel to hourly paid personnel, the proportion of production supervisors who were professionally qualified, the span of control for the CEO, and the importance placed on production control. There was a decrease in labor cost as a proportion of total cost, and nonlinear relationships were observed for the span of control of first line supervisors, the use of written communication, specialization, role definition, and the separation of production administration from production supervision (Woodward, 1958/1966: 16-18). These results are summarized in Table II-1. Her study introduced technology as the first contingency and was the impetus for three decades of research and debate.

Zwerman (1970) replicated the Woodward findings in a sample of 55 Minnesota manufacturers, and generally claimed to support Woodward's findings (noted in Table II-1). One notable exception is that Zwerman's data indicate that span of control for first line supervisors decreased as technical complexity increased, so Woodward's nonlinear relationship was not supported. Both Woodward and Zwerman found that unit and continuous process production firms (i.e., extreme ends of the scale) had more flexible (i.e., organic) structures, while mass-production operations were more likely to have relatively rigid (i.e., mechanistic) structures.

Another important finding of both Woodward and Zwerman that has been at the very heart of the technology-structure debate is that there was no significant relationship observed between the size of the firm and the system of production. However, Woodward pointed out that size did appear to have an effect on the number of levels of authority, and span of control within each production group when studied separately (Woodward, 1958/1966: 20). That is, when technology was controlled, size of the organization did affect structure.

Operations Variability

Harvey's (1968) study of 43 industrial organizations operationalizes technology as the number of product changes over a 10 year period. Organizations with 1 to 8 changes were classified as technically specific, those with 20 to 43 changes were called technically intermediate, and those with 72 to 145 changes were considered technically diffuse. Category ranges were determined by visual inspection of the data.

The results of Harvey's (1968) analyses indicated that as technical specificity increases (i.e., fewer product changes) the number of specialized subunits increases, the number of levels of authority increases, the ratio of managers and supervisors to total personnel increases, and the amount of program specification (i.e., formalization) increases. The findings are largely consistent with those obtained by Woodward (1965) and Zwerman (1970) since increases in technical specificity parallel the progress from unit production to continuous process production. However, Woodward (1965) observed a nonlinear relationship between her scale of technological complexity and formalization (i.e., formalization was highest for the middle grouping of mass production technology), while Harvey (1968) observed a positive linear relationship between formalization and technical specificity.

Workflow Integration

Neither Woodward (1958/1966), Zwerman (1970), nor Harvey (1968) used sophisticated analytic techniques. Instead they depended upon charts and visual patterns to illustrate their findings. Hickson et al. (1969) provided one of the earlier published attempts to use more sophisticated measures and multivariate correlational techniques.

This study of 52 British organizations is commonly referred to as the Aston Study and it may be the most significant contributor to the ongoing debate over the importance of technology as a determiner of organization structure.

Hickson et al. (1969) discussed the results of their analyses for both the workflow integration scale, and the production continuity scale. They found moderate correlations of workflow integration with three main structural dimensions: structuring of activities, concentration of authority, and line control of workflow, which "refers to control of operations on the throughputs being exercised directly by line management, as against impersonal control through records and procedures by staff departments" (Hickson et al., 1969: 385). Correlations with the constituent variables of those three dimensions were also moderate.

However, the correlations of those structural variables were stronger with size than with technology, and partialling out size seriously reduced the correlation of technology with structure. Nevertheless, some structural variables were related to technology and not to size. All were simple job-count variables and not related to the wider administrative and hierarchical structure (e.g., supervisors' span, and proportion of employees engaged in workflow supervision, design, methods, or inspection).

Hickson and his colleagues discounted the finding of any relationship to workflow integration as being due to "the crude difference between service and manufacturing which is reflected in the polar tendencies of service and manufacturing organizations on that scale" (1969: 388). To test this hypothesis they examined a subsample of 31 manufacturing firms. The previously observed correlation with the three main structural dimensions disappeared, but organization size continued to dominate in size of correlation. Similar results were observed for the production continuity scale.

In an effort to reconcile their findings with those of Woodward (1958/1966), Hickson et al. (1969) suggested that the small size of Woodward's organizations may have had an effect. The Aston sample had several very large organizations. Hickson et al. offered an alternative hypothesis to the technological imperative which states that "structural variables will be associated with operations technology only where they are centered on the workflow" (1969: 394). They also proposed that size of the organization will moderate the correlation of technology with structure. In small organizations the effect of technology will be greater than in large organizations where the effect is limited to a few job-count variables located on the workflow because technology has a more pervasive effect on structure in small organizations than in large organizations (1969: 394-395).

To test the conclusions of Hickson and his colleagues (1969), Aldrich (1972) reanalyzed the original Aston data using path analysis and demonstrated that there are several causal models which are consistent with the Aston data on size, technology, and structure. He argued that while the Aston interpretation implied that technology is dependent upon organization size, the causal link may be reversed. Aldrich argued that small observed correlations are not sufficient reason to reject an argument based on "sound, logical, temporal, and theoretical grounds" (1972: 33). When considering the developmental sequence of an organization over time, it is difficult to imagine size preceding technology.

Child and Mansfield (1972) also refuted Woodward's (1958/1966) argument that technology is the single major determinant of structure. However, they noted that the individual scales comprising workflow integration (i.e., workflow rigidity, automaticity, interdependence of workflow segments, and specificity of evaluation of operations) were differentially related to measures of structure (1972: 388). They also found that smaller organizations appeared to have stronger technology-structure relationships than did larger organizations thus supporting Hickson's alternative hypothesis. Their study, known as the National Study, included 82 British firms of various types.

In a study of 110 New Jersey manufacturers Blau et al. (1976) also rejected Woodward's notion of a broad technological imperative for linear relationships. However, they did find strong nonlinear relationships, independent of size, between production type and several structural variables. Although they generally supported the findings of the Aston Study, they rejected the Hickson et al. (1969) hypothesis of an interaction between size, production technology, and administrative structure.

Task Routineness

Perrow's model of technology may be the most frequently operationalized construct in the literature. The literature reviews of Fry (1982) and Gerwin (1981) both suggested that this construct has yielded the most consistent findings of any of the technology dimensions, yielding a moderately strong relationship to structure. Ford and Slocum (1977: 571) found that this conceptualization of technology has generally been shown to be positively correlated with the structural variables of administrative intensity, formalization, centralization, and both horizontal and vertical differentiation.

However, operationalization of this construct presents a dilemma for the study of technology and structure. The dilemma surrounds the issue of whether standardization is a dimension of structure, or of technology. Price and Mueller define standardization as "the uniformity of operating procedures" (1986: 237-242). They further suggest that the measure of analyzability developed by Withey, Daft, and Cooper (1983) fits the definition of standardization. In order to resolve this dilemma we must first recognize the extreme difficulty encountered in the operationalization of Perrow's two dimensional model. This is what Perrow meant when he commented that the most serious limitation in the study of technology is that the measurement of it "is confused by the effects of structure" (1986: 143-144).

Information Processing Technology

Whisler (1970) conducted a longitudinal study of 19 insurance companies to assess the impact of computers on organizations. He found that the primary impact on employment was a reduction in the number of clerical personnel. He also observed increased centralization, a reduction in the span of control at lower levels of the organization, a modest reduction in the number of hierarchical levels, and a move away from parallel structure toward functional differentiation (1970: 63).

It should be noted that Whisler's findings were based upon the application of mainframe computers. The introduction of personal computers into the workplace has had a significant impact on information processing over the past 15 to 20 years. It is difficult to imagine any segment of the business organization that is not affected by them today. However a conceptual distinction seems to be appropriate to separate the impact of automated production processes from automated information flow.

Blau and his colleagues (1976) found that production technology, and automation of administrative support functions were related to different dimensions of structure. They found that even when a factory had an in-house computer, it was used primarily for information processing, and very little for direct control of the manufacturing equipment. But, more importantly, they found that computer use was positively correlated with both horizontal and vertical differentiation, as well as the proportion of employees in nonproduction jobs, while production technology's effect was limited to production job-count variables (Blau et al., 1976).

Reimann (1980) also found support for the hypothesis that system level technology, which he defined as technological change and computerization of support functions, tends to relate primarily to system level structural variables such as formalization, specialization, and decentralization, but workflow level technology is related primarily to workflow level structural measures. Thus information technology can affect structure quite pervasively and systemically when the information technology is itself systems-level computerization, such as of the core administrative process.

Summary

The results of empirical studies have been inconsistent. First, Woodward (1958/1966) claimed that technology was the critical variable in determining the appropriate structure for organization success. Then, Hickson et al. (1969) refuted that claim and suggested that it is the size of the organization (i.e., number of organization members) that is the dominant factor. However, Harvey (1968) and Zwerman

(1970) came along on the side of Woodward's (1958/1966) position that technology is predominant. Next came Child and Mansfield (1972) who generally supported the conclusions of Hickson et al. (1969) that technology has a stronger impact on the structure of small organizations. Blau et al. (1976) found support for several of Woodward's (1958/1966) nonlinear relations, but they generally supported Hickson et al. (1969) with the exception of the interaction between size, technology, and structure.

The 10 years following the publication of Woodward's (1958/1966) study generated a literature in chaos. The inconsistency in this literature attracted the attention of several reviewers who sought to bring order to the confusion that reigned. These reviews will be discussed in the next section.

Literature Reviews

Following the publication of Woodward's (1965) study several other researchers tried to replicate her findings. The Aston Study (Hickson et al. 1969) obtained results that were inconsistent with those of Woodward. Likewise, the National Study (Child & Mansfield, 1972) failed to duplicate Woodward's (1965) results. Both of these replications found that while some aspects of structure (e.g., percentage of employees in maintenance, inspection, and other specialized roles related to the workflow, as well as span of control for supervisors) were related to technology, the more significant variable was organization size. Woodward (1965) found no relationship between organization size and structure. Zwerman (1970), on the other hand, claimed to have many findings consistent with Woodward (1965) in his replication study in Minneapolis.

Donaldson (1976) reviewed four of the major studies which had been published at the time (i.e., Child & Mansfield, 1972; Hickson et al., 1969; Woodward, 1965; Zwerman, 1970). He concluded that:

> [O]ut of the results which Woodward originally found, none of the trivariate relationships between structure, technology and performance have been confirmed by the sole attempt at replication which has been published to date, that of Zwerman. . . . Of the bivariate relationships which Woodward found, none have been confirmed by the four major studies. . . . The plainest way of interpreting the current evidence is that it disconfirms core aspects of the original Woodward thesis (Donaldson, 1976: 273).

This is a highly negative judgment.

Thus the critiques of Woodward are not just that technology is less important than organization size in determining structure. There is some argument that there may be no relationship between technology and structure at all.

A common conclusion reached by other reviewers is that several definitive factors may influence the inconsistent findings in the technology literature. These include: (a) the definition of technology and structure variables; (b) the type of organization (i.e., manufacturing versus service); and (c) the level of analysis (i.e., subunit versus total organization) (Gerwin, 1979b; Reimann & Inzerilli, 1979). There has also been criticism of the measures used by various researchers (Collins & Hull, 1986; Comstock & Scott, 1977; Kmetz, 1977). In short, the variation in observed results may be due, in part, to factors related to study design and methodology.

Multiple Operational Definitions

Stanfield suggests that much of what we perceive to be contradictory findings about the relationship between technology and structural variables is really due to "unrationalized categorization of variables" (1976: 489). This represents a failure to recognize both technology and structure as complex aggregates of variables. Instead there is a tendency to group variables unidimensionally and make inferences from one member variable to other variables in the group. When two researchers use different conceptual measures of technology and obtain contradictory relationships with the same structural variables, the two studies should not be interpreted as contradictory results for the relationship between the aggregates "technology" and "structure". Just as we have learned to describe an organization's social structure along several dimensions, we should learn to describe its technology along multiple dimensions.

Fry's (1982) review of 37 technology-structure studies grouped them into five different conceptual definitions (i.e., technical complexity, operations technology and operations variability, interdependence, routine-nonroutine, and manageability of raw materials). This proliferation of operational definitions has been suggested as one reason for the failure to find consistency across studies (Fry, 1982; Reimann & Inzerilli, 1979). The existence of multiple operational definitions according to Cooper is "the most important source of variance in the conclusions of different reviews meant to address the same topic" (1984: 24). Cooper's comment applies to all areas of research, not just technology-structure research, but is germane here.

Fry (1982) found in his review of empirical technology-structure research from 1965 through 1980 that two types of studies tended to contribute most of the results in opposition to a technological imperative. Those are studies of operations technology (versus material and knowledge technology), and studies using individuals as the unit of analysis (rather than the organization or subunit). Other measures, particularly routineness and interdependence, as well as technical complexity and operating variability, have consistently resulted in significant relationships with various indices of structure. These relate primarily to the conceptualizations of Thompson (1967) and Perrow (1967) discussed in Chapter I.

The argument made by Stanfield (1976) and the findings of Fry (1982) suggest a problem of construct validity in studies of technology. In other words, the various operational measures used may not be assessing the same construct. Hunter and Schmidt (in press) suggest that there are three ways to deal with imperfect validity. First, it can be corrected statistically. Second, it can be recognized as a source of uncorrectable artifact variation in the residual variance. Or, finally, the various measures used can be treated as a potential moderator variable. This last is the technique that will be applied in this study. If the various operationalizations do, in fact, measure a common construct, the operational definition used should not contribute to observed differences between studies.

Organization Type

Bowen, Siehl, and Schneider state that "service organizations tend to be organized differently from manufacturing organizations because of their greater amount of interaction with the customer" (1989: 76). They also identify five characteristics that exist on a continuum which distinguish service organizations from manufacturers. These are: (a) tangibility of output, (b) whether output is standardized or customized, (c) the extent of customer participation, (d) ability to hold inventories, and (e) labor intensity. Manufacturing organizations tend to have tangible output, standardized output, a technical core buffered from the customer, an inventory of goods for consumption at a later point in time, and are capital intensive. Service organizations, on the other hand, tend to have an intangible output, customized output, higher levels of customer participation, simultaneous production and consumption, and are more labor intensive (Bowen et al., 1989).

Reimann and Inzerilli (1979) suggest that organization type may be an important moderator. They stated at the conclusion of their review of the literature that "we must also take into consideration the possibility of fundamental differences in transformation technologies between organizations with different purposes (e.g., people-processing versus material processing)" (1979: 190).

The measurement of technology for manufacturers and service providers is problematic. Manufacturing organizations typically transform material inputs into outputs for sale to customers. In service organizations the customer is the input and the output. Many of the measures of operations technology may not be appropriate to service organizations. In evidence of this Aldrich (1972) found that the Aston scale of workflow integration yields an almost perfect dichotomy between manufacturing firms and service organizations. Manufacturers tend to score high, while service organizations score low. This was also supported by the findings in both the Aston Study (Hickson et al., 1969) and the National Study (Child & Mansfield, 1972) in which the correlation between workflow integration and the structural dimension of specialization dropped from significant to nearly zero when service organizations were excluded from the analysis. Thus it may be that technology-structure relationships only hold in manufacturing and not in service organizations, or at best these relationships can only be revealed in manufacturing firms where the current operationalizations of technology apply. It seems that the inconsistency in research results may be due partially to the type of organization studied.

However, an alternative explanation for these findings is that the manufacturing and the service subsamples are fairly homogeneous with regard to the workflow integration measure. The correlations observed for these subsamples would thus be attenuated by range restriction in the independent variable. If this were the case, then correction for range restriction would restore the observed correlation to its higher, unrestricted level. Meta-analysis can correct for range restriction in the manufacturing subgroup and the service subgroup to give an approximation of the unrestricted correlation of each organization type. The assumptions and methodology used to make this correction will be discussed in Chapter IV.

Levels of Analysis

Ford and Slocum (1977) claimed that the influence of unit of analysis differences is perhaps most evident in research focusing on the role of technology. They pointed out that most studies on technology at the organization level have rejected the idea of a technological imperative, finding size more strongly related to structure. But studies that have focused on the subunit have tended to support it. They also criticized the practice of measuring technology at one level, while the unit of analysis is at a higher level. This criticism was aimed particularly at studies that focus on the dominant operations technology, but measure structure at the organization level. It can be argued that this practice may serve to weaken the effect of technology on structure relative to other contingencies such as the size of the organization.

Reimann and Inzerilli (1979: 170) suggested that one reason why researchers have been unable to replicate the Woodward findings is that her firms were essentially pure types. She had excluded from her analyses firms with "mixed" technologies. It is entirely possible that the dominant technology in Woodward's firms permeated the entire organization. Perhaps the administrative and hierarchical structure was not so remote from the workflow in the Woodward sample.

Gerwin (1979b) argued that the concentration on the organizational level of analysis is the reason why technology has not been shown to relate to structure, and Perrow pointed out that there can be "systematic differences among organizations in the extent to which levels of the organizations vary in technology" (1986: 145). Perrow referred to the level of routineness, and suggested that the problems of communication between levels caused by this condition are likely to be reflected in the structure of the organization. Therefore inconsistencies could be due to level of analysis, especially the heterogeneity of technology at the level of the whole organization and the greater similarity at the subunit level. That is, technology is more homogeneous at the subunit level and that is why the technology effects are observed at subunit level.

Type of Measure Used

Efforts to develop operational measures of the dimensions of technology fail in one basic area. Researchers tend not to validate their measures (Ford & Slocum, 1977). This would be totally unacceptable in the physical sciences, or even in most behavioral sciences. The simple fact is that, for many of the studies published in the literature, there is no certainty regarding which dimensions of technology are being measured.

Withey et al. (1983) addressed the issue of validity using six subscales found in previous research to operationalize Perrow's work unit technology. A factor analysis from 169 respondents indicated that most scales loaded on one of two factors that clearly indicated the two dimensions of exceptions and analyzability. One scale loaded on neither factor, indicating that it was not really related to Perrow's construct of technology. As a result of this analysis these researchers were able to state that something called "analyzability" and "exceptions" can be defined and operationalized across organization work units using questionnaire methodology. However, it also points out that some indices, designed to measure the same constructs, fail to assess what they are designed to.

However, the measurement issue that has received the most attention in the literature reviews has not been the construct validity of different questionnaire measures, but rather the difference between questionnaire measures and institutional measures (Pennings, 1973). Some researchers use objective methods such as interviews with managers, observation, consultation or organization documentation, and a priori classification (e.g., Woodward, 1965; the Aston group). These are referred to as institutional measures. Others use subjective instruments such as questionnaires to measure perceptions and attitudes of organization participants (Hage & Aiken, 1969; Mohr, 1971; Van de Ven & Delbecq, 1974).

Sathe (1978) found poor convergent validity between these two methods of measurement. Pennings (1973) found some convergent validity when measured at the production department level. Both researchers suggested that the two methods may be measuring different constructs. Sathe (1978) pointed to a distinction between the designed structure and the emergent structure of organizations. He suggested that institutional measures assess the formal or designed structure, while questionnaire measures "reflect the degree of structure experienced by organization members in work-related activities on a day-to-day basis" (1978: 234). Much of the variation observed in study results may be due to the nature of the measure used.

Summary

While some reviewers essentially argued that the technology-structure relationships were inconsistent, and therefore called the whole idea of the technology thesis into question (Donaldson, 1976), most subsequent reviewers of the technology-structure literature generally suggest that Woodward (1958/1966) was right about technology, but she was wrong on the specifics. All suggested moderators to the relationship of technology and structure. This is captured in the comment from one of those reviews:

> [U]pon closer examination of the various studies, it becomes readily apparent that the lack of consistent findings is not so much an indictment against technological determinism per se as against the profusion of theoretical models and methodologies employed by researchers in this field (Reimann & Inzerilli, 1979: 188).

What has developed is not a theory of technology. Rather, it is a theory of moderators of the basic technology-structure relationship to explain inconsistencies.

However, as will be discussed in the next section, the traditional literature review is not a very reliable mechanism for determining the causes of inconsistent research results.

Critique of Previous Literature Reviews

Light and Pillemer (1984) and others (Glass, McGaw, & Smith, 1981; Hunter et al., 1982) have criticized the traditional literature review for being subjective, scientifically unsound, and an inefficient way to extract useful information. Instead of resolving conflicts among various studies, the subjective review may actually generate new conflicts.

One commonly utilized technique in the literature review is vote counting in which the reviewer counts the number of studies that support a position and the number that reject it and declares the position with the most votes to be the winner. This procedure ignores the effect of sample size, effect size, and research design. Finally, as the number of studies increases, it becomes more and more difficult for the unaided human intellect to adequately analyze the studies.

Statistical Power

The issue of statistical power is particularly relevant to traditional vote counting methods of literature review. Hedges and Olken (1985) have shown that when statistical power is low, the vote counting method will be more likely to arrive at the wrong conclusion as the number of studies increases. According to Hedges and Olken, as the number of studies becomes large "the proportion of studies yielding significant results is approximately the average power of the test" (1985: 51). As a matter of fact, it is shown that when average power is less than the vote count criterion (i.e., proportion of positive significant results needed to conclude the existence of a real effect), the power of the vote count method to arrive at the correct conclusion approaches zero as the number of studies increases. For example, a statistical power of .60 means that the probability of observing a statistically significant effect when there is a true effect is .60. Therefore, as the number of studies becomes large, the proportion of those studies with significant results will approach 60 percent. If the vote count criterion is set so that 70 percent of the results must be significant in order to conclude that a real effect does exist, it becomes nearly impossible to reach that correct conclusion as the number of studies becomes large. This becomes a particularly severe problem in studies of technology and structure where samples are generally small, and statistical power is low.

Fry's Review of the Literature

The most methodologically sophisticated literature review to date in the area of technology and structure was conducted by Fry (1982). He used a chi square analysis to test the hypothesis "that the percentage of statistically significant technology-structure relationships remains roughly equal across different conceptions of technology and structure, different levels of analysis, and different types of measures" (1982: 541). On the basis of the chi square he concluded that, contrary to previous reviews (Ford, 1979; Pennings, 1973; Sathe, 1978) whether the measure used is institutional or questionnaire had little effect on the outcome. The level of analysis did influence results of technology-structure studies however, as did the conceptual definition of technology.

There are several serious flaws with Fry's methodology. First, the chi square test is based on the assumption that each study has an equal probability of obtaining statistically significant results. The question being asked is whether the occurrence of significant findings is distributed disproportionately between the categories. Fry implicitly hypothesizes equal effect sizes for all relationships included in his analysis. This fails to recognize that whether a study finds statistically significant results is a function of sample size and effect size. Thus a set of studies will contain particular sample and effect sizes and this will prevent comparison with another set of studies. In addition, the chi square test compares the observed variance to the variance that would be expected due only to sampling error. It does not allow for other sources of artifactual variance such as differential reliability, and range restriction in the studies. These major flaws make Fry's findings suspect, but they do provide a point of departure for a meta-analytic review of the literature.

Donaldson's Review

Donaldson's (1976) narrative review of the technology-structure literature focused upon the Woodward concept of technology and compared the results from four studies (i.e., Child & Mansfield, 1972; Hickson et al., 1969; Woodward, 1965; and Zwerman, 1970). He argued that the failure to replicate the original Woodward findings supports the Aston critique of the technological imperative argument (1976: 263). Donaldson concluded that:

> Whilst further research is undoubtedly warranted it cannot be certain that such research will identify additional variables, or methodological factors, which will explain away the discrepancies between the findings of Woodward and those of the subsequent studies (Donaldson, 1976: 273).

This interpretation is based upon an implicit hypothesis that if the relationship does exist, it will appear consistently across studies. However, failure to replicate does not disconfirm the original findings although it does weaken the argument for technology. What this narrative review fails to consider is the low statistical power of all four of the studies. Given the small sample sizes one should not expect consistent findings. In fact, if these findings had been consistent, they would be suspect.

Hirst's Review

Meta-analysis provides a means of determining the effect of low statistical power on variation between studies. Hirst (1984) conducted a partial meta-analysis of the four studies included in Donaldson's (1976) review plus the Blau et al. (1976) study of 110 New Jersey manufacturers. His results contradicted Donaldson's (1976) conclusion that the discrepancy between Woodward's (1958/1966) findings and those of subsequent studies probably would not be explained away.

Hirst (1984) analyzed the relationship of production continuity with vertical span and with CEO span of control. The results indicated that sampling error alone can account for all variation in the findings for CEO span, but less than 10 percent of the variation for vertical span. This latter result suggests that there may be nonartifactual differences accounting for variation across studies, but since three other sources of artifactual variance were not corrected for, this conclusion is only tentative.

The most revealing finding of the Hirst (1984) meta-analysis was that the mean correlation between production continuity and CEO span was $\bar{r} = .11$. The four studies included in that meta-analysis had sample sizes ranging from 31 to 110 organizations. In order to reject the null hypothesis of "no effect" at an alpha level of .05 (two-tailed) the critical values of the sample correlations would have to be .355 and .19, respectively. In other words, the studies would all have to find an observed correlation greater than the mean correlation in order to declare statistical significance. Thus statistical significance testing within studies is hazardous, because of small sample size, in a situation where the true effect may be small.

Improvements in the Current Study

The meta-analyses to be conducted in this study are far more comprehensive than those conducted by Hirst (1984). First, the Hirst meta-analyses considered only two structural variables and one technology measure (i.e., the correlations of CEO span of control and vertical span with the Woodward scale of workflow continuity). The meta-analyses in this study will address 30 structural variables, and four conceptual measures of technology. These variables will be discussed in Chapter III. Second, Hirst's meta-analyses corrected for only one artifact (i.e., sampling error variance). The meta-analyses in this study will also make corrections for variance due to differences in the reliability of measures (both dependent and independent variables), and for variance due to differences in the amount of range restriction in the independent variable (i.e., technology). Finally, this study will include tests for hypothesized moderators of the relationship between technology and structure.[1]

Conclusion

The results of research into the relationship between technology and structure are inconsistent. No clear pattern of relationships has emerged over the past 30 years since Woodward's (1958/1966) study. Instead the realm of technology-structure research is characterized by numerous measures of technology with questionable validity, and several moderator variables proposed by reviewers of the literature.

However, the traditional literature reviews from which these moderators were derived are prone toward erroneous conclusions. Meta-analysis will allow these a posteriori conclusions to be tested on an a priori basis. Chapter III will discuss the structural variables to be analyzed as well as the hypotheses to be tested in later chapters of this study.

Note

[1]Meta-analysis is discussed in Chapter IV. As discussed there, the existence of moderator variables is suggested by high amounts of unexplained variation among correlations across studies. When all variation can be explained by study artifacts no test for moderators will be conducted.

Table II-1. Summary of Woodward's Findings with Regard to Technical Complexity

Organization Variable	
The number of levels of authority	Increased[a]
The span of control of first-line supervisors	$\cap$
The ratio of managers and supervisors to total personnel	Increased[a]
Labor cost as proportion of total cost	Decreased[a]
The ratio of indirect to direct labor	Increased[a]
The ratio of administrative and clerical staff to hourly paid workers	Increased
Proportion of production supervisory staff who are professionally qualified	Increased
The span of control of the CEO	Increased[a]
The amount of written, as opposed to verbal, communication (i.e., formalization)	$\cap$
The amount of specialization between the functions of management	$\cap$
The importance of production control	Increased
Separation of production administration from production supervision	$\cap$
Role definition	$\cap$

Note. Adapted from Woodward, J. 1958/1966. *Management and technology*: 16-18. London: Her Majesty's Stationery Office.

[a]Results confirmed by Zwerman (1970).

CHAPTER III

VARIABLES AND HYPOTHESES

This chapter includes a description of the variables included in these meta-analyses and a summary of the hypotheses that will be tested.

Structural Variables

Organizational structure may be viewed as the pattern of relationships that exist within the organization. This pattern may either be formally sanctioned by the organization or not. Whisler states that "the structure of the modern organization, at any point in time, represents current executive thinking about the most effective way of specializing effort and grouping specialists" (1970: 6).

Research on organizations has shown that there are a number of major dimensions of structure formed by the clustering of structural variables. Pugh, Hickson, Hinings and Turner (1968) used principal-components analysis to arrive at four dimensions. One of these dimensions is structuring of activities which is composed of overall role specialization, functional specialization, overall standardization of procedures, and overall formalization. A second dimension is concentration of authority which relates to the centralization of authority within the hierarchy. Pugh et al. (1968) observed a small negative correlation between centralization and structuring of activities and thus concluded that they represent two distinct dimensions of structure and that centralization cannot be considered to be an aspect of structuring. However, Child observed a larger negative correlation between centralization and the structuring variables, and thus proposed a "unitary conception of organizational control structure" which viewed structuring of activities and decentralization as related, rather than orthogonal dimensions of structure (1972: 174). A third dimension of structure suggested by Pugh et al. (1968) is line-control of workflow (versus impersonal control) which includes span of control of supervisors, percentage of workflow supervisors, and the extent of formalization of role performance recording. The fourth dimension of structure is the size of the supportive component and is "concerned with the amount of auxiliary activities of a noncontrol kind" (Pugh et al., 1968: 87).

In this section, structural variables found in studies of the effect of technology will be described. One exception should be noted. Some researchers treat vertical integration (i.e., control of input sources or output channels) as an element of structure (Khandwalla, 1974), while others consider it an element characteristic of technology (Rousseau, 1979). For this study, vertical integration is considered to be an element of strategy rather than a dimension of either structure or technology and will not be included.

Table III-1 contains a list of the numerous structural variables found in the literature. The labels used in this table correspond to the Aston variables because they provide the most detailed treatment. However, they are generally broad enough to capture the variables of other researchers as discussed below.

Specialization

Price and Mueller (1986) discussed specialization under the rubric of horizontal complexity. Related concepts that are found in the literature include functional differentiation, and role differentiation, among others. Pugh et al. (1968) define specialization as the division of labor within an organization. However, they make a distinction between specialization of organization functions, and the extent of division of labor within functions.

Functional Specialization

The Aston scale of functional specialization is defined as "the extent to which official duties are divided between discrete, identifiable functional areas" (Child, 1972: 164). It is based upon the extent to which 16 activities are performed by at least one specialist. A specialist is one who performs only that activity or function. Operatives who are in the line chain of command are not counted as specialists under this definition. No account is made here for the number of specialists, but only the existence of the specialism (Pugh et al., 1968: 72-74). Measures of horizontal differentiation such as the number of divisions or sections are frequently used (Blau et al., 1976), and are indices cf the degree of functional specialization.

Division of Labor

The Aston scale of overall role specialization assesses the extent of task differentiation within each of 16 specialisms. It is more precisely a measure of the extensiveness of division of labor among administrative work. Although this variable and functional specialism both come under the common rubric of horizontal complexity, they do not necessarily covary. It is possible to have a very few specialized activities that are highly fractionalized, or have several specialisms with little division of labor within each activity. Nevertheless, these two measures of specialization generally do correlate highly and positively.

Some researchers such as Blau and Schoenherr (1971) measure division of labor by a count of the job titles in an organization. While this is not precisely role specialization as defined by Aston, the underlying dimensions of structure appear to be the same. For this study, such measures of division of labor will be combined with measures of role specialization.

Standardization of Procedures

Pugh et al. describe standardization as being "a basic aspect of organizational structure, and in Weber's terms would distinguish bureaucratic and traditional organizations from charismatic ones" (1968: 74). Standardization is defined as "the extent to which activities are subject to standard procedures and rules" (Child, 1972: 164), or "the uniformity of operating procedures" (Price & Mueller, 1986: 237). Rules and procedures need not be documented so standardization should not be confused with the formalization variable to be discussed next. The Aston measure of standardization consists of 76 items assessing the extent to which standard procedures exist within each of 16 specialisms. The focus is on regularly occurring events that are legitimated by the organization.

Formalization

Formalization is defined as "the degree to which the norms of an organization are explicitly formulated" (Price & Mueller, 1986: 137-150) or "the extent to which rules, procedures, [and] instructions are written" (Pugh et al., 1968: 75). These definitions clearly distinguish formalization from standardization. Formalization relates to Weber's concept of "clear specification of duties" as a characteristic of his rational variant of bureaucracy (Price & Mueller, 1986: 28).

Measures of formalization are generally crude. Blau and Schoenherr (1971) counted the number of words in civil service manuals based upon a sample of pages. The advantages of "word counting" as a measure of formalization are simplicity and objectivity. The major disadvantage is that it does not consider qualitative factors. Which procedures are formalized? Are the formalized norms filed and followed, or only filed? In short, formalization is more than a stack of pages. The Aston scale of formalization makes some improvements. It consists of 38 items that assess the availability of specific documents (e.g., information booklets, organization charts, operating instructions, etc.) not just in terms of number but also in terms of who they are distributed to and the extent of application (Pugh et al., 1968).

An abbreviated version of the Aston formalization scale is labeled as role definition. It consists of 12 items taken from the 38 on the formalization scale. The 12 items deal with formalization of roles.

Even though a distinction is made here between standardization and formalization, most published studies do not make a clear distinction (e.g., Hage & Aiken, 1969). The Aston-type studies do make this distinction (e.g., Child & Mansfield, 1972; Hickson et al., 1969; Pugh et al., 1968). Measures that specify the existence of written documents will be treated as measures of formalization for these meta-analyses.

Vertical Span

Vertical span refers to the number of hierarchical levels within an organization. Price and Mueller refer to it as vertical complexity (1986: 100). Hierarchically ordered supervisory levels is one of the features of Weber's rational variant of bureaucracy. It implies "a firmly ordered system of super- and sub-ordination in which there is a supervision of the lower offices by the higher ones" (Gerth & Mills, 1958: 197).

The measures of vertical span vary in the literature although all are based on the same concept. Some researchers count the total number of levels from the CEO down to the lowest operant, inclusive (e.g., Hickson et al., 1969). Others exclude "assistant-to" levels in the count (Blau & Schoenherr, 1971; Child, 1973). Still others may compute the average number of levels in all the chains of authority (e.g., the study of finance departments reported in Blau & Schoenherr, 1971). All of these measures are attempting to measure the length of the organizational chain of authority, and would probably yield similar results if consistently applied within a study. In an earlier meta-analysis, Donaldson and Robertson (1986) concluded that these different types of scales did not moderate the effect of organization size on vertical span, so there is reason to believe that they will not moderate the relationship between technology and vertical span.

Centralization

Pugh et al. define centralization as "locus of authority for making decisions affecting the organization" (1968: 76). Several factors affect centralization including the location of the decision making unit, the existence of rules that limit subordinate discretion, and access to relevant information. A distinction is sometimes drawn between strategic policy decisions, and operations decisions (Hage & Aiken, 1967). This distinction recognizes that an organization may allow a high degree of autonomy to workers on their job yet retain centralized decision authority for policy formulation. Measures that focus solely on perceived job autonomy ignore this fact. As such, they could determine that an organization is highly decentralized, when no important decisions are actually delegated.

The Aston measure of centralization is based upon 37 specific decisions rated on a 6-point likert-type scale ranging from "0" for a decision made at the operating level, up to "5" for decisions made above the level of the chief executive officer. A high score indicates a high locus of authority.

For this analysis measures of decentralization, participative decision making, or worker autonomy will be treated as indices of centralization, but the signs of such correlations will be reversed to yield "centralization" measures.

Configuration

Configuration is a composite concept that includes various dimensions indicating the shape of the organization (Child, 1972: 164; Pugh et al., 1968). Price and Mueller consider the elements of configuration under the rubric of administrative intensity which includes span of control as well as the proportion of an organization's employees dedicated to management and administration (1986: 27-39). The span of control of the chief executive officer is generally measured as the number of subordinates that report directly to the chief executive. Supervisory span of control is the average number of subordinates per supervisor. Supervisors are generally defined as "the lowest job which does not include prescribed direct work" (Aston Data Bank, 1977: 108) but sometimes specific organization levels are specified (Blau & Schoenherr, 1971).

Blau defines administrative intensity as "the extent to which an organization allocates resources to the management of its output" (1973: 267). It is generally expressed as a ratio, but there are variations in the content. Some researchers compute the ratio between the number of administrators (A) to the number of production (P) workers (i.e., A / P). Others use the ratio of administrators to total personnel (i.e., A / (A + P)). These ratios certainly differ in magnitude, and the correlation with other structural and contextual variables may vary depending upon which ratio is used. For this study most ratios found in the literature will use total personnel in the denominator. Thus, since there is little variation in the operationalization of this variable, this should not be a significant source of variation across the studies included here.

The five percentage variables listed in Table III-1 under configuration are the ones most frequently encountered, and encompass nearly all operationalizations found in the literature. Following are the definitions used in the Aston Data Bank (1977: 106) and will be applied in this study to classify the measures of other researchers:

1. Direct workers: those employees who are directly involved in the production of goods and services.

2. Workflow supervisors: those supervisors and managers who have responsibility for the workflow, but have no prescribed direct work on the throughput.

3. Nonworkflow personnel: all personnel other than direct workers or workflow supervisors.

4. Supervisors: the lowest job which does not include prescribed direct work.

5. Clerical workers: non-workflow personnel with no supervisory responsibility, whose primary assigned task is writing and recording. It includes typists, stenographers, secretaries, and so forth. It does not include administrative staff personnel who often fall under the broad definition of clerical.

Employment Ratios

Both Woodward (1958/1966) and Harvey (1968) found increased use of specialists as the technology became more complex or more specific, respectively. These early findings may account for the interest displayed by other researchers in the assessment of specialization in organizations. This interest has extended beyond the mere existence of specialists (i.e., functional specialization) or division of labor to the assessment of the relative representation of different specialists in the organization.

The original Aston measurement scales (Pugh et al., 1968) include the percentages of total employees engaged in each of the 16 specialisms forming the scale of functional specialization described earlier. The abbreviated version of the Aston measurement scale, which has been more widely used than the original, does not include these variables. Whereas functional specialization is a measure of whether or not the specialism exists in the organization, these proportions represent the relative representation of each specialism in the organizations labor force. The 16 specialisms considered here, as well as in the three Aston scales of functional specialization, role specialization and formalization are described in Table III-2.

This level of detail is unique to the Aston measurement scales. Most researchers, such as Blau et al. (1976) and Blau and Schoenherr (1971), examine the more general categories of clerks, managers, or administrators.

Summary

Table III-1 includes 30 structural variables that are found in the technology-structure literature. Unlike the technology variable, there is general agreement among organization scholars regarding the dimensions of structure. This section has addressed the definitions used to classify correlations for meta-analysis.

The next section will summarize the hypotheses to be tested in later chapters of this study.

Hypotheses to be Tested

Situation Specificity Hypothesis

Meta-analysis procedures will be discussed in detail in Chapter IV. The basic hypothesis being tested by meta-analysis is that all of the variance observed among correlations is caused by artifacts. In other words, there is no variance among the true correlations and all of them come from the same population (i.e., there are no moderators). This hypothesis is stated as follows:

Hypothesis 1. All variance between observed correlations is caused by artifacts.

This hypothesis will be rejected if less than 90 percent of the observed variance between study correlations is explained by artifacts such as sampling error variance, differences between studies in measurement reliability, and differences between studies in the amount of range restriction. These artifacts will be discussed more in Chapter IV.

Moderator Hypotheses

Rejection of Hypothesis 1 suggests that situational factors may be moderating the correlations observed in the different studies. Several factors have been suggested as potential moderators of the relationship between technology and structure. These were discussed in Chapter II. Based upon the conclusions reached by past researchers and reviewers of the literature, several hypotheses can be proposed for testing.

Limited Impact of Technology on Structure

Hickson et al.'s (1969) hypothesis about the relationship of technology to structure specifies that it is limited to a few job count variables; specifically those centered on the workflow. Similarly, Scott (1981) makes a distinction between sources of structural complexity that develop within the technical core of an organization and those that occur in the "peripheral sectors" of the organization. He states that "the prime source of core complexity is seen to be the nature of the work being carried out -- the demands made by the technology on the structure. . . . [The structures of the peripheral sectors] are viewed as responding in particular to demands posed by the size or scale of the organization and to the task environment" (1981: 207). Peripheral sectors are those structures "less directly tied to the technical core" (1981: 234).

A partial test of Hickson's hypothesis will be conducted.

Hypothesis 2: The effect of technology will be stronger for structural variables linked with workflow such as job-counts than for more remote administrative and hierarchical structural variables.

Technology Operationalization

The proliferation of operational definitions of technology has been suggested as one of the reasons why there is a lack of consistency across studies (Fry, 1982; Reimann & Inzerilli, 1979). Cooper believes that the existence of multiple operational definitions is "the most important source of variance in the conclusions of different reviews meant to address the same topic" (1984: 24). This comment applies to integrative research reviews in all areas of research, not just technology-structure research.

Four broad conceptual definitions of technology will be used to classify studies in these analyses. They are workflow continuity, workflow integration and automation, task routineness, and information technology. These four classifications will be discussed further in Chapter IV.

The hypothesis to be tested in Chapter VIII is:

Hypothesis 3. Different operational definitions of technology result in significantly different correlations with measures of structure thus contributing to the variance observed between studies.

Organization Size

The predominant theoretical moderator of the effect of technology on organization structure, and the focus of debate over the past 30 years is organization size. Hickson et al. hypothesized that technology will have a greater impact on the structure of small organizations than of large organizations (1969: 394). The following hypothesis will be tested in Chapter IX.

Hypothesis 4. The correlation between technology and organization structure is stronger in small organizations than in large organizations.

<u>Organization Type</u>

Several reviewers have suggested that the fundamental differences between manufacturing and service organizations contribute to the inconsistency in research results (Gerwin, 1979b; Reimann & Inzerilli, 1979). This potential moderator will be examined in Chapter X.

Hypothesis 5. The correlation between technology and structure is affected by whether the sample includes manufacturing organizations, service providers, or a combination of both.

<u>Level of Analysis</u>

Two hypotheses will be tested regarding level of analysis. The first is generated by Fry's (1982) observation that the results of studies at the subunit level of analysis yield more consistent results. This can be tested by comparing the residual variance among studies at the subunit level of analysis to the variance among studies at other levels of analysis. The following hypothesis will be tested in Chapter XI.

Hypothesis 6a. The findings of studies at the subunit level of analysis will be more consistent than those for studies at the individual or organization level of analysis (i.e., variance between studies will be lower).

The second hypothesis to be tested in Chapter XI regards the relative size of correlations between technology and structure at different levels of analysis. Several reviewers have suggested the correlations obtained at subunit level are larger than those at organization level (Ford & Slocum, 1977; Gerwin, 1979b; Reimann & Inzerilli, 1979). This hypothesis is closely related to the Hickson et al. (1969) hypothesis that the effect of technology will be restricted to those structural variables centered on the workflow. Subunit structure would tend to be more centered on the workflow. Also, if technology is more heterogeneous across the whole organization it will be more homogeneous within subunits. Therefore, technology and its effects can be identified less ambiguously at subunit level. The second hypothesis to be tested in Chapter XI is therefore:

Hypothesis 6b. Studies conducted at the subunit level of analysis will have larger correlations than will studies using the organization level of analysis.

Thus results from hypothesis 6b will clarify the meaning of results from hypothesis 6a as to the respective roles of subunit, organization, and individual levels of analysis.

<u>Type of Measure</u>

Poor convergent validity between questionnaire and institutional measures has been indicated by several researchers (Ford & Slocum, 1977; Pennings, 1973; Sathe, 1978). These two methods may be measuring different things. However, Fry (1982) concluded that the type of measure used had no significant effect on study outcomes. The impact of measurement type is not certain. Chapter XII will test the following hypothesis:

Hypothesis 7. Questionnaire measures result in significantly different correlations from those obtained with institutional measures.

Conclusion

Meta-analyses will be performed to assess the relationship between technology and 30 structural variables. The basic hypothesis tested in all of these meta-analyses is that all variance between studies is due to artifacts (e.g., sampling error, differences in reliability). However, for those relationships where this hypothesis is rejected several moderator hypotheses will be tested. This will permit a priori tests of moderators proposed by previous literature reviewers.

Chapter IV will discuss the meta-analysis procedures that will be used in this study, and will describe the sources of studies included in the sample.

Table III-1. Structural Variables Included in Technology Research

Structuring of Activities:
Functional specialization
Division of labor
Standardization of procedures
Formalization
Overall
Roles
Vertical span
Concentration of Authority:
Overall centralization of decisions
Configuration:
CEO span of control
Supervisor's span of control
% Direct workers
% Workflow supervisors
% Nonworkflow personnel
% Supervisors
% Clerical personnel
Proportion of work force given over to specialisms:
% Public relations and advertising
% Sales and service
% Transportation
% Personnel
% Training and development
% Welfare and security
% Purchasing and stock control
% Facility maintenance
% Financial control
% Workflow planning and control
% Quality evaluation and control
% Work study
% Design and development
% Administration
% Legal and insurance
% Market research

Table III-2. Sixteen Specialisms Included in the Aston Scales

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1. Public relations and advertising involves activities to "develop, legitimise, and symbolise the organization's charter".

2. Sales and service involves activities to "dispose of, distribute and service the output" of the organization.

3. Transportation involves activities to "carry outputs and resources from place to place".

4. Personnel involves activities to "acquire and allocate human resources".

5. Training and development involves activities to "develop and transform human resources".

6. Employee morale and welfare involves activities to "maintain human resources and promote their identification with the organization".

7. Purchasing and stock control involves activities to "obtain and control materials and equipment".

8. Facility maintenance involves activities to "maintain and erect buildings and equipment".

9. Financial control involves activities to "record and control financial resources (accounts, costs, wages, etc.)".

10. Workflow planning and control involves activities to "control the workflow".

11. Quality evaluation and control involves activities to "control the quality of materials, equipment, and outputs".

12. Methods involves activities to "assess and devise ways of producing the output (work study, O.R., rate-fixing, methods study, etc.)".

13. Product design and development involves activities to "devise new outputs, equipment, and processes".

14. Administration involves activities to "develop and operate administrative procedures (registry, filing, statistics . . .)".

15. Legal and insurance involves activities to "deal with the legal and insurance requirements (legal, registrar, insurance, licensing, etc.)".

16. Market research involves activities to "acquire information on the operational field".

Note. Adapted from Aston Data Bank, 1977: 62. [Machine-readable data file manual]. Birmingham, England: University of Aston Management Centre Research Unit (Producer). Essex, England: University of Essex, ESRC Data Archive (Distributor).

CHAPTER IV

METHODS

Meta-Analysis Fundamentals

The goal of a meta-analysis of correlations is to describe the distribution of actual correlations between a given independent and a given dependent variable. The research hypothesis of a meta-analytical study is that there is one value of the correlation within a common population and the variation in observed correlations between studies can be attributed to study artifacts.

Artifactual Error

Sources of artifactual variance have been identified by Schmidt, Hunter, Pearlman, and Shane (1979).

1. σ^2_{e1} = Error variance due to differences between studies in reliability of the dependent variable measure.

2. σ^2_{e2} = Error variance due to differences between studies in reliability of the independent variable measure.

3. σ^2_{e3} = Error variance due to differences between studies in range restriction.

4. σ^2_{e4} = Error variance due to sampling error (i.e., variance due to $N < \infty$).

5. σ^2_{e5} = Error variance due to departures from perfect construct validity in the measures of the independent and the dependent variables.

6. σ^2_{e6} = Error variance due to computational and typographical

error.

For studies with small sample sizes, such as are found in the literature on technology and structure, the most important source of error variance is sampling error. This source alone may account for all variation across studies in many cases.

The basic hypothesis tested by meta-analysis is that the variance due to situation-specific factors is zero. Stated another way:

$$HO: \sigma^2_{total} - \sigma^2_{e1} - \sigma^2_{e2} - \sigma^2_{e3} - \sigma^2_{e4} - \sigma^2_{e5} - \sigma^2_{e6} = 0$$

Rejection of this hypothesis indicates the existence of situation-specific moderators. While it is nearly impossible to correct for the latter two sources of error, procedures have been developed to correct for the first four sources (Hunter et al., 1982).

Meta-Analysis Procedures

The simplest form of meta-analysis involves correction of the individual observed correlations for each source of artifactual error. The first step in the analysis is to compute the mean and the variance of the observed correlations. The best estimate of the population correlation is the sample-weighted mean correlation:

$$\bar{r} = \Sigma\ [N_i\ r_i]\ /\ \Sigma\ N_i$$

where r_i is the observed correlation in study i, and N_i is the number of organizations in study i. The frequency weighted average squared error is then calculated as:

$$S^2_r = \Sigma\ [N_i(r_i - \bar{r})^2]\ /\ \Sigma\ N_i$$

This calculation indicates the variance among observed correlations.

The next step is to compute the amount of variance that could be expected due to sampling error.

$$\sigma_e^2 = (1 - \bar{r}^2)^2 K / N$$

where K is the number of studies and $N = \Sigma N_i$, or the total sample size, and $\bar{r}$ is an estimate of the population correlation. As stated earlier, sampling error is a major source of error variance when dealing with small sample sizes.

The estimated variance of the population correlations (p) can then be computed as the difference between the observed variance and the amount of variance that could be expected due to sampling error.

$$\text{est } \sigma_p^2 = \sigma_r^2 - \sigma_e^2 = S_r^2 - ((1 - \bar{r}^2)^2 K / N)$$

It should be noted that it is perfectly reasonable to have a situation in which the observed variance among correlations is actually less than would be expected due to sampling error. This situation does not mean that meta-analysis can account for more variance than actually exists. That is a logical and mathematical impossibility. The situations in which the observed variance is less than would be expected are due to chance alone, and in such situations the estimated variance of the population correlations is in fact zero.

Effects of Measurement Error

Correction for attenuation due to error of measurement is calculated as:

$$r_c = r_{xy} / (\sqrt{r_{xx}} \sqrt{r_{yy}})$$

where r_{xx} represents reliability of the independent variable, r_{yy} represents reliability of the dependent variable, r_{xy} is the observed correlation between x and y, and r_c is the corrected correlation.

Many researchers voice opposition to correcting the observed correlation for attenuation due to unreliability of measurement. The argument made runs along these lines: "If you correct for attenuation you increase your chances for rejecting the null hypothesis. It is better to error on the side of conservatism and retain the null hypothesis." However, this is an erroneous statement. The correction for attenuation does not affect the results of a statistical significance test. While the correction does increase the size of the correlation, it also increases the standard error used in the test for statistical significance. By the same token, it is doubtful that any researcher, if faced with a choice between a highly reliable measure and one with only moderate reliability, would intentionally use the less reliable scale on the grounds of conservatism. What these researchers fail to recognize is that there is very little difference between using a perfectly reliable measure and correcting for attenuation. However, it would be preferable to have more reliable measures in the first place to control sampling error.

The error variance for the corrected correlations is calculated as:

$$\sigma^2_{ec} = \sigma^2_e / (r_{xx} \; r_{yy})$$

Note that this correction for attenuation reduces the <u>systematic</u> error of measurement, but increases the amount of sampling error. However, this sampling error component will average to zero over many observations.

Effects of Range Differences

The observed correlations for different studies will differ due to differences in the range for the independent variable. Range restriction may occur either directly or indirectly. Direct range restriction might occur when a researcher limits the sample of organizations to only those firms that have a mass production orientation to the exclusion of small batch and unit production. Indirect range restriction can occur when selection of the sample is based upon some criterion variable that is correlated with the independent variable. For example, if only organizations listed among the Fortune 500 are included in the sample the restriction in organization size could also restrict the variance in the technology variable. In either situation, range restriction will reduce the size of the observed correlation.

Range enhancement in organizational research is most likely to occur when the researcher intentionally, or unintentionally, selects the sample from the extreme ends of the population. Firms low on the attribute may be compared to firms high on the attribute in an effort to determine whether the attribute of interest has an effect. The exclusion of mid-range values on the variable of interest will increase the observed correlation above that which exists within the reference population. This condition is more likely to occur in experimental designs, but it can occur in any study design.

Correction for restriction of range in the independent variable is calculated as:

$$p_1 = up_2 \,/\, \sqrt{((u^2 - 1)p_2^2 + 1)}$$

where p_1 is the correlation in the reference population;

p_2 is the correlation in the study population (estimated by $\bar{r}$);

$u = \sigma_{x1} \,/\, \sigma_{x2}$;

σ_{x1} is the standard deviation of the reference population; and

σ_{x2} is the standard deviation observed in the study.

A value of $u > 1$ indicates restricted range which reduces the observed correlation, while $u < 1$ indicates enhanced range which inflates the observed correlation. The correction for range restriction provides an estimate of what the correlation would have been had all studies had the same standard deviation in their independent variable. In this study the reference population is all work organizations. Range correction will be made using an average standard deviation as an estimate of the reference population. This will be discussed more fully later in this chapter.

The order in which the corrections are made for attenuation due to error of measurement and for range restriction depends upon whether the reliability coefficient is computed for the reference population or for the restricted study group. In the first case, the correction for range restriction is performed first. In the latter case, the correction for attenuation is performed, using the restricted reliability coefficient, and then the correction for range restriction is performed.

Artifact Distribution Techniques

It is generally the case in the social sciences that published studies do not include the information required to make corrections to each correlation separately. The studies included in these analyses are no exception. While some studies provide both the correlation and standard deviation data needed to correct for range restriction, many more provide only one or the other. Even fewer researchers provide reliability data. For this analysis the noninteractive artifact distributions approach described by Hunter et al. (1982: 73-92) will be used. The artifact distribution approach calculates residual variance (i.e., variance not explained by artifacts) as total observed variance less the variance due to each artifact. A detailed description of this procedure can be found in Schmidt et al. (1979) and in Pearlman, Schmidt, and Hunter (1980), which form the basis for the following discussion.

Formulas Used

The first step in the artifact distributions procedure is the same as described for simple meta-analysis. That step is to compute the mean and the variance of the uncorrected correlations. The mean and variance are then corrected to remove the effects of the various artifacts (i.e., sampling error, differential range restriction, and differential measurement error). This reverses the procedure described earlier in which each correlation is corrected separately. In that situation, each correlation is corrected for the effects of artifacts, and then the mean and variance are computed for those corrected correlations.

Four distributions must be developed for the artifact distribution procedure. First, correlations (r_{xy}) and related sample sizes (N) are needed from any study included in the analysis. Then, reliability coefficients for the independent variable (r_{xx}) and the dependent variable (r_{yy}) are collected from any study where they are provided. Finally, the standard deviation of the independent variable is collected from any studies that provide it. Sources of reliability coefficients and standard deviations are not restricted to those studies that contribute correlation coefficients.

Given these distributions, we compute the square root of r_{xx} and

r_{yy}, designated a and b, respectively. We also compute the ratio of the study standard deviation to the standard deviation in the reference population (s/S), designated by u. If we then designate c to be $\sqrt{u^2 + (1-u^2)\bar{r}_{xy}^2}$, we can express the population correlation between true scores in the reference population as:

$$\bar{p}_{TU} = \bar{p}_{xy} / \bar{a}\bar{b}\bar{c}$$

and we can also express the variance of these population correlations as:

$$\sigma_{TU}^2 = \frac{\sigma_{pxy}^2 - \bar{p}_{TU}^2 (\bar{b}^2 \bar{c}^2 \sigma_a^2 + \bar{a}^2 \bar{c}^2 \sigma_b^2 + \bar{a}^2 \bar{b}^2 \sigma_c^2)}{\bar{a}^2 \bar{b}^2 \bar{c}^2}$$

where $\bar{p}_{xy} = \bar{r}_{xy}$, and $\sigma_{pxy}^2 = \sigma_{rxy}^2 - \sigma_e^2$, where σ_e^2 is defined as before. Note that these calculations require the means and the variances of the distributions of a, b, c, and r_{xy} which are derived from the four artifact distributions. This variance (σ_{TU}^2) is the sampling error corrected variance corrected for the effect of the other three artifacts (Hunter et al., 1982).

Moderator Tests

The existence of a significant residual variance indicates that there is a variation across studies due to nonartifactual differences (i.e., moderators). The hypothesis tested by meta-analysis is that this residual variance will be zero. If this hypothesis can be rejected, then tests for moderator variables can be conducted by blocking on the potential moderator variable and conducting separate meta-analyses for each subset. The presence of a moderator variable will show itself in two ways: "(1) the average correlation will vary from subset to subset and (2) the corrected variance will average lower in the subsets than for the data as a whole" (Hunter et al., 1982: 48).

The meta-analyses to be performed in this study will employ a rule of thumb for the percentage of variance accounted for. If 90 percent of the variance between study correlations can be explained by artifacts then the other 10 percent of variance will be considered to be due to artifacts also. However, if less than 90 percent of the variance can be attributed to artifacts then moderator tests will be performed.

The primary criterion that will be used to determine the existence of a moderator will be the size of the difference between the mean correlations for the subgroups formed on the moderator variable. If the difference is statistically significant, a moderator effect is indicated.

Second Order Sampling Error in Meta-Analysis

When performing a meta-analysis of a small number of studies, as in this case, one must be cautious in the interpretation of the results obtained. The meta-analytic estimates of standard deviations is affected by second order sampling error. This is not an unique characteristic of meta-analysis, but is common to ordinary statistics. Small samples are strongly influenced by the peculiarities of the individual data points included. The amount of variance observed relative to that expected due to sampling error can shift considerably due to second order sampling error. As a result, the interpretation of the percentage of variance accounted for can be very misleading. Recall the discussion earlier about situations in which expected variance exceeds observed variance. Second order sampling error can operate in both directions. Just as there is a chance that expected variance exceeds the observed variance, there is also a chance that unexplained variance is also due to artifacts.

While the statistical power of meta-analysis is fairly high with respect to the mean correlation, the small number of studies included here reduces the power with respect to the variance. The 75 percent rule of thumb in meta-analysis states that "whenever 75 percent or more of the variance . . . is accounted for by the four artifacts that are corrected for" we may conclude that the rest of the variance is due to uncorrectable artifacts (Schmidt et al., 1979: 265). Elsewhere it is reported that while this rule does have superior statistical power to detect an effect with a small number of studies, relative to other techniques such as the chi square test, it also has a higher probability of erroneously concluding that a moderator is present when there is not (Sackett, Harris, & Orr, 1986). This is especially true when a small number of studies is included. The criterion should not be purely the proportion of variance accounted for. Meta-analytic findings that are consistent with theory and previous research findings, even of a very small set of studies, can provide the best interpretation of cumulative research findings.

Sources of Sample

The target population for these analyses is all published and unpublished studies that either contain correlation coefficients for technology and structure measures, or contain sufficient data to allow calculation of the correlations.

A fairly extensive literature search was conducted. Published studies were found through a computer search of The Social Science

Citation Index using keywords of "technology" and "structure". Using the bibliographies of these studies an ancestry approach was used to locate additional studies. In addition, the following journals were physically examined for every issue published since 1965: Administrative Science Quarterly, Academy of Management Journal, Academy of Management Review, American Journal of Sociology, American Sociological Review, Human Relations, Journal of Management Studies, Management Science, Organization and Administrative Sciences, Organization Studies, OMEGA, and Pacific Sociological Review.

Selection of 1965 as a cut-off was not purely arbitrary. Research into the impact of technology on the social structure of organizations was not an area of extensive interest prior to the mid-1960s, and those studies that were conducted prior to that were generally narrative case studies. It should be noted that Woodward's (1958/1966) study was the first to treat technology as a measurable attribute that varies from one organization to another.

The major source of unpublished data was a computer search of Dissertation Abstracts International. An initial search focusing on the joint appearance of the words "size", "technology", and "structure" identified six dissertations. A second computer search focused on titles which included the words "organization", "organizational", or "structure". This resulted in 33,631 citations. This number was systematically reduced by imposing additional restrictive criteria for the search. The end result was a list of 81 dissertations with the words "organization" or "organizational", and "structure" in the title plus one or more words relating to the technology variable (i.e., technology, routine, workflow, throughput, task, context, mechanization, computer, contingency, automation, or mass output).

Several of the dissertations identified in the computer search were excluded from consideration based upon a reading of the abstract. For example, the search picked up two dissertations in archaeology, one in literature, two on technology transfer between nations, and one in computer engineering. Others clearly indicated that they were case studies of one or two organizations, or used the terms "technology" and "structure" differently than intended for these analyses. A reading of the abstracts for these 81 dissertations indicated that 48 appeared to be potential sources of relevant data, plus another 5 showed weak possibilities. These 53 dissertations were examined.

Twenty-two of those dissertations provided correlations for inclusion in these meta-analyses (Al-Jibouri, 1983; Ayoubi, 1975; Beckett, 1972; Carter, 1981; Cox, 1981; Davis, 1985; Fernandez, 1974; Ford, 1975; Garthright, 1981; Jester, 1982; Kedia, 1976; Khandwalla, 1970; Kmetz, 1975; Loveridge, 1982; Mark, 1982; Piernot, 1979; Pitsiladis, 1979; Reimann, 1972; Shrader, 1984; Vazzana, 1987; Williams, 1984; Worley, 1983). A list of the 53 dissertations examined is at Appendix A.

Another major source of unpublished correlations was the Aston Data Bank (1976). This data bank contains the results from the majority of studies conducted in different parts of the world prior to 1973 which employed the standardized original measures, or the abbreviated derivation, developed at the University of Aston in Birmingham, England. These data are in 80-column card format and are available on magnetic tape from the University of Essex.[1]

Many, but not all, of the studies in this data bank have been published (e.g., the Aston Study, and the National Study). However, even those studies did not publish all of the results from the data that were collected. The data bank was used in these meta-analyses as a supplement to published correlations, not as a substitute for them. That is, correlations were taken from the data bank only when no published source could be cited.

Unpublished studies were also sought from other persons who have done research in this area in the past. Letters were written to 82 scholars who have done work in the general area of technology and structure. A list of researchers written to is at Appendix B. Only 47 of these researchers responded, even after a second request was sent out (a response rate of 57 percent). Forty-five of the 47 responses received were negative; no additional studies were available. Two unpublished papers were received (Kmetz, 1981; Wong & Birnbaum, 1989). Very little can be said about the 35 researchers who did not respond. However, since 45 of the 47 responses received were negative, it might be assumed that there are few unpublished studies among the other 35.

Studies Included

Correlations

The correlations included in these meta-analyses were obtained from the following sources: Al-Jibouri, 1983; Aston Data Bank, 1976; Ayoubi, 1975, 1981; Badran and Hinings, 1981; Beckett, 1972; Bell, 1967; Beyer and Trice, 1979; Blau, 1973; Blau et al., 1976; Blau and Schoenherr, 1971; Budde, Child, Francis, and Kieser, 1982; Carter, 1981, 1984; Child and Kieser, 1979; Child and Mansfield, 1972; Collins and Hull, 1986; Comstock and Scott, 1977; Conaty, Mahmoudi and Miller, 1983; Cox, 1981; Davis, 1985; Dewar and Hage, 1978; Fernandez, 1974;

Ford, 1975; Freeman, 1973; Fry and Slocum, 1984; Garthright, 1981; Glisson, 1978; Hage and Aiken, 1969; Harvey, 1968; Hickson et al., 1969; Hinings and Lee, 1971; Hrebiniak, 1974; Hsu, Marsh and Mannari, 1983; Hull and Collins, 1987; Inkson, Pugh and Hickson, 1970; Inkson, Schwitter, Pheysey and Hickson, 1970; Jester, 1982; Kedia, 1976; Khandwalla, 1970, 1974, 1977; Kimberly and Rottman, 1987; Kmetz, 1975, 1977, 1981; Kuc, Hickson and McMillan, 1981; Leatt and Schneck, 1981, 1982; Loveridge, 1982; Mahmoudi and Miller, 1985; Mark, 1982; McKinley, 1987; McMillan, Hickson, Hinings and Schneck, 1973; Miller and Droege, 1986; Mills, Turk and Margulies, 1987; Mohr, 1971; Moorhead, 1981; Negandhi and Reimann, 1973; Paulson, 1980; Payne and Mansfield, 1973; Pennings, 1975; Pfeffer and Leblebici, 1977; Piernot, 1979; Pitsiladis, 1979; Reimann, 1972, 1980; Rousseau, 1978; Routamaa, 1985; Shenoy, 1981; Shrader, 1984; Sutton and Rousseau, 1979; Tracy and Azumi, 1976; Van de Ven, Delbecq and Koenig, 1976; Vazzana, 1987; Williams, 1984; Wong and Birnbaum, 1989; Woodward, 1965; Worley, 1983; Zeffane, 1981; and Zwerman, 1970. These sources provide a total of 833 individual correlations across four broad technology concepts and 30 structural variables. An annotated bibliography of these studies is at Appendix C, and Tables IV-1 through IV-3 display the correlations included from each source.

Note that each of these references is numbered in Appendix C and in Tables IV-1 through IV-3. These numeric codes will be used to cite these sources in the rest of this study.

Many studies were excluded for these analyses for a variety of reasons. For example, industry level studies were excluded since the focus of this study is the relationship between technology and the internal structure of organizations (e.g., Dalto, 1975; Legendre, 1977; Rushing, 1968). Also, studies that used multiple regression analysis, but did not include the correlation matrix, had to be excluded (e.g., Lincoln, Hanada, & McBride, 1986). Finally, some studies were excluded because they were analyses of subsamples from other published studies (Collins, 1986; Hoffman, 1988; Meyer, 1968; Schoenherr, 1971).

Categories of Technology Used

The 833 correlations were assigned to four broad conceptual definitions of technology. Each refers to commonly occurring operational measures found in the literature, and each appears to be conceptually different from the other.

1. Workflow continuity: This category includes all versions of Woodward's (1965) scale of unit, mass, and continuous process production. Hickson et al. (1969) considered this to be a subcategory of operations technology, but as the original scale of technology reported in the literature (Woodward 1958/1966), it has been set apart as a separate category for these analyses.

Studies included in this category are those that applied versions of Woodward's scale (Studies 3, 5, 12 & 61, 18, 38, 41, 54, 69, 77, 83, 96, 97, and 99), or the Aston scale of throughput continuity designed for application to both manufacturing and service organizations (Studies 4c, 4d, 4e, and 4h). This category also includes studies that used the Khandwalla (1970) scale of mass output orientation (Studies 22, 46, 47, 49, 65, and 78).

2. Workflow integration and automation: This category includes all measures of operations or production technology other than continuity measures. It is dominated by the workflow integration scale developed by the Aston researchers (Hickson et al.,

1969). Since this is primarily composed of a scale of automaticity it may also be considered to be a measure of operations mechanization. As such, this category includes all studies that measured workflow automation as well as those that used the Aston scale of workflow integration (Studies 3, 4a, 4b, 4c, 4d, 4e, 4f, 4g, 4h, 5, 7, 11, 12 & 42, 14 & 17, 15, 18 & 4i, 20, 21a, 21b, 32, 38 & 4k, 39, 41, 43, 44, 49, 51, 62, 71, 77, 80, 81, 86, 95, 98a, 98b, and 98c). Studies that measure interdependence among workflow segments (Thompson, 1967) are also included in this category (Studies 31, 33, 40, 53, 60, 67, 72, 85, and 90).

3. Task routineness: This category includes all studies that operationalize Perrow's (1967) concept of routineness. Whereas workflow continuity and workflow integration emphasize characteristics of the workflow, routineness refers to the characteristics of the task performed. Comstock and Scott (1977) suggested that task characteristics have a different impact on structure than do workflow characteristics. Studies that provide correlations in this category are reference numbers 4a, 4b, 4c, 4d, 4e, 4f, 4i, 4j, 4k, 4l, 4m, 4n, 8, 9, 10, 19, 20, 24, 25, 30, 31, 33, 34, 35, 36, 37, 40, 45, 50, 53, 55, 57, 60, 66, 67, 68, 70, 74, 75a, 75b, 75c, 84, 86, 90, and 93.

Figure IV-1 illustrates some of the many concepts found in the literature. Fry stated that while there are many different operationalizations of task routineness, they all have the same "conceptual underpinnings" (Fry, 1982: 538). However, some researchers score their scales so that a high score reflects routineness, while for others the high score reflects nonroutine technology. Before these correlations can be included in a meta-analysis the signs of those correlations must reflect a common underlying continuum.

An effort was made during the data collection phase of this study to insure that all correlations reflected scales of increasing routineness as indicated in Figure IV-1. The signs of the correlations had to be reversed in several cases (Studies 4a, 4b, 4c, 4d, 4e, 4f, 4i, 4j, 4k, 4l, 4m, 4n, 25, 55, 60, 67, 70, 84, 86, 90, and 93). This was necessary not only to maintain consistency within the task routineness category, but also to allow comparison of the task routineness category with the other three technology concepts.

4. Information technology: It has been suggested that automation of information processing has a more pervasive impact on the hierarchical structure of organizations than does operations technology (Blau et al., 1976). Studies that investigate the impact of computer applications in the administrative component of organizations will be analyzed under this category, while computer application to the workflow will be analyzed under workflow integration and automation. Correlations included come from Studies 3, 4i, 11, 13a, 13b, 13c, 15, 21a, 21b, 49, 59, 73, 77 & 78, 81, 91, 98a, 98b, and 98c.

Artifact Distributions

The artifact distribution method of meta-analysis was discussed earlier in this chapter. This section will include descriptions of the artifact distributions that will be used.

Range Restriction

Three separate distributions were constructed for range restriction in the measure of technology. There is one for workflow continuity, one for workflow integration and automation, and one for task routineness. These distributions are based upon comparisons of the standard deviations from different studies on the same measurement scale. No range restriction distribution could be constructed for information technology, because no single scale is used frequently enough to make the necessary comparisons of standard deviations.

Workflow Continuity

Table IV-4 presents the calculation of the range restriction distribution for workflow continuity scales. There are basically four versions of this scale found in the literature; 3-point scales (Negandhi & Reimann, 1973; Woodward, 1965; Worley, 1983; Zwerman, 1970), 5-point scales (Cox, 1981; Kedia, 1976; Khandwalla, 1970, 1974; Miller & Droege, 1986; Reimann, 1980), 7-point scales (McKinley, 1987; Reimann, 1972), and 10-point scales (Aston Data Bank, 1976; Ayoubi, 1975).

No common reference study was readily apparent for all of these four versions of the workflow continuity scale, but fortunately Woodward provides the distribution of her sample on an 11-point scale (Woodward, 1965: 39). The data were used to compute the standard deviation that would exist with each of the four types of scales, so that each of the four types could use the Woodward sample as the reference standard deviation. The extent of range restriction is calculated by dividing each sample standard deviation by the reference standard deviation (i.e., $U = s / S$).

The second column from the right in Table IV-4 indicates what the artifact distribution would be if the Woodward (1965) study is used as a reference. Notice that all except one of these values of U is less than one. This indicates that the range on the technology measure was greater in the Woodward (1965) sample than in most of the other samples studied since. This might explain why subsequent researchers have not consistently observed significant relationships between technology and structure.

However, it was desirable that the reference studies for the range restriction distributions be the same for all technology concepts. Therefore, the average value of U for the Aston Study and the National Study was used as a reference point (Aston Data Bank, 1976). The resulting artifact distribution for workflow continuity measures is shown in the last column of Table IV-4.

Workflow Integration and Automation

Table IV-5 displays the calculations performed to arrive at the artifact distribution for range restriction in the measures of workflow integration and automation. The major source for the standard deviations used is the Aston Data Bank (1976). Standard deviations were computed for the original 5-item scale of workflow integration (i.e., FULL-O), and for the abbreviated 3-item version of that scale (i.e., SKO). However, only the SKO was used in the artifact distribution. Note in Table IV-5 that there were more studies that used the SKO, and every study that used the FULL-O also provided data for the SKO. The reference standard deviation for the 15 SKO studies was computed as the sample-weighted mean standard deviation for 3 studies with samples including both manufacturing and service organizations (Aston Data Bank, 1976 (Child, 1967-69; Hickson & Inkson, 1967; Pugh et al., 1962-63)).

Three studies used a 2-item scale of automaticity (Aston Data Bank, 1976 (Pugh & Loveridge, 1971); Hsu et al., 1983; Rousseau, 1978). The reference standard deviation for these three scales was the sample-weighted mean standard deviation for all three studies.

In addition to the artifact distribution for the total samples, separate distributions were constructed for manufacturing and service samples. Both distributions use the same reference standard deviation. These distributions will be used in Chapter X where the moderator effect of organization type is examined.

Task Routineness

The artifact distribution developed in Table IV-6 will be used to adjust for the effects of range restriction in measures of task routineness. It was stated earlier that there is a variety of scales used to measure task routineness, and researchers will frequently tailor the scales they use by adding and/or deleting items. As a result, it is difficult to find several studies that use the same scale, and even harder to find studies that include the standard deviation for the scale.

However, two researchers (Collins & Hull, 1986; Tracy & Azumi, 1976) used a scale of task variability that reflects the extent to which the organization's output is standardized or customized to the customer's specifications. This same measure is included in the Aston scales as a measure of charter (i.e., customer orientation) (Aston Data Bank, 1977). This scale was used to construct the artifact distribution in Table IV-6.

All of the standard deviations for the artifact distribution in Table IV-6 were derived from studies in the Aston Data Bank (1976). The reference studies used in this distribution were the same three that were used in the distribution for workflow integration and automation (Aston Data Bank, 1976 (Child, 1967-69; Hickson & Inkson, 1967; Pugh et al., 1962-63)). The separate distributions for manufacturing and service organizations are also computed in the same way as done for workflow integration and automation.

Summary

Tables IV-4 through IV-6 contain the artifact distributions that will be used to adjust for the effects of range restriction in the technology variable. All of these distributions use the standard deviation from the same studies as the reference standard deviation.

The following discussion will describe the sources of reliability coefficients for the measures of technology and structure.

Reliability

Table IV-7 through Table IV-11 list the reliability coefficients found or computed for the four technology concepts used to classify studies, and for 6 of the 30 structural variables that are being analyzed. All of the reliability coefficients in these tables represent coefficients of random equivalence (i.e., coefficient alpha) (Cronbach, 1951).

Technology

Workflow Continuity

Table IV-7 contains estimates of the reliability for the single-item workflow continuity scales. These were calculated as the correlation between two measures of the same construct applied to the same sample. Nunnally states that "when only one correlation is taken as an estimate of a hypothetical infinite number of correlations, however, it is right to question how efficient such estimates are" (1978: 199). The reliability coefficients displayed in Table IV-7 are high and may be overestimates of the real reliability. Therefore, the corrections that will be made using these coefficients is a conservative correction. That is, the corrected correlation will be a low estimate of the true score correlation. Nevertheless, the reliability coefficients in Table IV-7 are the best estimates available.

Workflow Integration and Automation

As a general rule published studies that employ the Aston scale of workflow integration do not include reliability information. Most of the reliability coefficients displayed in Table IV-8 were calculated for the studies in the Aston Data Bank (1976). Dissertations were another source of reliability coefficients (Al-Jibouri, 1983; Ayoubi, 1975, 1981; Carter, 1981, 1984). Researchers who report the results of studies that measure the interdependence of workflow segments have tended to be more mindful of the importance of measurement reliability (Fry & Slocum, 1984; Lynch, 1974; Pennings, 1975; Van de Ven, 1977).

The reliability coefficients in Table IV-8 range from .27 (Aston Data Bank, 1976 (Reimann, 1970-71)) to .92 (Ayoubi, 1975, 1981; Carter, 1981, 1984). The mean value of the square roots of these coefficients is .81. This suggests that, on average, the observed correlation between these measures and measures of structure are 23 percent lower than they would be if a perfectly reliable measure could be used (i.e., (1 / .81) - 1 = .23). Thus, correction for measurement error increases the correlation by 23 percent.

Task Routineness

Table IV-9 lists 49 reliability coefficients for measures of the various operationalizations of Perrow's (1967) concept of routineness. Published research that employs this concept of technology is most likely to include reliability data. Reliability coefficients are provided for measures of task routineness (Davis, 1985; Glisson, 1978; Loveridge, 1982; Lynch, 1974; Shrader, 1984; Withey et al., 1983), task variety (Aiken, Bacharach & French, 1980; Alexander & Randolph, 1985; Daft & Macintosh, 1981; Dewar & Simet, 1981; Dewar, Whetten & Boje, 1980; Fernandez, 1974; Ford, 1975; Fry & Slocum, 1984; Hrebiniak, 1974; Leatt & Schneck, 1981; Loveridge, 1982; Lynch, 1974; Ramsey, 1979; Van de Ven & Delbecq, 1974; Victor & Blackburn, 1987; Withey et al., 1983), and task analyzability (Daft & Macintosh, 1981; Fernandez, 1974; Fry & Slocum, 1984; Hrebiniak, 1974; Loveridge, 1982; Lynch, 1974; Victor & Blackburn, 1987; Withey et al., 1983). There are also measures of task complexity (Middlemist & Hitt, 1981), task difficulty (Van de Ven & Delbecq, 1974), task instability (Leatt & Schneck, 1981; Withey et al., 1983), and task uncertainty (Drazin & Van de Ven, 1985; Leatt & Schneck, 1981; Lynch, 1974; Mills et al., 1987; Van de Ven, 1977).

The coefficients in Table IV-9 range from .34 for a measure of task routineness (Withey et al., 1983) to .92 for a measure of task uncertainty (Van de Ven, 1977). The mean square root of these 49 coefficients is .84 so the average correlation with structural variables is attenuated approximately 19 percent due to measurement error in the technology scale.

Information Processing

Table IV-10 includes seven reliability coefficients for measures of information technology or the use of automated information processing (Al-Jibouri, 1983; Aston Data Bank, 1976 (Child, 1967-69);

Blau & Schoenherr, 1971; Carter, 1981, 1984; Conaty et al., 1983; Vazzana, 1987). The coefficients range from .64 (Aston Data Bank, 1976) to .92 (Vazzana, 1987).

The mean square root of these coefficients is .90 so the observed correlation between these measures and measures of organization structure are attenuated an average of 11 percent due to measurement error in the technology scale.

Structural Variables

The previous section described the artifact distributions for reliability of the technology measures; the independent variable. In this section the reliability coefficients for measures of organization structure will be described. Table IV-11 lists those coefficients. Reliability coefficients could be found, or computed, for only 6 of the 30 structural variables included in these meta-analyses. Those 6 structural measures are division of labor, functional specialization, standardization, overall formalization, role formalization, and centralization.

Division of Labor

Seven reliability coefficients were obtained for measures of division of labor (Aston Data Bank, 1976 (Child, 1967-69; Kieser, 1970-72; Lee, 1966-67); Ford, 1975; Fry & Slocum, 1984; Glisson, 1978; Pitsiladis, 1979; Sathe, 1978).

Functional Specialization

Seventeen reliability coefficients are displayed in Table IV-11 for measures of functional specialization (Al-Jibouri, 1983; Aston Data Bank, 1976 (Child, 1967-69; Glueck, 1970-71; Hickson & Inkson, 1967-68; Lee, 1966-67; Payne & Mansfield, 1969; Pheysey, 1971-72; Pugh et al., 1962-63; Pugh & Loveridge, 1971; Reimann, 1970-71; Schwitter, 1968); Ayoubi, 1975; Conaty et al., 1983; Davis, 1985; Drazin & Van de Ven, 1985; Miller & Droege, 1986).

Standardization

There are 12 reliability coefficients for measures of standardization listed in Table IV-11 (Alexander & Randolph, 1985; Al-Jibouri, 1983; Aston Data Bank, 1976 (Child, 1967-69; Hinings, 1972; Lee, 1966-67; Pheysey & Payne, 1967-69; Tauber, 1967-68); Ayoubi, 1975; Conaty et al., 1983; Drazin & Van de Ven, 1985; Loveridge, 1982).

Overall Formalization

There are 32 reliability coefficients in Table IV-11 for measures of overall formalization (Al-Jibouri, 1983; Aston Data Bank, 1976 (Child, 1967-69; Lee, 1966-67; McMillan 1971, 1972, 1972-73; Pheysey & Payne, 1967; Tauber, 1967-68); Ayoubi, 1975; Comstock & Scott, 1977; Conaty et al., 1983; Davis, 1985; Dewar et al., 1980; Drazin & Van de Ven, 1985; Duncan, 1971; Ford, 1975; Fry & Slocum, 1984; Glisson, 1978; Khandwalla, 1970, 1974, 1977; Kmetz, 1975, 1977; Lynch, 1974; McKinley, 1987; Miller & Droege, 1986; Mills et al., 1987; Pitsiladis, 1979; Ramsey, 1979; Sathe, 1978; Shrader, 1984).

Role Formalization

Table IV-11 contains 17 reliability coefficients for measures of role formalization. Sixteen of these coefficients were computed for studies in the Aston Data Bank, 1976 (Child, 1967-69; Glueck, 1970-71; Hickson & Inkson, 1967-68; Hinings, 1972; Lee, 1966-67; McMillan, 1971, 1972, 1972-73; Payne & Mansfield, 1969; Pheysey, 1971-72;

Pheysey & Payne, 1967-69; Pugh et al., 1962-63; Pugh & Loveridge, 1971; Reimann, 1970-71; Schwitter, 1968; Tauber, 1967-68). One additional reliability coefficient was provided by Kmetz (1975, 1977).

Centralization

There are 35 reliability coefficients in Table IV-11 for measures of centralization. Seven of these coefficients were computed for studies in the Aston Data Bank, 1976 (Child, 1967-69; Kieser, 1970-72; Lee, 1966-67; McMillan, 1971, 1972, 1972-73; Pheysey & Payne, 1967-69). The other 28 coefficients came from dissertations and published studies (Aiken et al., 1980; Alexander & Randolph, 1985; Ayoubi, 1975; Carter, 1981, 1984; Conaty et al., 1983; Dewar et al., 1980; Duncan, 1971; Fernandez, 1974; Ford, 1975; Fry & Slocum, 1984; Glisson, 1978; Hrebiniak, 1974; Khandwalla, 1970, 1974, 1977; Kmetz, 1975, 1977; Loveridge, 1982; McKinley, 1987; Miller & Droege, 1986; Mills et al., 1987; Pitsiladis, 1979; Ramsey, 1979; Sathe, 1978; Shrader, 1984; Ungson, 1978).

Summary

This section has described the artifact distributions that will be used in the meta-analyses to be performed in this study. Range restriction distributions were presented for workflow continuity, workflow integration and automation, and task routineness but no range restriction distribution could be constructed for measures of information technology.

Artifact distributions for the reliability of all four technology concepts and six structural variables were also presented.

Computer Program

Artifact distribution techniques were discussed in an earlier section of this chapter, then the sources of the four distributions needed to apply this technique were discussed. Again, those four distributions are the study correlations and sample sizes (r_{xy} and N), the reliability coefficients for the independent variable and the frequency with which each appears (r_{xx} and f), the reliability coefficients for the dependent variable and their frequency (r_{yy} and f), and the extent and frequency of range restriction (U and f).

A computer program was perfected by Frank Schmidt in January 1985 to perform the noninteractive artifact distribution technique on the Commodore 64 personal computer. Appendix D contains a modified version of that program that has been converted to run on an IBM compatible PC using GW Basic Version 2.0 or higher. This program will be used for all of the meta-analyses performed in this study. This program prompts the user to enter the names of the sequential data files that contain the correlations and artifact distributions.

Study Attributes

Each study that provided a correlation for these meta-analyses was coded to indicate the average size of the organization in the study, the type of organization studied, the level of analysis of the study, and whether the measure used was institutional or questionnaire. The purpose of this coding was to facilitate moderator tests.

Table IV-12 is a listing of all of the studies that provided correlations and the coding of those attributes that have been proposed as moderators of the relationship between technology and structure.

Summary

This chapter has described the methodology to be employed in this study and the sources of the data to be included in the analyses.

Chapter V will address some preliminary issues that need to be considered before proceeding to the primary analyses of this study. Specifically, it addresses the question of linearity in the relationship between technology and structure, and the role of organization performance in the technology-structure relationship.

Note

[1]As of this writing, the Aston Data Bank can be acquired for the cost of a blank magnetic tape, and the cost of mailing it. Interested researchers should contact:

ESRC Data Archive
University of Essex
Wivenhoe Park
Colchester CO4 3SQ
Essex England

Table IV-1. Studies and Correlations Included

#	Study	Technology[a] Concept	Division of Labor r	N	Functional Speciali-zation r	N	Standardi-zation r	N	For... Overall r	N
3	Al-Jibouri, 1983	1			.410[b]	27	.431[b]	27	.472[b]	[illegible]
	Al-Jibouri, 1983	2A			-.100	27	-.020	27	.000	[illegible]
	Al-Jibouri, 1983	4			.643	27	.742	27	.689	[illegible]
		Average			.318	27	.384	27	.387	[illegible]
	Aston Data Bank, 1976[c]									
4a	(Glueck, 1970-71)	1			.431	12				
	(Glueck, 1970-71)	3[d]			-.518	12				
		Average			-.044	12				
4b	(Hickson & Inkson, 1967-68)	1			.594	44				
	(Hickson & Inkson, 1967-68)	3[d]			-.040	44				
		Average			.277	44				
4c	(McMillan, 1971)	1			.536	12			.369	1
	(McMillan, 1971)	2B			.195	12			.690	1
	(McMillan, 1971)	3[d]			-.096	12			-.300	1
		Average			.212	12			.253	1
4d	(McMillan, 1972)	1			.299	14			.245	1
	(McMillan, 1972)	2B			.062	14			.809	1
	(McMillan, 1972)	3[d]			-.067	14			.152	1
		Average			.098	14			.402	1
4e	(McMillan, 1972-73)	1			-.002	50			-.018	4
	(McMillan, 1972-73)	2B			.093	50			.078	4
	(McMillan, 1972-73)	3[d]			-.295	50			-.321	5
		Average			-.068	50			-.090	4
4f	(Pheysey, 1971-72)	1			.582	10				
	(Pheysey, 1971-72)	3[d]			.449	10				
		Average			.516	10				
4g	(Pugh & Loveridge, 1971)	1			.517	16				
4h	(Tauber, 1967-68)	1	-.741	6	-.172	6	.540	6	.907	
	(Tauber, 1967-68)	2B	.741	6	.172	6	-.540	6	-.907	
		Average	.000	6	.000	6	.000	6	.000	
5	Ayoubi, 1975; 1981	1			.430	34	.270	34	.400	3
	Ayoubi, 1975	2A			.370	34	.360	34	.350	3
		Average			.400	34	.315	34	.375	3
7	Badran & Hinings, 1981	1			.480	31	.490	31		
8	Beckett, 1972	3								
9	Bell, 1967	3								

ional ali- on N	Standardization r	N	Formalization Overall r	N	Formalization Roles r	N	Vertical Span r	N	Centralization r	N	CEO Span of Control r	N	Supervisor's Span of Control r	N
b 27	.431[b]	27	.472[b]	27			.431[b]	27			.410[b]	27	-.207[b]	27
27	-.020	27	.000	27			-.050	27			-.050	27	-.070	27
27	.742	27	.689	27			.707	27			.655	27	.116	27
27	.384	27	.387	27			.363	27			.338	27	-.054	27
12					.410	12								
12					-.558	12								
12					-.074	12								
44					.314	44					.296	42		
44					-.066	44					.095	44		
44					.124	44					.193	43		
12			.369	12	.162	12	-.280	10	.020	12	-.118	12	-.063	12
12			.690	12			-.049	10	.210	12	-.148	12	-.200	12
12			-.300	12	-.200	12	.435	10	-.029	12	-.174	12	-.096	12
12			.253	12	-.019	12	.035	10	.067	12	-.147	12	-.120	12
14			.245	14	.519	14	-.229	14	.247	14	.307	14	-.135	14
14			.809	14			.102	14	.182	14	.071	14	-.434	14
14			.152	14	.384	14	.065	14	-.198	14	-.121	14	-.120	14
14			.402	14	.452	14	-.021	14	.077	14	.086	14	-.230	14
50			-.018	49	.201	49			.078	50	.096	37	-.063	47
50			.078	48					.158	50	.169	38	.026	46
50			-.321	50	-.327	49			.114	50	.114	38	.017	47
50			-.090	49	-.063	49			.117	50	.126	38	-.007	47
10					.538	10								
10					.573	10								
10					.556	10								
16					.206	16					.612	16		
6	.540	6	.907	6	.869	6			-.166	6			-.354	6
6	-.540	6	-.907	6	___	_			.166	6			.354	6
6	.000	6	.000	6	.869	6			.000	6			.000	6
34	.270	34	.400	34			.400	34	-.260	34	-.030	34	.040	34
34	.360	34	.350	34			.310	34	.160	34	.070	34	-.480	34
34	.315	34	.375	34			.355	34	-.050	34	.020	34	-.220	34
31	.490	31			.420	31			-.520	31				
									.274[c]	20				
													.470[b]	30

Table IV-1--continued

#	Study	Technology[a] Concept	Division of Labor r	Division of Labor N	Functional Speciali-zation r	Functional Speciali-zation N	Standardi-zation r	Standardi-zation N	Form[...] Overall r	Form[...] Overall N
10	Beyer & Trice, 1979	3	-.009[e]	71	.023[e]	71				
11	Blau, 1973	1			.165	115				
	Blau, 1973	4			.544[f]	115				
		Average			.354	115				
12	Blau, Falbe, McKinley & Tracy, 1976	1			-.010	110				
	Blau, Falbe, McKinley & Tracy, 1976	2A			.110	110				
	Blau, Falbe, McKinley & Tracy, 1976	4			.560	110				
42	Hull & Collins, 1987	1	.362[b]	110						
61	McKinley, 1987	2A								
		Average	.362	110	.220	110				
13a	Blau & Schoenherr, 1971	4	.645[f]	52	.244[f]	53				
13b	Blau & Schoenherr, 1971	4			.281	416			.302	400
13c	Blau & Schoenherr, 1971	4	.369	1201						
14 17	Budde, Child, Francis, & Kieser, 1982; Child & Kieser, 1979	1	.100	51	.080	51	-.070	51		
15	Carter, 1981; 1984	1			.299[b]	60			.171[b]	60
	Carter, 1981; 1984	4			.336[f]	60			.141[f]	65
		Average			.318	60			.156	62
16	Child & Mansfield, 1972	1	.390	82	.410	82	.260	82	.100	82
	Child & Mansfield, 1972	2A	-.240	40	-.170	40	-.260	40	-.270	40
4i	Aston Data Bank, 1976:[c]									
	(Child, 1967-69)	1								
	(Child, 1967-69)	3[d]	.240	82	.329	82	.204	82	.114	82
	(Child, 1967-69)	4	.346	82	.351	82	.327	82	.387	82
		Average	.246	72	.289	72	.190	72	.134	72
19	Collins & Hull, 1986	3								
20	Comstock & Scott, 1977	1							.220	123
	Comstock & Scott, 1977	3	.290	142						
		Average	.290	142					.220	123
21a	Conaty, Mahmoudi & Miller, 1983	1	.220	65	-.100	65	.400	65	.350	65
	Conaty, Mahmoudi & Miller, 1983	4	.440	65	.190	65	.600	65	.380	65
		Average	.330	65	.045	65	.500	65	.365	65
21b	Conaty, Mahmoudi & Miller, 1983	1	.470	64	.130	64	-.160	64	-.060	64
	Conaty, Mahmoudi & Miller, 1983	4	.410	64	.440	64	.120	64	.220	64
		Average	.440	64	.285	64	-.020	64	.080	64

...tional ...iali- ...ion r	N	Standardi- zation r	N	Formalization: Overall r	N	Formalization: Roles r	N	Vertical Span r	N	Centrali- zation r	N	CEO Span of Control r	N	Supervisor's Span of Control r	N
3[e]	71							.019[e]	71						
5	115							.254	115	-.139	115	.029	115		
[f]	115							.503	115	-.284[f]	115	-.013	115		
	115							.378	115	-.212	115	.008	115		
)	110							.100	110	.050	110	.080	110	-.060	110
)	110							.100	110			.060	110	-.090	110
)	110							.270	110			-.190	110	-.220	110
						.240[b]	110								
										.270	110				
	110					.240	110	.157	110	.160	110	-.017	110	-.123	110
[f]	53					.331[f]	51	.565[f]	53	-.461[d,f]	53	.206[f]	53	.297[f]	53
	416			.302	400			.425	415					.173	415
								.205	1201			.231	1201	.106	1201
	51	-.070	51							-.040	51				
[b]	60			.171[b]	60					-.272[b]	62				
[f]	60			.141[f]	65					-.169[d,f]	62				
	60			.156	62					-.220	62				
	82	.260	82	.100	82			.170	82	.130	82	.050	82	.140	82
	40	-.260	40	-.270	40			-.190	40	.220	40	.340	40	.020	40
						.091	82								
	82	.204	82	.114	82	.144	82	.217	82	.138	82	.015	82	.108	82
	82	.327	82	.387	82			.203	82	-.167	82	.131	82	-.136	80
	72	.190	72	.134	72	.118	82	.142	72	.060	72	.104	72	.036	71
														.040[b]	95
				.220	123					.253[b]	142				
										-.180	142				
				.220	123					.036	142				
	65	.400	65	.350	65			.420	65	-.180	65				
	65	.600	65	.380	65			.340	65	-.260	65				
	65	.500	65	.365	65			.380	65	-.220	65				
	64	-.160	64	-.060	64			-.200	64	.360	64				
	64	.120	64	.220	64			.030	64	.400	64				
	64	-.020	64	.080	64			-.085	64	.380	64				

Table IV-1--continued

#	Study	Technology[a] Concept	Division of Labor r	N	Functional Speciali- zation r	N	Standardi- zation r	N	Formal[ization] Overall r	N
22	Cox, 1981	2A[g]								
24	Davis, 1985	3			.140[d]	116			.260[d]	114
25	Dewar & Hage, 1978	3	-.423[d,h]	16	-.147[d,h]	16				
30	Fernandez, 1974	3	.556[c]	8					-.073[c]	8
31	Ford, 1975	1	.041	68	-.033	68			.182	68
	Ford, 1975	3	-.228	82					.611	82
		Average	-.106	75	-.033	65			.416	75
33	Fry & Slocum, 1984	1	.120	61					.070	61
	Fry & Slocum, 1984	3	.178[b]	61					.116[b]	61
		Average	.149	61					.093	61
34	Garthright, 1981	3					.468[e]	28		
35	Glisson, 1978	3	.425	30					.225	30
36	Hage & Aiken, 1969	3							.412[h]	16
37	Harvey, 1968	3			.700[c]	43				
38	Hickson, Pugh & Pheysey, 1969	1	.380	46	.440	46	.460	46	.170	46
	Hickson, Pugh & Pheysey, 1969	2A	.520	31	.340	31	.350	31	.270	31
4k	Aston Data Bank, 1976:									
	(Pugh et al., 1962-63)[c]	1								
	(Pugh et al., 1962-63)[c]	3[d]	-.069	52	-.191	52	-.137	52	-.152	52
		Average	.233	43	.162	43	.193	43	.064	43
39	Hinings & Lee, 1971	1	.140	9	.090	9	.000	9	.410	9
	Hinings & Lee, 1971	2A	.060	9	-.150	9	-.060	9	.100	9
4j	Aston Data Bank, 1976:[c]									
	(Lee, 1966-67)	3[d]	.065	10	-.009	9	.194	10	.240	10
		Average	.088	9	-.023	9	.050	9	.250	9
40	Hrebiniak, 1974	1							.140[d]	174
	Hrebiniak, 1974	3							.025[b]	174
		Average							.082	174
41	Hsu, Marsh & Mannari, 1983;	1			.070	50			.460	50
	Hsu, Marsh & Mannari, 1983;	2A			.190	50			.330	50
		Average			.130	50			.395	50
43	Inkson, Pugh & Hickson, 1970	1								

ctional Speciali- zation		Standardi- zation		Formalization				Vertical Span		Centrali- zation		CEO Span of Control		Supervisor's Span of Control	
				Overall		Roles									
r	N	r	N	r	N	r	N	r	N	r	N	r	N	r	N
								.417	20					.284	20
10[d]	116			.260[d]	114										
17[d,h]	16							-.310[d,h]	16						
				-.073[c]	8					.484[c]	8				
13	68			.182	68									-.177	68
—	—			.611	82					.473[d]	82			-.029[d,i]	82
13	65			.416	75					.473	82			-.096	75
				.070	61					-.140[d]	61			-.120	61
				.116[b]	61					-.080[b]	61			.392[d,i]	61
				.093	61					-.110	61			.136	61
		.468[e]	28			.355[e]	28								
				.225	30					.213[b]	30				
				.412[h]	16					.439[b]	16				
0[c]	43					.710[c]	43	.640[c]	43						
0	46	.460	46	.170	46			.090	46	-.160	46	.060	46	.350	46
0	31	.350	31	.270	31			.510	31	.000	31	.080	31	-.090	31
						.102	52								
1	52	-.137	52	-.152	52	-.007	52	-.063	52	.306	52	-.029	52	-.266	50
2	43	.193	43	.064	43	.048	52	.129	43	.066	43	.029	43	.000	42
0	9	.000	9	.410	9	.280	9	.130	9	.360	9	.260	9	-.710	9
0	9	-.060	9	.100	9	.190	9	.310	9	.290	9	-.360	9	.530	9
9	9	.194	10	.240	10	.185	9	.084	10	.079	10	.024	9	.072	10
3	9	.050	9	.250	9	.218	9	.171	9	.237	9	-.025	9	-.032	9
				.140[d]	174					.079[b]	174				
				.025[b]	174					.177[b]	174				
				.082	174					.128	174				
0	50			.460	50			-.060	50	.010	50	.280	50	-.260	50
0	50			.330	50			.160	50	.030	50	.650	50	.170	50
0	50			.395	50			.050	50	.020	50	.465	50	-.045	50
										-.390[j]	40				

Table IV-1--continued

#	Study	Technology[a] Concept	Division of Labor r	N	Functional Speciali-zation r	N	Standardi-zation r	N	Forma... Overall r	N
44	Inkson, Schwitter, Pheysey & Hickson, 1970	1			.640	21				
4n	Aston Data Bank, 1976:[c] (Schwitter, 1968)	3[d]			.199	21				
		Average			.420	21				
45	Jester, 1982	3							.491[c]	8
46	Kedia, 1976	2A[g]			.250	17				
47	Khandwalla, 1970; 1974	2A[g]							.080	79
49	Khandwalla, 1977	1							.430	103
	Khandwalla, 1977	2A[g]							.300	103
	Khandwalla, 1977	4							.550	103
		Average							.427	103
50	Kimberly & Rottman, 1987	3	.376	123						
51	Kmetz, 1975; 1977	1							-.041	131
53	Kmetz, 1981	1			.010[h]	27	.120[h]	27	.300[h]	27
	Kmetz, 1981	3			.037	27	.136	27	.113	27
		Average			.024	27	.128	27	.206	27
54	Kuc, Hickson & McMillan, 1981	2A			.670	11			.260	11
55	Leatt & Schneck, 1981	3								
57	Loveridge, 1982	3					-.080	62		
59	Mahmoudi & Miller, 1985	4							.610	10
60	Mark, 1982	1					.222[b,d]	86	.246[b,d]	86
	Mark, 1982	3					.266	81	.010	81
		Average					.244	84	.132	84
62	McMillan, Hickson, Hinings & Schneck, 1973	1			.130	24				
65	Miller & Droege, 1986	2A[g]			.190	93			-.095[f]	93
66	Mills, Turk & Margulies, 1987	3								
67	Mohr, 1971	1								
	Mohr, 1971	3								
		Average								

...ional ...ali- ...on r	...ional ...ali- ...on N	Standardization r	Standardization N	Formalization Overall r	Formalization Overall N	Formalization Roles r	Formalization Roles N	Vertical Span r	Vertical Span N	Centralization r	Centralization N	CEO Span of Control r	CEO Span of Control N	Supervisor's Span of Control r	Supervisor's Span of Control N
	21					.450	21								
	21					.225	21								
	21					.338	21								
				.491[c]	8					.144[c]	8				
	17					-.010	23			-.210	23				
				.080	79					-.110	79				
				.430	103					-.280[d]	103				
				.300	103					-.210	103				
				.550	103					-.400	103				
				.427	103					-.300	103				
				-.041	131	.390	131			.030	131				
	27	.120	27	.300	27					.240	27				
[h]	27	.136[h]	27	.113[h]	27					.028[h]	27				
	27	.128	27	.206	27					.134	27				
	11			.260	11					-.350	11				
						.103[b,d]	148			.090[b]	148				
		-.080	62							-.070	62				
				.610	10										
		.222	86	.246	86					-.003	86				
		.265[b,d]	81	.010[b,d]	81					.049[b,d]	81				
		.244	84	.132	84					.022	84				
	24					.060	24								
	93			-.095[f]	93			.220	93	-.020	93				
										.360	337				
										-.310[d]	144				
										.180[d]	144				
										-.065	144				

Table IV-1--continued

#	Study	Technology Concept[a]	Division of Labor r	N	Functional Speciali-zation r	N	Standardi-zation r	N	Formali Overall r	N
68	Moorhead, 1981	3								
69	Negandhi & Reimann, 1973	2A								
70	Paulson, 1980	3	-.390[d]	77	-.250[d]	77				
71	Payne & Mansfield, 1973	1			.680	14				
41	Aston Data Bank, 1976:[c] (Payne & Mansfield, 1969-70)	3[d]			.533	13				
		Average			.609	14				
72	Pennings, 1975	1	-.250[h]	40						
73	Pfeffer & Leblebici, 1977	4			.498[k]	38				
74	Piernot, 1979	3	.700	31					.630	31
75a	Pitsiladis, 1979	3	-.012[h]	16					-.034[h]	16
75b	Pitsiladis, 1979	3	-.206[h]	16					-.133[h]	16
75c	Pitsiladis, 1979	3	.185[h]	16					.039[h]	16
77	Reimann, 1972	1			-.024	19				
	Reimann, 1972	2A								
	Reimann, 1972	4								
78	Reimann, 1980	2A[g]			-.040	20				
	Reimann, 1980	4			.470	20				
4m	Aston Data Bank, 1976:[c] (Reimann, 1970-71)	3[d]			-.092	20				
		Average			.078	20				
80	Rousseau, 1978	1								
81	Routamaa, 1985	1			.200	122			.190	122
	Routamaa, 1985	4			.430	122			.300	122
		Average			.315	122			.245	122
83	Shenoy, 1981	2A			.450	35			.500	35
84	Shrader, 1984	3							.110[d]	36
85	Sutton & Rousseau, 1979	1							-.120	155
86	Tracy & Azumi, 1976	1								
	Tracy & Azumi, 1976	3								
		Average								

nctional eciali- ation		Standardi- zation		Formalization Overall		Formalization Roles		Vertical Span		Centrali- zation		CEO Span of Control		Supervisor's Span of Control	
	N	r	N	r	N	r	N	r	N	r	N	r	N	r	N
										.250	16				
										-.082	30				
250[d]	77														
680	14					.360	14					.390	14		
533	13					.235	13					-.234	13		
609	14					.300	14					.090	14		
498[k]	38							.539[k]	38						
				.630	31			.500	31						
				-.034[h]	16					.132[h]	16				
				-.133[h]	16					.255[h]	16				
				.039[h]	16					.202[h]	16				
024	19					-.336	19	.000	19	-.235[b]	19	.040	20		
										.297	19				
										-.178	19				
040	20					.470	20	.180	20			-.060	20	-.150	20
470	20					.320	20	.310	20			.070	20	.200	20
092	20					.545	20					.463	20		
078	20					.445	20	.166	20	-.039	19	.128	20	.025	20
						-.036[c]	19	.043[c]	19	-.276[c]	19				
200	122			.190	122			.160	122	-.040	122	.100	122	.080	122
430	122			.300	122			.260	122	-.060	122	.170	122	.040	122
315	122			.245	122			.210	122	-.050	122	.135	122	.060	122
450	35			.500	35					.320	35				
				.110[d]	36					.360	36				
				-.120	155					-.330	155				
						-.030	44								
						.070[d]	44								
						.020	44								

Table IV-1--continued

#	Study	Technology Concept[a]	Division of Labor r	N	Functional Speciali-zation r	N	Standardi-zation r	N	Formal Overall r	N
90	Van de Ven, Delbecq & Koenig, 1976	1							-.260[d]	197
	Van de Ven, Delbecq & Koenig, 1976	3							.490[d]	197
		Average							.115	197
91	Vazzana, 1987	4	.391	295			.288	299		
93	Williams, 1984	3							-.030[d]	100
95	Wong & Birnbaum, 1989	1			.006	39			.012	39
96	Woodward, 1965	2A								
97	Worley, 1983	2A	-.057[e]	36					.429[e]	36
98a	Zeffane, 1981	1			.465[b]	65				
	Zeffane, 1981	4			.622[b]	69				
		Average			.546	67				
98b	Zeffane, 1981	1			.178[b]	47				
	Zeffane, 1981	4			.424[b]	36				
		Average			.285	42				
98c	Zeffane, 1981	1			.590[b]	47				
	Zeffane, 1981	4			.718[b]	59				
		Average			.661	53				
99	Zwerman, 1970	2A								

[a] 1 = Workflow integration/automation; 2A = Production continuity; 2B = Throughput continuity; 3 = Task r

[b] Composite correlation computed. [c] Correlation calculated from raw data. [d] Sign reversed. [e] Computed r_{pb}.

[g] Mass output orientation scale developed by Khandwalla (1970). [h] Mean correlation for multiple measures.

[k] This is a partial correlation controlling for organization size.

ctional Speciali- tion		Standardi- zation		Formalization Overall		Formalization Roles		Vertical Span		Centrali- zation		CEO Span of Control		Supervisor's Span of Control	
	N	r	N	r	N	r	N	r	N	r	N	r	N	r	N
				-.260	197										
				<u>.490</u>[d]	<u>197</u>										
				.115	197										
		.288	299												
				-.030[d]	100					.070[d]	45				
06	39			.012	39			.042	39	-.061	39				
								.772[c]	50					-.231[c]	78
				.429[e]	36			.238[e]	36	.082[e]	36	.163[e]	36		
55[b]	65									.060	65				
<u>22</u>[b]	<u>69</u>									<u>-.120</u>	<u>66</u>				
16	67									-.031	66				
78[b]	47									-.200	47				
<u>24</u>[b]	<u>36</u>									<u>.050</u>	<u>36</u>				
35	42									-.092	42				
00[b]	47									.160	47				
<u>18</u>[b]	<u>59</u>									<u>.080</u>	<u>55</u>				
51	53									.117	51				
								.537[c]	54			.325[c]	52		

2B = Throughput continuity; 3 = Task routineness; 4 = Information technology.

data. [d]Sign reversed. [e]Computed r_{pb}. [f]Composite correlation with multiple measures.

an correlation for multiple measures. [i]Hierarchy of control index. [j]Concentration of authority.

Table IV-2. Correlations Included for Structural/Percentage Variables: Part I

#	Study	Technology Concept[a]	Direct Workers r	N	Workflow Supervisors r	N	Nonworkflow Personnel r	N	Supervisors r	N	Clerical Personne r	N
3	Al-Jibouri, 1983[b]	1	-.096	27	-.185	27	-.185	27			.191	
	Al-Jibouri, 1983	2A	-.190	27	-.090	27	-.090	27			.050	
	Al-Jibouri, 1983	4	.046	27	.209	27	.214	27			.597	
		Average	-.080	27	-.022	27	-.020	27			.279	
	Aston Data Bank, 1976											
4c	(McMillan, 1971)	1	.183	10								
	(McMillan, 1971)	2B	-.363	10								
	(McMillan, 1971)[c,d]	3	-.242	10								
		Average	-.142	10								
4d	(McMillan, 1972)	1	-.161	14								
	(McMillan, 1972)	2B	-.203	14								
	(McMillan, 1972)[c,d]	3	-.177	14								
		Average	-.180	14								
4e	(McMillan, 1972-73)	1	.168	47								
	(McMillan, 1972-73)	2B	.157	46								
	(McMillan, 1972-73)[c,d]	3	.246	47								
		Average	.190	47								
4h	(Tauber, 1967-68)	1	-.791	6	-.187	6	.732	6			.597	
	(Tauber, 1967-68)	2B	.791	6	.187	6	-.732	6			-.597	
		Average	.000	6	.000	6	.000	6			.000	
5	Ayoubi, 1975	1	.010	34	-.010	34	-.020	34			.400	3
	Ayoubi, 1975	2A	-.630	34	.270	34	.600	34			.430	3
		Average	-.310	34	.130	34	.290	34			.415	3
11	Blau, 1973	1									.080	11
	Blau, 1973	4									.235	11
		Average									.158	11
12	Blau, Falbe, McKinley & Tracy, 1976	1	-.090	110			-.080	110	.040	110	-.150	11
	Blau, Falbe, McKinley & Tracy, 1976	2A	-.210	110			.010	110	.140	110	.020	11
	Blau, Falbe, McKinley & Tracy, 1976	4	-.150	110			.330	110	.220	110	.270	11
		Average	-.150	110			.087	110	.133	110	.047	11
13a	Blau & Schoenherr, 1971[e]	4							-.305	51	-.016	5
13c	Blau & Schoenherr, 1971	4							-.147	1201	-.022	120
15	Carter, 1981[b]	1							-.089	61		
16	Carter, 1981; 1984	4							-.058	61		
		Average							-.073	61		

ructural/Percentage Variables: Part I

ect ers		Workflow Super-visors		Nonwork-flow Personnel		Super-visors		Clerical Personnel		Public Relations & Advertising		Sales & Service		Transpor-tation		Personnel		Training & Devel-opment	
r	N	r	N	r	N	r	N	r	N	r	N	r	N	r	N	r	N	r	N
6	27	-.185	27	-.185	27			.191	27	-.185	27	-.178	27	-.123	27	-.171	27	-.178	27
0	27	-.090	27	-.090	27			.050	27	-.090	27	-.090	27	-.070	27	-.080	27	-.090	27
6	27	.209	27	.214	27			.597	27	.203	27	.197	27	.209	27	.203	27	.203	27
0	27	-.022	27	-.020	27			.279	27	-.024	27	-.024	27	.005	27	-.016	27	-.022	27
3	10																		
3	10																		
2	10																		
2	10																		
1	14																		
3	14																		
7	14																		
0	14																		
3	47																		
7	46																		
6	47																		
0	47																		
1	6	-.187	6	.732	6			.597	6			.068	6	-.258	6			-.141	6
1	6	.187	6	-.732	6			-.597	6			-.068	6	.258	6			.141	6
0	6	.000	6	.000	6			.000	6			.000	6	.000	6			.000	6
0	34	-.010	34	-.020	34			.400	34			-.050	34	.340	34				
0	34	.270	34	.600	34			.430	34			.220	34	.260	34				
0	34	.130	34	.290	34			.415	34			.085	34	.300	34				
								.080	115										
								.235	115										
								.158	115										
	110			-.080	110	.040	110	-.150	110										
	110			.010	110	.140	110	.020	110										
	110			.330	110	.220	110	.270	110										
	110			.097	110	.133	110	.047	110										
						-.305	51	-.016	53										
						-.147	1201	-.022	1201										
						-.089	61												
						-.058	61												
						-.073	61												

Table IV-2--continued

#	Study	Technology[a] Concept	Direct Workers r	N	Workflow Super-visors r	N	Nonwork-flow Personnel r	N	Super-visors r	N	Clerical Personnel r	N
18	Child & Mansfield, 1972	1	.230	82	-.180	82	-.170	82				
	Child & Mansfield, 1972	2A	.000	40	-.140	40	.040	40				
4i	Aston Data Bank, 1976:											
	(Child, 1967-69)	1							-.232	80	-.321	8
	(Child, 1967-69)	2A							-.150	54	-.078	5
	(Child, 1967-69)[c,d]	3	.036	81	-.270	81	.045	81	-.244	80	-.124	8
	(Child, 1967-69)	4	-.243	81	-.116	81	.268	81	-.048	81	.199	8
		Average	.007	71	-.182	71	.046	71	-.170	74	-.081	7
22	Cox, 1981	2A			-.212	20						
37	Harvey, 1965	3							.760[c]	43		
38	Hickson, Pugh & Pheysey, 1969	1	-.180	46	-.530	46	.340	46				
	Hickson, Pugh & Pheysey, 1969	2A	-.140	31	.130	31	.220	31				
4k	Aston Data Bank, 1976:											
	(Pugh et al., 1962-63)	1									.051	5
	(Pugh et al., 1962-63)	2A									.052	3
	(Pugh et al., 1962-63)[c,d]	3	-.063	52	.182	52	-.002	52			.184	5
		Average	-.123	43	-.084	43	.173	43			.101	4
39	Hinings & Lee, 1971	1			.160	9	.150	9			-.380	[illegible]
	Hinings & Lee, 1971	2A			-.320	9	-.360	9			-.220	[illegible]
4j	Aston Data Bank, 1976:											
	(Lee, 1966-67)	1	-.177	10								
	(Lee, 1966-67)	2A	.418	10								
	(Lee, 1966-67)[c,d]	3	-.314	10	-.306	10	.331	10			.713	1
		Average	-.024	10	-.161	9	.051	9			.062	[illegible]
41	Hsu, Marsh & Mannari, 1983	1	-.480	50			.170	50	.260	50	.090	5
	Hsu, Marsh & Mannari, 1983	2A	-.420	50			.380	50	-.070	50	.070	5
		Average	-.450	50			.275	50	.095	50	.080	5
45	Jester, 1982	3							.154[c]	8		
55	Leatt & Schneck, 1981; 1982	3									-.212[d]	148
65	Miller & Droege, 1986	2A							-.060	93		
77	Reimann, 1972	1					-.059	19				
	Reimann, 1972	2A					.447	19				
78	Reimann, 1972; 1980	4					.332	19				
		Average					.240	19				
81	Routamaa, 1985	1							-.050	122	.160	122
	Routamaa, 1985	4							-.160	122	.090	122
		Average							-.105	122	.125	122
96	Woodward, 1965	2A	-.680[c]	75								

[a]1 = Workflow integration/automation; 2A = Production continuity; 2B = Throughput continuity; 3 = Task

[b]Composite correlation computed. [c]Correlation calculated from raw data. [d]Sign reversed. [e]Composite c

Workflow Supervisors r	N	Nonworkflow Personnel r	N	Supervisors r	N	Clerical Personnel r	N	Public Relations & Advertising r	N	Sales & Service r	N	Transportation r	N	Personnel r	N	Training & Development r	N
-.180	82	-.170	82									.550	82	.050	82		
-.140	40	.040	40									.680	40	.210	40		
				-.232	80	-.321	81	.360	81	.050	81					.153	82
				-.150	54	-.078	54	.080	53	.019	53					.127	54
-.270	81	.045	81	-.244	80	-.124	81	.351	81	.337	81	.328	79	.090	82	.225	82
-.116	81	.268	81	-.048	81	.199	81	.147	81	-.048	81	-.308	79	.386	82	.293	82
-.182	71	.046	71	-.170	74	-.081	74	.249	74	.096	74	.264	70	.180	72	.206	75
-.212	20																
				.760[c]	43												
-.530	46	.340	46									.190	46	-.030	46		
.130	31	.220	31									.450	31	.040	31		
						.051	52	-.035	52	.246	52					.075	52
						.052	36	.036	36	.135	36					.315	36
.182	52	-.002	52			.184	52	.021	52	.175	52	.103	52	-.215	52	.124	52
-.084	43	.173	43			.101	47	.004	47	.191	47	.217	43	-.088	43	.155	47
.160	9	.150	9			-.380	9										
-.320	9	-.360	9			-.220	9										
-.306	10	.331	10			.713	10										
-.161	9	.051	9			.062	9										
		.170	50	.260	50	.090	50										
		.350	50	-.070	50	.070	50										
		.275	50	.095	50	.080	50										
				.154[c]	8												
						-.212[d]	148										
				-.060	93												
		-.059	19														
		.447	19														
		.332	19														
		.240	19														
				-.050	122	.160	122										
				-.160	122	.090	122										
				-.105	122	.125	122										

inuity; 2B = Throughput continuity; 3 = Task routineness; 4 = Information technology.

from raw data. [d]Sign reversed. [e]Composite correlation with multiple measures.

Table IV-3. Correlations Included for Structural/Percentage Variables: Part II

#	Study	Technology[a] Concept	Welfare & Security r	N	Purchasing & Stock Control r	N	Facility Mainte- nance r	N	Financial Control r	N	Workflow Planning & Control r	N
3	Al-Jibouri, 1983[b]	1	.120	27	.120	27	.062	27	-.191	27	-.185	27
	Al-Jibouri, 1983	2A	-.050	27	-.090	27	.060	27	-.090	27	-.090	27
	Al-Jibouri, 1983	4	.203	27	.203	27	.377	27	.191	27	.203	27
		Average	.081	27	.078	27	.166	27	-.028	27	-.024	27
4h	Aston Data Bank, 1976:											
	(Tauber, 1967-68)	1	.395	6	.053	6	-.532	6	-.969	6		
	(Tauber, 1967-68)	2B	-.395	6	-.053	6	.532	6	.969	6		
		Average	.000	6	.000	6	.000	6	.000	6		
5	Ayoubi, 1975	1			-.060	34	.310	34	.120	34		
	Ayoubi, 1975	2A			.300	34	.410	34	.220	34		
		Average			.120	34	.360	34	.170	34		
11	Blau, 1973	1										
	Blau, 1973	4										
		Average										
12	Blau, Falbe, McKinley & Tracy, 1976	1					.240	110				
	Blau, Falbe, McKinley & Tracy, 1976	2A					.430	110				
	Blau, Falbe, McKinley & Tracy, 1976	4					-.180	110				
		Average					.163	110				
13a	Blau & Schoenherr, 1971[c]	4										
18	Child & Mansfield, 1972	1			.070	82	.690	82			-.360	82
	Child & Mansfield, 1972	2A			-.200	40	.540	40			-.650	40
4i	Aston Data Bank, 1976:											
	(Child, 1967-69)	1	.466	80					-.264	80		
	(Child, 1967-69)[d,e]	2A	.411	52					.181	52		
	(Child, 1967-69)	3	.178	80	.001	79	.435	78	-.138	80	-.230	79
	(Child, 1967-69)	4	.197	80	.284	79	.055	78	.164	80	.027	79
		Average	.304	73	.072	70	.419	70	-.033	74	-.256	70
32	Freeman, 1973	1										
38	Hickson, Pugh & Phevsey, 1969	1			-.050	46	-.010	46			.270	46
	Hickson, Pugh & Phevsey, 1969	2A			-.100	31	.200	31			-.440	31
4k	Aston Data Bank, 1976:											
	(Pugh et al., 1962-63)	1	.131	52					-.103	52		
	(Pugh et al., 1962-63)[d,e]	2A	.271	36					.141	36		
	(Pugh et al., 1962-63)	3	.053	52	-.030	52	.018	52	.227	52	-.125	52
		Average	.138	47	-.054	43	.052	43	.082	47	-.061	43

/Percentage Variables: Part II

hasing Stock trol r	N	Facility Mainte- nance r	N	Financial Control r	N	Workflow Planning & Control r	N	Quality Evaluation & Control r	N	Work Study r	N	Design & Devel- opment r	N	Adminis- tration r	N	Legal & Insurance r	N	Market Research r	N
.20	27	.062	27	-.191	27	-.185	27	-.171	27	.123	27	-.185	27	.157	27			-.185	27
'90	27	.060	27	-.090	27	-.090	27	-.080	27	-.190	27	-.090	27	.190	27			-.090	27
:03	27	.377	27	.191	27	.203	27	.208	27	.267	27	.203	27	-.185	27			.203	27
'78	27	.166	27	-.028	27	-.024	27	-.014	27	.067	27	-.024	27	.054	27			-.024	27
53	6	-.532	6	-.969	6			.717	6			.298	6						
53	6	.532	6	.969	6			-.717	6			-.298	6						
00	6	.000	6	.000	6			.000	6			.000	6						
60	34	.310	34	.120	34			.250	34					.100	34				
00	34	.410	34	.220	34			.370	34					.310	34				
20	34	.360	34	.170	34			.310	34					.205	34				
														-.031	115				
														-.202	115				
														-.116	115				
		.240	110											-.040	110				
		.430	110											-.070	110				
		-.180	110											.300	110				
		.163	110											.063	110				
														-.270	52				
70	82	.690	82			-.360	82	.340	82	-.030	82	.090	82						
00	40	.540	40			-.650	40	-.470	40	-.490	40	-.210	40						
				-.264	50									-.066	81	.040	82	.188	81
				.181	52									.337	53	.212	54	.303	53
01	79	.435	78	-.138	50	-.230	79	.265	79	.124	79	.170	81	.080	81	.118	82	.313	81
34	79	.055	78	.164	80	.027	79	.390	79	.020	79	.201	81	.244	81	.181	82	.209	81
72	70	.419	70	-.033	74	-.256	70	.217	70	-.038	70	.102	71	.125	74	.131	75	.248	74
														.245	33				
i0	46	-.010	46			.270	46	.390	46	.380	46	.450	46						
00	31	.200	31			-.440	31	-.150	31	-.030	31	-.180	31						
				-.103	52									-.110	52	-.005	57	.047	52
				.141	36									-.072	36	.473	36	.002	36
10	52	.018	52	.227	52	-.129	52	-.405	52	-.269	52	-.299	52	.090	52	.371	52	.028	52
i4	43	.052	43	.082	47	-.061	43	-.060	43	.020	43	-.003	43	-.026	47	.258	47	.028	47

Table IV-3--continued

#	Study	Technology[a] Concept	Welfare & Security r	N	Purchasing & Stock Control r	N	Facility Mainte-nance r	N	Financial Control r	N	Workflo Plannin & Contr r
77	Reimann, 1972	1									
78	Reimann, 1980	2A					.460	20			.040
	Reimann, 1972; 1980	4					.330	20			.490
		Average					.395	20			.265
81	Routamaa, 1985	1									
	Routamaa, 1985	4									
		Average									
86	Tracy & Azumi, 1976	1									
	Tracy & Azumi, 1976	3									
		Average									
96	Woodward, 1965	2A									

[a]1 = Workflow integration/automation; 2A = Production continuity; 2B = Throughput continuity; 3 = Ta

[b]Composite correlation computed.

[c]Composite correlation with multiple measures.

[d]Correlation calculated from raw data.

[e]Sign reversed.

...asing ...ock ...rol N	Facility Mainte-nance r	N	Financial Control r	N	Workflow Planning & Control r	N	Quality Evaluation & Control r	N	Work Study r	N	Design & Devel-opment r	N	Adminis-tration r	N	Legal & Insurance r	N	Market Research r	N
													.088	19				
	.460	20			.040	20					-.050	20	.060	20				
	.330	20			.490	20					.390	20	.550	20				
	.395	20			.265	20					.170	20	.235	20				
													.020	122				
													.030	122				
													.025	122				
													.120	44				
													-.140[e]	44				
													-.010	44				
													.507[d]	75				

...y; 2B = Throughput continuity; 3 = Task routineness; 4 = Information technology.

Table IV-4. Range Restriction/Enhancement for Workflow Continuity Measures

Study	Production Continuity Scale Ranges 1 - 3 s.d.	1 - 3 N	1 - 5 s.d.	1 - 5 N	1 - 7 s.d.	1 - 7 N	1 - 10 s.d.	1 - 10 N	U = s / S Scale Ranges 1 - 3	1 - 5	1 - 7	1 - 10	Range Restriction (Woodward as a Reference)	Artifact[a] Distribution Used
Aston Data Bank, 1976														
(Child, 1967-69)							2.029	54				.709	.709	.979
(Lee, 1966-67)							1.059	9				.370	.370	.511
(Pugh et al., 1962-63)							2.140	36				.747	.747	1.032
Ayoubi, 1975							2.310	34				.807	.807	1.115
Cox, 1981			.842	20						.560			.560	.773
Kedia, 1976			.420	23						.280			.280	.387
Khandwalla, 1970; 1974			1.200	79						.799			.799	1.104
McKinley, 1987					1.550	110					.699		.699	.965
Miller & Droege, 1986			1.800	50						1.198			1.198	1.655
Negandhi & Reimann, 1973	.780	80							.991				.991	1.369
Reimann, 1972					1.727	19					.779[b]		.762	1.052
Reimann, 1980			1.118	19						.744[b]				
Worley, 1983	.500	36							.635				.635	.877
Zwerman, 1970	.634	54							.805				.805	1.112
Woodward, 1965[c]	.787	80	1.502	80	2.216	80	2.863	83	1.00	1.00	1.00	1.00	1.00	1.381

[a]This actual distribution used for range restriction in measures of workflow continuity uses the average level of range restriction in two studies as a reference (Child, 1967-69; Pugh et al., 1962-63). This was accomplished by dividing the values in the column using Woodward, 1965 as a reference by the average value of U for those two studies (i.e., .724). This process provides a distribution using the same reference studies as used for other technology measures.

[b]Reimann, 1972 and Reimann, 1980 use the same data set with different scales of production continuity. Both scales reveal approximately equal degrees of range restriction when compared to Woodward, 1965. The mean value of U is used in the artifact distribution (i.e., .762).

[c]Woodward provides the frequency distribution for her sample of organizations on an 11-point scale of technical complexity (Woodward, 1965: 39). This data was distributed on a 3-point scale, a 5-point scale, a 7-point scale, and a 10-point scale. This procedure allows each of the other studies that use versions of the Woodward scale to be compared to the Woodward sample for determining the extent of range restriction.

Table IV-5. Range Restriction/Enhancement for Workflow Integration and Automation

Study	Number of Items	Scale[b]	Mean	Total s.d.	Total N	Manufacturing s.d.	Manufacturing N	Service s.d.	Service N	U = s / $\bar{S}$ Calculated for Scale: $\bar{S}$=3.665 Full[c]	$\bar{S}$=2.353 SKO	$\bar{S}$=2.295 Automaticity	Distribution Used[a]: Total	Manufacturing	Service
Aston Data Bank, 1976															
(Child, 1967-69)	3	SKO	5.46	2.195	82	1.73	55	1.649	27		.933		.933	.735	.701
(Child, 1967-69)	5	FULL-O	9.68	3.344	82	2.664	55	1.866	27	.912					
(Glueck, 1970-71)	3	SKO	4.25	1.815	12	n.a.		1.815	12		.771		.771		.771
(Hickson & Inkson, 1967-68)	3	SKO	5.43	2.68	44	1.524	30	2.377	14		1.139		1.139	.648	1.010
(Kieser, 1970-72)	3	SKO	5.55	1.419	51	1.419	51	n.a.			.603		.603	.603	
(Kieser, 1970-72)	5	FULL-O	10.51	2.302	51	2.302	51	n.a.		.628					
(Lee, 1966-67)	3	SKO	6.89	1.167	9	1.167	9	n.a.			.496		.496	.496	
(Lee, 1966-67)	5	FULL-O	11.20	1.476	9	1.476	9	n.a.		.403					
(McMillan, 1971)	3	SKO	5.58	2.109	12	2.109	12	n.a.			.896		.896	.896	
(McMillan, 1971)	5	FULL-O	12.83	2.082	12	2.082	12	n.a.		.568					
(McMillan, 1972)	3	SKO	6.71	2.164	14	2.164	14	n.a.			.920		.920	.920	
(McMillan, 1972)	5	FULL-O	13.07	2.556	14	2.556	14	n.a.		.697					
(McMillan, 1972-73)	3	SKO	5.71	1.307	49	1.307	49	n.a.			.555		.555	.555	
(McMillan, 1972-73)	5	FULL-O	11.16	2.721	50	2.721	50	n.a.		.742					
(Payne & Mansfield, 1969-70)	3	SKO	6.29	2.234	14	2.234	14	n.a.			.949		.949	.949	
(Pheysey, 1971-72)	3	SKO	7.10	2.846	10	2.846	10	n.a.			1.210		1.210	1.210	
(Pheysey & Payne, 1967-69)	3	SKO	6.50	2.121	2	2.121	2	n.a.			.901		.901	.901	
(Pheysey & Payne, 1967-69)	5	FULL-O	12.50	4.950	2	4.950	2	n.a.		1.351					
(Pugh et al., 1962-63)	3	SKO	5.83	2.324	52	1.142	37	2.072	15		.988		.988	.485	.881
(Pugh et al., 1962-63)	5	FULL-O	10.65	4.172	52	2.63	37	3.335	15	1.138					
(Pugh & Loveridge, 1971)	2	auto	6.13	2.029	16	2.035	15	n.a.	1			.884	.884	.884	

Table IV-5--continued

Study	Number of Items	Scale[b]	Mean	Total s.d.	Total N	Manufacturing s.d.	Manufacturing N	Service s.d.	Service N	U = s / $\bar{S}$ Calculated for Scale: $\bar{S}$=3.665 Full[c]	$\bar{S}$=2.353 SKO	$\bar{S}$=2.295 Automaticity	Distribution Used[a] Total	Distribution Used[a] Manufacturing	Distribution Used[a] Service
(Reimann, 1970-71)	3	SKO	7.80	1.281	20	1.281	20	n.a.			.544		.544	.544	
(Schwitter, 1968)	3	SKO	7.48	1.327	21	1.327	21	n.a.			.564		.564	.564	
(Tauber, 1967-68)	3	SKO	3.33	1.033	6	n.a.		1.033	6		.439		.439		.439
(Tauber, 1967-68)	5	FULL-O	5.00	1.549	6	n.a.		1.549	6	.423					
Hsu, Marsh & Mannari, 1983	2	auto	5.12	2.050	50	2.050	50	n.a.				.893	.893	.893	
Rousseau, 1978	2	auto	6.68	2.670	44	2.670	44	n.a.				1.163	1.163	1.163	

[a] Only the SKO and automaticity scales were used to develop this artifact distribution. The reference standard deviation for the automaticity scale is the sample weighted average for the three studies using that scale. The reference for the SKO is the weighted average of three studies (Child, 1967-69; Hickson & Inkson, 1967; Pugh et al., 1962-63). These three studies are those including both manufacturing and service firms. Manufacturing and service distributions use the same reference studies.

[b] Full-O refers to the original 5-items scale of workflow integration included in the Aston scales of measure (Pugh, Hickson, Hinings, & Turner, 1969) while SKO refers to the 3-item abbreviated scale (Inkson, Pugh & Hickson, 1970). Other researchers measure only the extent of automaticity (i.e., auto).

[c] Information only. Not used in artifact distribution.

Table IV-6. Range Restriction/Enhancement for Task Variability[a]

Study	Total s.d.	Total N	Manufacturing s.d.	Manufacturing N	Service s.d.	Service N	Distribution Used[b] U = s / $\bar{S}$ Total	Manufacturing	Service
Aston Data Bank, 1976									
(Child, 1967-69)	1.057	82	1.058	55	.724	27	.953	.954	.653
(Glueck, 1970-71)	.937	12			.937	12	.845		.845
(Hickson & Inkson, 1967-68)	1.033	44	1.020	30	1.051	14	.931	.920	.948
(Lee, 1966-67)	1.302	9	1.302	9			1.174	1.174	
(McMillan, 1971)	1.311	12	1.311	12			1.182	1.182	
(McMillan, 1972)	1.099	14	1.099	14			.991	.991	
(McMillan, 1972-73)	.994	50	.994	50			.896	.896	
(Payne & Mansfield, 1969-70)	1.144	13	1.144	13			1.032	1.032	
(Pheysey, 1971-72)	1.075	10	1.075	10			.969	.969	
(Pugh et al., 1962-63)	1.256	52	1.206	37	1.234	15	1.133	1.087	1.113
(Reimann, 1970-71)	.875	20	.875	20			.789	.789	
(Schwitter, 1968)	1.136	21	1.136	21			1.024	1.024	

[a]This distribution will be used as a surrogate for the range restriction in measures of task routineness. The scale used is the measure of customer orientation in the Aston scales (Aston Data Bank, 1977). Tracy and Azumi (1976) used this as a measure of task variability. Collins and Hull (1986) used a similar measure for task variability.

[b]The reference standard deviation for this distribution was calculated in the same manner as for workflow integration and automation. A weighted average standard deviation for three studies was used (Child, 1967-69; Hickson & Inkson, 1967-68; Pugh et al., 1962-63). The reference used is $\bar{S}$ = 1.109.

Table IV-7. Reliability Coefficients for Measures of Technology: Workflow Continuity

Study	R_{xx}
Aston Data Bank, 1976	
(Child, 1967-69)	.62[a]
(Lee, 1966-67)	.96[a]
(Pugh et al., 1962-63)	.99[a]
Ayoubi, 1975, 1981	.52[a]
Reimann, 1972, 1980	.92[b]

[a]Correlation between workflow continuity scale and throughput continuity in manufacturing organizations.

[b]Correlation between a 7-point version of Woodward's scale (Reimann, 1972) and a 5-point version of Khandwalla's scale (Reimann, 1977a). Data from each was used to calculate this correlation.

Table IV-8. Reliability Coefficients for Measures of Technology: Workflow Integration, Automation, and Interdependence

Study	Technology Measure	R_{XX}
Al-Jibouri, 1983	Production Automation	.87
Aston Data Bank, 1976		
(Child, 1969)	Workflow integration	.42
(Glueck, 1970-71)	Workflow integration	.69
(Hickson & Inkson, 1967-68)	Workflow integration	.82
(Kieser, 1970-72)	Workflow integration	.32
(McMillan, 1971)	Workflow integration	.68
(McMillan, 1972)	Workflow integration	.72
(McMillan, 1972-73)	Workflow integration	.33
(Pheysey, 1971-72)	Workflow integration	.81
(Pheysey & Payne, 1967-69)	Workflow integration	.89
(Pugh et al., 1962-63)	Workflow integration	.84
(Pugh & Loveridge, 1971)	Workflow integration	.84
(Reimann, 1970-71)	Workflow integration	.27
(Schwitter, 1968)	Workflow integration	.30
(Tauber, 1967-68)	Workflow integration	.89
Ayoubi, 1975, 1981	Workflow integration	.89
Ayoubi, 1975, 1981	Workflow rigidity	.86
Ayoubi, 1975, 1981	Production automation	.92
Carter, 1981, 1984	Production automation	.92
Fry & Slocum, 1984	Interdependence	.66
Lynch, 1974	Interdependence	.50
Pennings, 1975	Interdependence	.49
Van de Ven, 1977	Interdependence	.85

Table IV-9. Reliability Coefficients for Measures of Technology: Task Routineness

Study	R_{xx}
Routineness:	
Davis, 1985	.69
Glisson, 1978	.69
Loveridge, 1982	.80
Lynch, 1974	.90
Shrader, 1984	.81
Withey, Daft & Cooper, 1983	.34
Variety:	
Aiken, Bacharach & French, 1980	.70
Alexander & Randolph, 1985	.75
Daft & Macintosh, 1981	.77
Dewar & Simet, 1981	.90
Dewar, Whetten & Boje, 1980	.74
Dewar, Whetten & Boje, 1980	.82
Fernandez, 1974	.50
Ford, 1975	.85
Fry & Slocum, 1984	.80
Hrebiniak, 1974	.72
Leatt & Schneck, 1981	.90
Loveridge, 1982	.82
Lynch, 1974	.50
Ramsey, 1979	.48
Ramsey, 1979	.40
Van de Ven & Delbecq, 1974	.89
Victor & Blackburn, 1987	.81
Withey, Daft & Cooper, 1983	.75
Withey, Daft & Cooper, 1983	.54
Withey, Daft & Cooper, 1983	.69
Withey, Daft & Cooper, 1983	.51
Withey, Daft & Cooper, 1983	.81

Table IV-9--continued

Study	R_{xx}
Task analyzability:	
Daft & Macintosh, 1981	.86
Fernandez, 1974	.51
Fry & Slocum, 1984	.64
Hrebiniak, 1974	.59
Loveridge, 1982	.81
Lynch, 1974	.70
Victor & Blackburn, 1987	.82
Withey, Daft & Cooper, 1983	.78
Withey, Daft & Cooper, 1983	.38
Withey, Daft & Cooper, 1983	.73
Withey, Daft & Cooper, 1983	.68
Withey, Daft & Cooper, 1983	.85
Task complexity:	
Middlemist & Hitt, 1981	.70
Task difficulty:	
Van de Ven & Delbecq, 1974	.86
Task instability:	
Leatt & Schneck, 1981	.82
Withey, Daft & Cooper, 1983	.71
Task uncertainty:	
Drazin & Van de Ven, 1985	.84
Leatt & Schneck, 1981	.82
Lynch, 1974	.30
Mills, Turk & Margulies, 1987	.65
Van de Ven, 1977	.92

Table IV-10. Reliability Coefficients for Measures of Technology: Automation of Information Processing

Study	R_{xx}
Al-Jibouri, 1983	.85
Aston Data Bank, 1976 (Child, 1967-69)	.64
Blau & Schoenherr, 1971	.79
Carter, 1981, 1984	.68
Conaty, Mahmoudi & Miller, 1983	.85
Conaty, Mahmoudi & Miller, 1983	.91
Vazzana, 1987	.92

Table IV-11. Sources of Reliability Coefficients for Measures of Structural Variables

Study	Division of Labor	Functional Speciali-zation	Standard-ization	Formalization Overall	Formalization Roles	Central-ization
Aiken, Bacharach & French, 1980						.900
Alexander & Randolph, 1985			.610			.740
Al-Jibouri, 1983		.930	.970	.930		
Aston Data Bank, 1976						
(Child, 1967-69)	.921	.802	.897	.845	.719	.837
(Glueck, 1970-71)		.720			.643	
(Hickson & Inkson, 1967-68)		.806			.673	
(Hinings, 1972)			.723		.501	
(Kieser, 1970-72)	.906					.887
(Lee, 1966-67)	.917	.859	.940	.896	.502	.927
(McMillan, 1971)				.795	.818	.872
(McMillan, 1972)				.862	.784	.750
(McMillan, 1972-73)				.927	.831	.923
(Payne & Mansfield, 1969)		.679			.635	
(Pheysey, 1971-72)		.897			.732	
(Pheysey & Payne, 1967-69)			.946	.963	.973	.872
(Pugh et al., 1962-63)		.829			.791	
(Pugh & Loveridge, 1971)		.851			.572	
(Reimann, 1970-71)		.701			.660	
(Schwitter, 1968)		.872			.457	
(Tauber, 1967-68)			.156	.496	.814	
Ayoubi, 1975		.940	.950	.930		.840
Carter, 1981, 1984						.792
Comstock & Scott, 1977				.827		
Conaty, Mahmoudi & Miller, 1983		.860	.880	.860		.880
Conaty, Mahmoudi & Miller, 1983		.840	.900	.900		.900
Davis, 1985		.770		.960		
Dewar, Whetten & Boje, 1980				.760		.950
Dewar, Whetten & Boje, 1980				.760		.920
Dewar, Whetten & Boje, 1980						.930
Dewar, Whetten & Boje, 1980				.450		.810

Table IV-11--continued

Study	Division of Labor	Functional Speciali- zation	Standard- ization	Formalization Overall	Formalization Roles	Central- ization
Drazin & Van de Ven, 1985		.850	.800	.680		
Duncan, 1971				.527		.496
Fernandez, 1974						.500
Ford, 1975	.730			.793		.855
Fry & Slocum, 1984				.700		.650
Glisson, 1978	.750			.790		.880
Hrebiniak, 1974						.790
Khandwalla, 1970, 1974				.770		.860
Khandwalla, 1977				.800		.810
Kmetz, 1975, 1977				.810	.920	.850
Loveridge, 1982			.750			.760
Lynch, 1974				.700		
McKinley, 1987						.850
Miller & Droege, 1986		.800		.650		.820
Miller & Droege, 1986				.780		
Mills, Turk & Margulies, 1987				.650		.780
Pitsiladis, 1979	.482			.715		.689
Ramsey, 1979				.782		.794
Rousseau, 1978						
Sathe, 1978	.704			.826		.883
Shrader, 1984				.600		.780
Ungson, 1978						.730

Table IV-12. Study Attributes

#	Study	Technology[a] Concept	Size	Type	Level of Analysis	Type of Measure
3	Al-Jibouri, 1983	1, 2A, 4	<1,000	Manuf.	Organization	Inst.
	Aston Data Bank, 1976					
4a	(Glueck, 1970-71)	1, 3	547	Serv.	Organization	Inst.
4b	(Hickson & Inkson, 1967-68)	1, 3	2,616	Mixed[b]	Organization	Inst.
4c	(McMillan, 1971)	1, 2B, 3	515	Manuf.	Organization	Inst.
4d	(McMillan, 1972)	1, 2B, 3	639	Manuf.	Organization	Inst.
4e	(McMillan, 1972-73)	1, 2B, 3	947	Manuf.	Organization	Inst.
4f	(Pheysey, 1971-72)	1, 3	3,045	Manuf.	Organization	Inst.
4g	(Pugh & Loveridge, 1971)	1	17,559	Mixed[b]	Organization	Inst.
4h	(Tauber, 1967-68)	1, 2B	868	Serv.	Organization	Inst.
5	Ayoubi, 1975; 1981	1, 2A	234	Manuf.	Organization	Inst.
7	Badran & Hinings, 1981	1	1,375	Mixed	Organization	Inst.
8	Beckett, 1972	3	25	Serv.	Organization	Ques.
9	Bell, 1967	3	<1,000	Serv.	Subunit	Ques.
10	Beyer & Trice, 1979	3	<1,000	Serv.	Organization	Ques.
11	Blau, 1973	1, 4	304	Serv.	Organization	Inst.
12	Blau, Falbe, McKinley & Tracy, 1976	1, 2A, 4	497	Manuf.	Organization	Inst.
42	Hull & Collins, 1987	1	497	Manuf.	Organization	Inst.
61	McKinley, 1987	2A	497	Manuf.	Organization	Inst.
13a	Blau & Schoenherr, 1971 (n=53)	4	1,194	Serv.	Organization	Inst.
13b	Blau & Schoenherr, 1971 (n=416)	4	70	Serv.	Subunit	Inst.
13c	Blau & Schoenherr, 1971 (n=1201)	4	26	Serv.	Subunit	Inst.
14 17	Budde, Child, Francis, & Kieser, 1982; Child & Kieser, 1979	1	920	Manuf.	Organization	Inst.
15	Carter, 1981; 1984	1, 4	177	Mixed[c]	Organization	Inst.
18	Child & Mansfield, 1972	1	1,542	Mixed[b]	Organization	Inst.
4i	Aston Data Bank, 1976: (Child, 1967-69)	1, 3, 4	1,542	Mixed[b]	Organization	Inst.
18	Child & Mansfield, 1972	2A	1,687	Manuf.	Organization	Inst.
4i	Aston Data Bank, 1976: (Child, 1967-69)	2A	1,687	Manuf.	Organization	Inst.
19	Collins & Hull, 1986	3	246	Manuf.	Subunit	Inst.
20	Comstock & Scott, 1977	1, 3	24	Serv.	Subunit	Ques.

Table IV-12--continued

#	Study	Technology[a] Concept	Size	Type	Level of Analysis	Type of Measure
21a	Conaty, Mahmoudi & Miller, 1983	1, 4	582	Mixed	Organization	Inst.
21b	Conaty, Mahmoudi & Miller, 1983	1, 4	251	Mixed	Organization	Inst.
22	Cox, 1981	2A	38,036	Manuf.	Subunit	Inst.
24	Davis, 1985	3	n.a.	Serv.	Organization	Inst.
25	Dewar & Hage, 1978	3	188	Serv.	Organization	Inst.
30	Fernandez, 1974	3	28	Serv.	Organization	Inst.
31	Ford, 1975	1	<1,000	Mixed	Organization	Inst.
	Ford, 1975	3	<1,000	Mixed	Organization	Ques.
32	Freeman, 1973	1	<1,000	Manuf.	Organization	Inst.
33	Fry & Slocum, 1984	1, 3	<1,000	Serv.	Subunit	Ques.
34	Garthright, 1981	3	<1,000	Manuf.	Subunit	Ques.
35	Glisson, 1978	3	n.a.	Serv.	Organization	Ques.
36	Hage & Aiken, 1969	3	188	Serv.	Organization	Ques.
37	Harvey, 1968	3	<1,000	Manuf.	Organization	Inst.
38	Hickson, Pugh & Pheysey, 1969	1	3,370	Mixed[b]	Organization	Inst.
4k	Aston Data Bank, 1976: (Pugh et al., 1962-63)	1, 3	3,370	Mixed[b]	Organization	Inst.
38	Hickson, Pugh & Pheysey, 1969	2A	3,411	Manuf.	Organization	Inst.
4k	Aston Data Bank, 1976: (Pugh et al., 1962-63)	2A	3,411	Manuf.	Organization	Inst.
39	Hinings & Lee, 1971	1, 2A	1,187	Manuf.	Organization	Inst.
4j	Aston Data Bank, 1976: (Lee, 1966-67)	1, 2A, 3	1,187	Manuf.	Organization	Inst.
40	Hrebiniak, 1974	1, 3	n.a.	Serv.	Individual	Ques.[d]
41	Hsu, Marsh & Mannari, 1983	1, 2A	687	Manuf.	Organization	Inst.
43	Inkson, Pugh & Hickson, 1970	1	2,616	Mixed	Organization	Inst.
44	Inkson, Schwitter, Pheysey & Hickson, 1970	1	5,150	Manuf.	Organization	Inst.
4n	Aston Data Bank, 1976: (Schwitter, 1968)	3	5,150	Manuf.	Organization	Inst.
45	Jester, 1982	3	33	Serv.	Subunit	Inst.
46	Kedia, 1976	2A	999	Manuf.	Organization	Inst.
47	Khandwalla, 1970; 1974	2A	n.a.	Manuf.	Organization	Inst.
49	Khandwalla, 1977	1, 2A, 4	n.a.	Mixed	Organization	Inst.

Table IV-12--continued

#	Study	Technology[a] Concept	Size	Type	Level of Analysis	Type of Measure
50	Kimberly & Rottman, 1987	3	n.a.	Serv.	Organization	Inst.
51	Kmetz, 1975; 1977	1	n.a.	Mixed	Subunit	Inst.
53	Kmetz, 1981	1, 3	n.a.	Serv.	Subunit	Inst.
54	Kuc, Hickson & McMillan, 1981	2A	496	Manuf.	Organization	Inst.
55	Leatt & Schneck, 1981; 1982	3	n.a.	Serv.	Subunit	Ques.
57	Loveridge, 1982	3	n.a.	Serv.	Subunit	Ques.
59	Mahmoudi & Miller, 1985	4	615	Serv.	Organization	Inst.
60	Mark, 1982	1, 3	113	Serv.	Organization	Inst.
62	McMillan, Hickson, Hinings & Schneck, 1973	1	500	Manuf.	Organization	Inst.
65	Miller & Droege, 1986	2A	298	Mixed	Organization	Inst.
66	Mills, Turk & Margulies, 1987	3	n.a.	Serv.	Individual	Ques.[d]
67	Mohr, 1971	1, 3	n.a.	Serv.	Subunit	Ques.
68	Moorhead, 1981	3	n.a.	Serv.	Subunit	Inst.
69	Negandhi & Reimann, 1973	2A	1,132	Manuf.	Organization	Inst.
70	Paulson, 1980	3	20	Serv.	Organization	Inst.
71	Payne & Mansfield, 1973	1	2,401	Manuf.	Organization	Inst.
41	Aston Data Bank, 1976: (Payne & Mansfield, 1969-70)	3	2,401	Manuf.	Organization	Inst.
72	Pennings, 1975	1	100	Serv.	Subunit	Ques.
73	Pfeffer & Leblebici, 1977	4	576	Manuf.	Organization	Inst.
74	Piernot, 1979	3	<1,000	Serv.	Organization	Inst.
75a	Pitsiladis, 1979	3	>1,000	Manuf.	Subunit	Ques.
75b	Pitsiladis, 1979	3	>1,000	Manuf.	Subunit	Ques.
75c	Pitsiladis, 1979	3	>1,000	Manuf.	Subunit	Ques.
77	Reimann, 1972	1, 2A, 4	1,265	Manuf.	Organization	Inst.
78	Reimann, 1980	2A, 4	1,230	Manuf.	Organization	Inst.
4m	Aston Data Bank, 1976: (Reimann, 1970-71)	3	1,230	Manuf.	Organization	Inst.
80	Rousseau, 1978	1	16	Mixed	Subunit	Inst.
81	Routamaa, 1985	1, 4	<1,000	Manuf.	Organization	Inst.

Table IV-12--continued

#	Study	Technology[a] Concept	Size	Type	Level of Analysis	Type of Measure
83	Shenoy, 1981	2A	3,214	Manuf.	Organization	Inst.
84	Shrader, 1984	3	23	Serv.	Organization	Ques.
85	Sutton & Rousseau, 1979	1	150	Mixed	Individual	Ques.[d]
86	Tracy & Azumi, 1976	1, 3	1,875	Manuf.	Organization	Inst.
90	Van de Ven, Delbecq & Koenig, 1976	1, 3	<1,000	Serv.	Subunit	Inst.
91	Vazzana, 1987	4	369	Serv.	Subunit	Inst.
93	Williams, 1984	3	468	Serv.	Organization	Inst.
95	Wong & Birnbaum, 1989	1	11,100	Serv.	Organization	Inst.
96	Woodward, 1965	2A	<1,000	Manuf.	Organization	Inst.
97	Worley, 1983	2A	935	Manuf.	Organization	Inst.
98a	Zeffane, 1981 (n=69)	1, 4	<1,000	Manuf.	Organization	Inst.
98b	Zeffane, 1981	1, 4	>1,000	Manuf.	Organization	Inst.
98c	Zeffane, 1981	1, 4	>1,000	Manuf.	Organization	Inst.
99	Zwerman, 1970	2A	<1,000	Manuf.	Organization	Inst.

[a]1 = Workflow integration/automation; 2A = Production continuity; 2B = Throughput continuity; 3 = Task routineness; 4 = Information technology.

[b]The data for the manufacturing and service subsamples of these mixed samples is available for analysis.

[c]Newspapers.

[d]Individual level involves no aggregation of scores.

Figure IV-1. Task Routineness Measures Scoring Techniques

Low <-------------------------Score-------------------------> High

Nonroutine - Routine

Unanalyzable Search - - - - - - - - - - - - - - - - Analyzable Search

Many exceptions - Few exceptions

Complex - Simple

Uncertain - Certain

Difficult - Simple

Insufficient knowledge - - - - - - - - - - - - - Sufficient knowledge

Low predictability - - - - - - - - - - - - - - - High predictability

Not understandable - - - - - - - - - - - - - - - - - - Understandable

CHAPTER V
PRELIMINARY ANALYSES

Two issues need to be addressed before embarking upon a comprehensive meta-analysis of correlations between technology and structure. The first relates to the extent of nonlinearity in the relationships between technology and organization structure. The second is the role of organization performance on the relationship between technology and structure.

The Question of Linearity

Woodward (1965) found a nonlinear relationship between technology and five structural variables. These five were the span of control of first line supervisors, the amount of written communication, the amount of specialization, the extent to which production administration is separated from production supervision, and the amount of role definition.

Several subsequent research efforts (Blau et al., 1976; Child & Mansfield, 1972; Hickson et al., 1969) have addressed the nonlinearity question by computing the correlation ratio (i.e., eta). However, while some of these researchers did find statistically significant values for eta, none of them addressed the significance of the deviation from the linear coefficient (i.e., the Pearson r). If there is a significant deviation from linearity it may not be appropriate to conduct a meta-analysis on Pearson correlation coefficients.

The following sections will address the extent of deviation from linearity for all studies that provided both the Pearson r and eta. The test of the statistical significance of this difference comes from Chambers (1964: 92):

$$z = 1.1513 \log_{10} [(N - a)(Eta^2 - r^2)] / [(a - 2)(1 - Eta^2)];$$

where N is the total sample size, and a is the number of arrays (i.e., the number of subgroups used to compute eta).

Woodward's Study

Woodward provides a description of the data for only one of the proposed nonlinear relationships; the relationship between technology and the first line supervisor's span of control (1965: 69). The Pearson correlation for these 78 organizations is $r = -.23$ and eta is .73.

Based upon an N of 78, and three arrays for Woodward's technology scale, Chambers' formula yields $z = 2.19$ for the deviation from linearity, and this is statistically significant (i.e., $p < .01$, two-tailed). Thus, Woodward's data do deviate significantly from a linear relationship between technology and supervisor's span of control.

The Aston Study

Hickson et al. (1969) used a 10-point version of Woodward's scale of workflow continuity (i.e., number of arrays is 10). Table V-1 displays the results obtained by these researchers and the results of the comparison of r with eta. The 31 organizations included in the analysis are the manufacturing organizations in the Aston study. None of the Pearson correlation coefficients or the eta values are statistically significantly different from zero. The difference between the Pearson r and the eta for these three relationships is not statistically significant. Note in Table V-1 that the probability of a difference this large being due to chance ranges from .42 for percentage inspection to .69 for supervisor's span of control. Thus, there is not a significant deviation from linearity in the Aston Study.

The National Study

Child and Mansfield (1972) calculated eta for all of the relationships displayed in Table V-2. Their measure of technology was the Aston scale of workflow integration. They did not indicate how many arrays were formed to calculate eta, but they did say that there was an S-shaped array for percentage accounts (1972: 383). This implies that there were at least four arrays, because an S-shaped array could not appear otherwise.

Notice in the Chambers formula presented earlier that the value of z decreases as the number of arrays (i.e., a) increases. Therefore, the use of four arrays in Table V-2 results in the largest possible value of z under conditions that will allow an S-shaped array to appear. Nevertheless, none of the eta values deviate significantly from the linear correlation coefficient. Thus, there is not a significant deviation from linearity in the National Study.

New Jersey Manufacturers

Blau et al. (1976) calculated eta for 21 structural variables and a 7-point version of Woodward's scale of workflow continuity. Their sample consisted of 110 New Jersey manufacturing firms. These data are presented in Table V-3.

Notice that the Pearson r reported in this study was actually larger than the value reported for eta in the cases of numbers of levels, number of sections, functional specialization, indirect production, and span of control for division heads. This is not a possibility if the relationships are truly nonlinear; eta will be larger than r. It is no surprise then that Blau et al. (1976) did not detect a nonlinear pattern for these relationships when the data were visually inspected in a 3-category version of the Woodward (1965) scale.

None of the 16 relationships for which a test of the deviation from linearity could be performed resulted in a statistically significant difference. Table V-3 indicates that the probability of differences as large as those observed between eta and the Pearson r range from .10 for number of divisions to .71 for span of control of first line supervisors in direct production. Thus, there is not a significant deviation from linearity in the data for the 110 New Jersey manufacturers.

Summary

Four studies were evaluated for the extent of deviation from linearity in the relationship between technology and structure. The only significant deviation was found in the Woodward (1965) study for the relationship of technology and supervisor's span of control. However, three other studies that measured supervisor's span of control did not deviate significantly from linearity (Blau et al., 1976; Child & Mansfield, 1972; Hickson et al., 1969).

The results of the analyses performed in this section do not mean that the relationship between technology and structure is perfectly linear. However, they do suggest that the deviation from linearity is not significant. Therefore, the results of a meta-analysis of Pearson r's should adequately describe the relationship of technology to organization structure.

Technology, Structure, and Organization Performance

The basic conceptual framework of contingency theory assumes a general pattern of conditional relationships between environmental contingencies and organizational structure, and these two contribute to organizational performance. More specifically, there must be an appropriate fit between technology and structure if an organization is going to be successful.

The linkage between technology, structure, and performance is fundamental to Woodward's (1965) thesis. She found no direct link between organization structure and performance, but discovered that within each of her three technology types the more successful organizations had very similar structures. She concluded that "not only was the system of production an important variable in the determination of organizational structure, but also that one particular form of organization was most appropriate to each system of production" (1965: 69-71).

The implication of Woodward's thesis is that the level of success will moderate the correlation between technology and structure. If the more successful firms have obtained an appropriate fit between technology and structure, while less successful firms have not, there should be higher correlations between technology and structure among the more successful firms.

Woodward provides a table that includes the data for the relationship between technology and the span of control of first line supervisors (1965: 69). These data were used to calculate the correlations between technology and span of control for each of three levels of success. Table V-4 includes the correlations of span of control with the squared value of the technology measure to recognize the nonlinear nature of this relationship. Even though the small sample sizes prevent the differences between correlations from being statistically significant, the results in Table V-4 do tend to support the hypothesis that the correlation between technology and span of control is higher among more successful firms.

Given the central role of organization performance within the basic framework of contingency theory, and the evidence presented above that the correlation between technology and structure may vary with the level of success, one might ask why performance is not one of the moderators to be tested in these meta-analyses. The answer, unfortunately, is that organization researchers have tended to ignore the performance variable. The absence of performance measures in the literature makes it impossible to code the studies so that a moderator test can be performed.

Absence of the performance moderator in the technology-structure literature means that the technology-structure relationship in general would be weaker than the technology-structure relationship for the high performance group only. However, in Table V-4 we see that this difference is not great; a correlation of $r = -.33$ for the overall sample versus $r = -.48$ for the high performance group. Thus, even though the moderator effect of performance cannot be assessed here, it should not make a large difference in the results obtained. The object of this study is to inquire into the inconsistencies within the literature concerned with technology-structure, and that literature is unmoderated by performance. Therefore, comparison across studies, even without the performance moderator, is a comparison of equals.

The inability to test the moderating effect of organization performance is not a flaw in the meta-analysis technique, but is indicative of the state of the literature. Future researchers should make the effort to assess the trivariate relationships between structure, technology, and performance.

Conclusion

The relationship between technology and structure does not seem to deviate significantly from the linear model. The implication of this finding not only means that the results of a meta-analysis of correlation coefficients can be meaningfully interpreted, but it also suggests that the use of multivariate statistical techniques is appropriate in technology-structure research.

The absence of performance data in studies of technology and structure makes it impossible to test the moderating effect of performance in the meta-analyses to be performed. This represents a gap in the contingency theory literature that should be filled by future research. Until this is done, organization performance level must remain a potential source of variation in study outcomes.

Table V-1. The Aston Study: Deviation from Linearity

	N	a	r	Eta	Eta^2	z	p
Supervisor's Span of Control	31	10	-.09	.36	.13	-.50	.69
Percentage Inspection	31	10	-.15	.62	.38	.20	.42
Percentage Maintenance	31	10	.20	.46	.21	-.30	.62

Note. The data for this table are from Hickson, D. J., Pugh, D. S., & Pheysey, D. C. 1969. Operations technology and organization structure: An empirical reappraisal. Administrative Science Quarterly, 14: 378-397.

Table V-2. The National Study: Deviation from Linearity

	N	a	r	Eta	Eta^2	z	p
Percentage Employed In:							
Sales and Service	82	4	.06	.42	.18	1.05	.15
Purchasing	82	4	.07	.29	.08	.61	.27
Accounts	82	4	-.26	.45	.20	.94	.17
Design and Development	82	4	.09	.26	.07	.46	.32
Market Research	82	4	.19	.37	.14	.76	.22
Degree of Role Specialism:							
Employment	82	4	.02	.29	.08	.64	.26
Workflow Control	82	4	-.09	.31	.10	.67	.25
Design and Development	82	4	.07	.35	.12	.89	.19
Other Structural Variables:							
CEO Span of Control	82	4	.05	.39	.15	.96	.17
Supervisor's Span of Control	82	4	.14	.44	.19	1.06	.14
Percentage Direct Workers	82	4	.23	.42	.18	.88	.19

Note. The data for this table are from Child, J. & Mansfield, R. 1972. Technology, size and organization structure. Sociology, 6: 383.

Table V-3. New Jersey Manufacturers: Deviation from Linearity

	N	a	r	Eta	Eta^2	z	p
Differentiation							
Number of levels	110	7	.10	.04	.00	n.a.	
Number of divisions	110	7	.01	.06	.00	-1.31	.10
Number of sections	110	7	.14	.13	.02	n.a.	
Number of job titles	110	7	-.10	.13	.02	-.97	.17
Occupational diversity	110	7	.09	.28	.08	.23	.59
Functional specialization	110	7	.11	.07	.00	n.a.	
Personnel Components (%s)							
Nonproduction	110	7	.01	.21	.04	-.03	.49
Supervisors	110	7	.14	.35	.12	.44	.67
Staff	110	7	-.07	.17	.03	-.34	.37
Clerks	110	7	.02	.09	.01	-.92	.18
Professionals	110	7	-.01	.17	.03	-.25	.40
College graduates	110	7	.12	.23	.05	-.09	.46
Indirect production	110	7	.34	.32	.10	n.a.	
Maintenance	110	7	.43	.49	.24	.20	.58
Direct production	110	7	-.21	.33	.11	.20	.58
Craftsmen	110	7	.01	.26	.07	.20	.58
Spans of control							
Chief executive officers	110	7	.06	.20	.04	-.12	.45
Division heads	110	7	-.25	.20	.04	n.a.	
Section heads	110	7	-.01	.25	.06	.16	.56
First line supervisors							
All	110	7	-.09	.24	.06	.04	.52
Direct production	110	7	-.03	.36	.13	.56	.71

Note. The data for this table are from Blau, P. M., Falbe, C. M., McKinley, W., & Tracy, P. K. 1976. Technology and organization in manufacturing. Administrative Science Quarterly, 21: 20-40.

Table V-4. Pearson Correlations for Woodward's (1965) Data Regarding the Relationship of Technology and Supervisor's Span of Control by Level of Success

		Correlation with Span of Control	
	N	Technology	Technology Squared
Above Average in Success	16	-.361	-.482**
Average Success	47	-.235	-.353*
Below Average in Success	15	-.088	-.161
Total	78	-.231	-.327

*p < .02. **p < .06.

CHAPTER VI
OMNIBUS TEST OF THE SITUATIONAL SPECIFICITY HYPOTHESIS

This chapter presents the results of overall meta-analyses of correlations between measures of technology and 30 structural variables. This discussion will begin with a description of these 30 individual meta-analyses, then the results of a second order meta-analysis (i.e., a meta-analysis of meta-analyses), and end with a summary of these results.

As discussed earlier, the correlations included in these analyses are presented in Table IV-1 through Table IV-3. A bibliography of all studies included is in Appendix C. References to studies included will use the numbers assigned to each study in Table IV-1 through Table IV-3, and Appendix C. Examination of Table IV-1 through Table IV-3 reveals that several studies provided correlations with more than one measure of technology. Inclusion of these separate correlations in a meta-analysis would violate the assumption of independence. To avoid this condition a sample-weighted mean correlation was calculated for each study for inclusion in the meta-analysis. In those few cases where the sample size varied within studies due to the use of subsamples an average sample size was used (Studies 18, 31, 38, 60, and 98). This procedure treats these multiple measures as conceptual replications as discussed by Hunter et al. (1982).[1]

Situational Specificity Hypothesis

The hypothesis being tested in this chapter is that all of the variance in observed correlations is caused by artifacts. The situation specificity hypothesis states that many factors can affect the outcome of studies. Several factors have been proposed to affect the relationship between technology and organization structure. These factors have been addressed in an earlier chapter (e.g., organization size, level of analysis, etc.). The omnibus procedure applied in this chapter "can be used to test all . . . moderators simultaneously--even those that have not (yet) been named" (Hunter & Schmidt, in press: 9-9). To the extent that the observed variance can be explained by artifacts, the hypothesis that situational moderators contribute to the variance can be rejected. The null hypothesis may therefore be stated as follows:

Hypothesis 0: Situational moderators contribute to the variance in observed correlations.

The alternative hypothesis is:

Hypothesis 1: All variance between observed correlations is caused by artifacts.

A 90 percent rule will be used in these meta-analyses. That is, if 90 percent (or more) of the observed variance between correlations can be explained by artifacts, then it will be assumed that the other 10 percent (or less) is caused by other artifacts. This is a more stringent criterion than the 75 percent rule discussed by Schmidt et al. (1979). However, since several factors have been proposed as moderators of the relationship between technology and structure, the higher 90 percent cut off is deemed more appropriate. It increases the confidence we can have in the conclusion that all variance is due to artifacts; that is, there are no moderators.

Rejection of the situational specificity hypothesis also means that different operational definitions of variables do not contribute to differences in study outcomes. For example, in later sections of this chapter we will find that the inclusion of correlations that use different definitions of formalization, supervisor's span of control, percentage clerical personnel, and percentage administration does not appear to be the cause of increased variation. If artifacts account for all or most of the variance (i.e., there is a small residual variance) then the differences in operational measures cannot be a contributor to the variance observed.

Discussion of Results

Results of these analyses are summarized in Table VI-1. This section will briefly describe the results of each analysis. However, it is important that the reader first understand the distinction between the credibility interval shown on Table VI-1 and a confidence interval. Both types will be referred to during discussion of these results.

The credibility interval is based upon the corrected correlation and the corrected residual standard deviation. Both statistics have been corrected for measurement reliability, range restriction in the independent variable, and sampling error. In this way the credibility interval describes the distribution of true score correlations included in the meta-analysis after correcting for artifacts.

The confidence interval, on the other hand, is based upon the standard error which can be expected due to sampling error. It estimates the potential range of second order sampling error in the meta-analysis mean. The key distinction then is that the credibility interval has sampling error removed while the confidence interval is based on only sampling error. Also, the credibility interval refers to the distribution of <u>true score</u> correlations, while the confidence interval refers to the <u>mean</u> correlation. The calculation of the standard error of the mean correlation is described in Appendix E.

Division of Labor

Twenty-six studies provided correlations between technology and division of labor ranging from r = -.42 (Study 25) to r = +.70 (Study 74). See Table IV-1 and Appendix C Studies 4h, 10, 13a, 13c, 14 & 17, 18 & 4i, 20, 21a, 21b, 25, 30, 31, 33, 35, 38 & 4k, 39 & 4j, 42, 50, 70, 72, 74, 75a, 75b, 75c, 91, and 97.

Division of labor includes studies using the Aston scale of role specialization which assesses the degree to which 16 functional areas are fractionalized into subactivities (Studies 4h, 14, 18 & 4i, 38 & 4k, and 39 & 4j). It also includes studies counting the number of job titles (Studies 10, 13a, 13c, 42, and 74), the number of occupational specialties (Studies 21, 25, 31, and 70), the degree of distribution among job titles (Studies 20 and 33), as well as those that simply assess "division of labor" (Studies 30, 35, 72, 91, and 97).

These 26 studies represent a combined sample of 2,726 and a mean correlation of $\bar{r}$ = +.29. Artifacts account for nearly 42 percent of the observed variance across studies, and sampling error alone accounts for 19 percent. Probably more significant than the proportion of variance explained by artifacts is the corrected standard deviation (i.e., .228) relative to the corrected correlation (i.e., .423). These two values have been corrected for unreliability in the measures, range restriction in the independent variable, and sampling error. They represent the best estimates of the population parameters. The 90 percent credibility interval based upon these two values indicates that over 95 percent of the corrected correlation can be expected to be positive. This provides evidence that the relationship between technology and the division of labor is positive. The existence of a fairly large residual variance (i.e., .024) suggests that situational moderators might be operating in this relationship.

Functional Specialization

Forty-four studies were included in the analysis of functional specialization. Values ranged from r = -.25 (Study 70) to r = +.70 (Study 37). See Table IV-1 and Appendix C Studies 3; 4a; 4b; 4c; 4d; 4e; 4f; 4g; 4h; 5; 7; 10; 11; 12; 13a; 13b; 14 & 17; 15; 18 & 4i; 21a; 21b; 24; 25; 31; 37; 38 & 4k; 39 & 4j; 41; 44 & 4n; 46; 53; 54; 62; 65; 70; 71 & 41; 73; 77, 78 & 4m; 81; 83; 95; 98a; 98b; and 98c.

Functional specialization includes studies using the Aston scale of functional specialization which assesses how many of 16 functional areas have at least one person who performs that function and no other function (Studies 3, 4a, 4b, 4c, 4d, 4e, 4f, 4g, 4h, 5, 7, 14, 18 & 4i, 21a, 21b, 24, 38 & 4k, 39 & 4j, 41, 44, 46, 54, 65, 71, 77, 81, 83, 95, and 98). It also includes studies that count the number of divisions (Studies 10, 12, 13a, and 13b), the number of departments (Studies 11, 25, and 73), and the number of functional areas (Studies 31 and 37). Other studies included here assess the addition of new positions requiring a job description (Study 15), the proportion of personnel who are specialized (Study 53), and the extent to which an organization's activities are subdivided into mutually exclusive sets (Study 62).

The combined sample size for these studies is 2,378 and the mean correlation is $\bar{r}$ = +.24. Artifacts account for 57 percent of the observed variance, and sampling error alone accounts for 42 percent. The corrected correlation of .338 and the corrected standard deviation of .179 yield a 90 percent credibility interval that is above zero. Based on these results we can reject the hypothesis that the true correlation is zero, but the residual variance suggests the possibility of situational moderators.

Standardization

The meta-analysis of standardization involved 15 correlations ranging from r = -.08 (Study 57) to r = +.50 (Study 21). See Table IV-1 and Appendix C Studies 3, 4h, 5, 7, 14 & 17, 18 & 4i, 21a, 21b, 34, 38 & 4k, 39 & 4j, 53, 57, 60, and 91.

Standardization includes studies using the Aston scale of overall standardization which assesses the degree to which specific procedures are covered by rules or definitions that are applied invariably (Studies 3, 4h, 5, 7, 14, 18 & 4i, 38 & 4k, 39 & 4j, and 60). It also includes the uniformity of work procedures and stability over time (Study 53), systemizing procedures (Study 91), and "destandardization" (Study 57). This last study required the reversal of the correlation's sign to yield a correlation with standardization.

The mean observed correlation of $\bar{r}$ = +.23 is based upon a total sample size of 902. Four artifacts explain 80 percent of the observed variance. Sampling error alone can explain 52 percent of that variance. The 90 percent credibility interval is completely in the positive range and the residual variance (i.e., .0057) is small. These results suggest that the relationship between technology and standardization is generally positive, and the low residual variance indicates that situational moderators have a very limited impact if they operate at all.

Formalization

The major criterion for inclusion of a study under formalization is the existence of written documents. It is the explicitness of procedures that distinguishes formalization from standardization. Two measures of formalization were analyzed. Overall formalization represents the existence of written documents. Role formalization is more limited in scope; it relates specifically to documents pertaining to role performance.

Overall Formalization

Forty-three studies were included in the meta-analysis of overall formalization. These correlations ranged from r = -.13 (Study 75) to r = +.63 (Study 74). See Table IV-1 and Appendix C Studies 3, 4c, 4d, 4e, 4h, 5 & 6, 13b, 15 & 16, 18 & 4i, 20, 21a, 21b, 24, 30, 31, 33, 35, 36, 38 & 4k, 39 & 4j, 40, 41, 45, 47 & 48, 49, 51 & 52, 53, 54, 59, 60, 65, 74, 75a, 75b, 75c, 81, 83, 84, 85, 90, 93, 95, and 97.

Overall formalization includes those studies that used the Aston scale of overall formalization which counts the number of documents available in an organization (Studies 3, 4c, 4d, 4e, 4k, 5, 18 & 4i, 31, 38 & 4k, 39 & 4j, 54, 60, 65, 81, 83, and 95). However, the definition of overall formalization that is applied in these meta-analyses is more inclusive than the Aston definition. Other studies included count the number of procedure manuals (Studies 13b and 36), assess the "explicitness of procedures" (Study 20), the frequency and usage of written guidelines (Studies 24, 41, 74, 84, 85, and 97), and the perceived extent of written direction (Study 33). Still others assess the length and frequency of revision of organization manuals and charts (Study 15), the existence of rules and formal evaluations (Study 30), rule usage (Studies 40, 51, and 59), procedural specification (Study 35), and impersonal coordination modes such as plans and schedules (Studies 90 and 93). Finally, three studies use Khandwalla's scale of "use of sophisticated controls" which Gerwin (1981) considers a scale of formalization (Studies 47, 49, and 53).

The combined sample size for these 43 studies is 2,853, which yields a sample-weighted mean correlation of $\bar{r}$ = +.17. Artifacts explain only 56 percent of the observed variance; sampling error alone explains 44 percent. The corrected correlation (i.e., +.25) and standard deviation (i.e., .171) result in a 90 percent credibility interval that includes zero. We cannot reject the possibility that the true correlation is zero.

Role Formalization

Twenty-five correlations ranging from r = -.07 (Study 4a) to r = +.87 (Study 4h) result in a mean correlation of $\bar{r}$ = +.22 and artifacts explain a substantial percentage of the observed variance (i.e., 71.5 percent). See Table IV-1 and Appendix C Studies 4a; 4b; 4c; 4d; 4e; 4f; 4g; 4h; 4i; 4k; 7; 13a; 34; 37; 39 & 4j; 42; 44 & 4n; 46; 51 & 52; 55; 62; 71 & 41; 77, 78 & 4m; 80; and 86.

Formalization of roles includes all studies using the abbreviated Aston scale which assesses formalization of role definition (Studies 4a; 4b; 4c; 4d; 4e; 4f; 4g; 4h; 4i; 4k; 7; 39 & 4j; 44 & 4n; 46; 71 & 41; 77, 78 & 4m; 80; and 86). Others assess the extent of job codification (Study 51), the extent to which intended behavior is prescribed in writing (Study 62), and the extent of role programming and output programming (Study 37). One study uses the number of words in personnel manuals as a measure (Study 13a), and another counts the number of pages in standard operating procedures, operating instructions, organization charts, and written job descriptions (Study 42).

Sampling error alone can explain 56 percent of the variance. The corrected correlation and corrected standard deviation for role formalization yield a 90 percent credibility interval that is greater than zero so we can be fairly certain that the true correlation is positive.

Vertical Span

Meta-analysis of vertical span (i.e., the number of hierarchical levels) involved 29 correlations ranging from r = -.31 (Study 25) to r = +.77 (Study 96). See Table IV-1 and Appendix C Studies 3, 4c, 4d, 5 & 6, 10, 11, 12, 13a, 13b, 13c, 18 & 4i, 21a, 21b, 22, 25, 37, 38 & 4k, 39 & 4j, 41, 65, 73, 74, 77 & 78, 80, 81, 95, 96, 97, and 99.

All studies included here assess vertical span as the number of levels of hierarchy within the organization being studied. Those using the Aston measure count the number of levels from the CEO to the direct worker using the longest line of authority (Studies 3, 4c, 4d, 5, 18 & 4i, 38 & 4k, 39 & 4j, 65, 77, 80, 81, and 95). Other researchers count the number of levels in the division with the most strata (Study 13a, 13b, 13c, 21a, 21b, 41, and 97). Still others assess "vertical differentiation" as levels of hierarchy, levels of management, or levels of supervision (Studies 10, 11, 12, 22, 25, 37, 73, 74, 96, and 99). In their study of 416 state, county, and municipal finance departments reported by Blau and Schoenherr, the average number of levels across divisions was computed (Study 13b).

The total sample size represented by these 29 studies is 2,964. Only three artifacts could be corrected for because no reliability coefficients are available for the measure of vertical span. However, it is fairly certain that the reliability is not perfect (i.e., $r_{xx} < 1.0$) and that it varies from one study to another. If this correction could be made then the percentage variance explained would be greater than the 50 percent now shown, and the corrected correlation and standard deviation would exceed those shown (i.e., mean = +.34, and s.d. = .154).

In a limited meta-analysis of production technology and vertical span involving only five correlations Hirst, (1984) found a mean correlation of $\bar{r} = +.36$, and sampling error explained only 10 percent of the observed variance. The results of the analysis presented here are consistent with those earlier findings. In the expanded analysis presented here the mean observed correlation is $\bar{r} = +.27$ and sampling error explains only 27 percent of the observed variance. Other artifacts (i.e., differences in reliability of technology measures, and the extent of range restriction) account for an additional 23 percent of the observed variance.

As pointed out in previous discussions, however, it is not only the percentage variance explained that is important. The corrected standard deviation is less than half the size of the corrected correlation so that the 90 percent credibility interval is totally within the positive range. This suggests that 95 percent of the time the true correlation between technology and the number of hierarchical levels should be greater than r = +.09.

Centralization

Fifty-six correlations were included in this meta-analysis of centralization ranging from r = -.52 (Study 7) to r = +.48 (Study 30). See Table IV-1 and Appendix C Studies 4c, 4d, 4e, 4h, 5 & 6, 7, 8, 11, 12 & 61, 13a, 14 & 17, 15 & 16, 18 & 4i, 20, 21a, 21b, 30, 31, 33, 35, 36, 38 & 4k, 39 & 4j, 40, 41, 43, 45, 46, 47 & 48, 49, 51 & 52, 53, 54, 55, 57, 60, 65, 66, 67, 68, 69, 75a, 75b, 75c, 77, 80, 81, 83, 84, 85, 93, 95, 97, 98a, 98b, and 98c.

Centralization is operationalized in a number of ways, but all assess the degree to which decision making authority is distributed within an organization. The Aston measure assesses the level at which 36 decisions can be taken on a scale ranging from zero for the operator level to five for a level above the CEO (Studies 4c, 4d, 4e, 5, 7, 14, 18 & 4i, 38 & 4k, 39 & 4j, 41, 43, 46, 54, 60, 65, 68, 77, 80, 81, 83, and 95). Similarly, some assess the "locus of authority" (Studies 11, 12, 98a, 98b, and 98c), the "extent of centralized authority" (Study 93), and "lack of participation" in decision processes (Study 35). Still others assess the inverse of centralization; decentralization (Studies 15, 55, 57, 69, 84, and 97), delegation (Studies 13a, 47, and 49), participation (Studies 31, 33, 36, 40, 51, 66, 67, and 85), and the amount of discretion possible (Study 30). All of these have the signs of the correlation modified to reflect measures of increasing centralization. Two studies computed an index of centralization by subtracting the perceived power of lower level managers from the perceived power of upper level managers (Studies 8 and 20).

The mean correlation of $\bar{r}$ = +.02 is very near the middle of the range, and an examination of the correlations in Table IV-1 reveals a fairly symmetrical distribution around that mean. The analysis of centralization results in the second largest residual variance of all of the 30 analyses presented in Table VI-1. Only 31 percent of the observed variance can be explained by artifacts and sampling error accounts for all of that. These results suggest that situational moderators may be affecting the correlation between technology and centralization of decision making authority.

CEO Span of Control

The 20 correlations included in the meta-analysis of CEO Span of Control range from r = -.15 (Study 4c) to r = +.61 (Study 4g). See Table IV-1 and Appendix C Studies 3; 4b; 4c; 4d; 4e; 4g; 5 & 6; 11; 12; 13a; 13c; 18 & 4i; 38 & 4k; 39 & 4j; 41; 71 & 41; 77, 78 & 4m; 81; 97; and 99.

The span of control is generally measured as the number of subordinates who report directly to the CEO. This definition applies to those studies using the Aston measure (Studies 3, 4b, 4c, 4d, 4e, 4g, 5, 18 & 4i, 38 & 4k, 39 & 4j, 41, 71, 77, and 81), as well as others (Studies 12, 97, and 99). The span of control of university presidents would also come under this definition (Study 11). Blau and Schoenherr measured the span of control for agency directors in their study of 52 state employment agencies, and the span for the local office managers in the study of 1,201 local offices of the employment service (Studies 13a and 13c). These represent the top executive officers within the units under analysis and are therefore included under CEO span of control.

The total sample size of 2,081 yields a weighted average correlation of $\bar{r}$ = +.19. Three artifacts explain all of the observed variation and sampling error explains 78 percent by itself. The results of this analysis indicate that there is only one true correlation for all of the studies (i.e., $\bar{r}$ = +.24) and all observed variation is due to artifacts. These results are consistent with those obtained in an earlier meta-analysis of the relationship between production technology and CEO span of control. Only four studies were included in that analysis, and only sampling error was corrected for, but over 100 percent of the variance was explained. The mean observed correlation was $\bar{r}$ = +.11 (Hirst, 1984).

For the analysis of CEO span of control, and for all remaining variables in Table VI-1, correction can be made for only three artifacts. All of these variables are single-item scales so indices of internal consistency are not available, nor are multiple-item measures available to allow estimation of single-item reliability. If this fourth artifact correction could be made the percentage of variance explained would be greater than shown in Table VI-1.

Supervisor's Span of Control

The 22 studies included in the analysis of supervisor's span of control provide correlations ranging from r = -.23 (Study 4d and Study 96) to r = +.47 (Study 9) and a total sample size of 2,592. See Table IV-1 and Appendix C Studies 3, 4c, 4d, 4e, 4h, 5 & 6, 9, 12, 13a, 13b, 13c, 18 & 4i, 19, 22, 31, 33, 38 & 4k, 39 & 4j, 41, 78, 81, and 96. Supervisor's span of control is generally measured as the average number of direct workers per first line supervisor (Studies 3, 4c, 4d, 4e, 4h, 5, 13b, 13c, 18 & 4i, 22, 38 & 4k, 39 & 4j, 41, 78, 81, and 96), or the number of subordinates controlled (Study 9). However, for these meta-analyses the term "supervisors" is not restricted to first line supervisors. Blau and Schoenherr measured division head's span of control in their study of 53 employment agencies (Study 13a). Two studies used the hierarchy of control index developed by Samuel and Mannheim (1970); the higher the score, the narrower the span of control. The sign of the correlation was adjusted to reflect increasing span of control (Studies 31 and 33).

Some readers may believe that the inclusion of these 3 correlations with spans of control for non-first line supervisors will be a major source of variance. However, it should be noted that none of these 3 correlations (i.e., $r = -.096$ for Study 31, $r = .136$ for Study 33, and $r = .297$ for Study 13a) is an extreme value in the distribution of the 22 correlations included. In other words, the range of values for 19 correlations with first line supervisor's span of control encompasses the 3 correlations with non-first line supervisor's span of control. Furthermore, the results of the meta-analysis to be discussed in the next paragraph indicate that most of the variance among these 22 correlations is due to artifacts. Therefore, the difference in operational definition has little or no effect on the results of this meta-analysis.

The mean observed correlation of $\bar{r} = +.08$ has a very small residual variance after correction for only three artifacts (i.e., .0043). These three artifacts explain 68 percent of the observed variance and sampling error explains 63 percent by itself. The 90 percent credibility interval includes zero so we cannot rule out the credibility of a corrected correlation of zero nor a negative correlation. The residual variance, although it is not zero, is very small and represents the upper-bound for the effect of any moderators. The impact of those moderators, if present, must therefore be considered to be trivial.

Percentage Direct Workers

Only 12 studies relating technology to the proportion of workers engaged in direct labor were found. Correlations included ranged from r = -.68 (Study 96) to r = +.19 (Study 4e). The resulting mean correlation is $\bar{r}$ = -.21. See Table IV-2 and Appendix C Studies 3, 4c, 4d, 4e, 4h, 5, 12, 18 & 4i, 38 & 4k, 39 & 4j, 41, and 96.

Most researchers measured this variable as the proportion of total personnel engaged in direct labor (Studies 3, 4c, 4d, 4e, 4h, 5, 18 & 4i, 38 & 4k, and 39 & 4j). However, one researcher measured the percentage of labor hours devoted to direct labor (Study 41), and Woodward computed the ratio of direct workers to indirect workers (Study 96).

The total sample size is 497 resulting in a small average sample size of only 41. The observed variance for this variable is the largest among the 30 correlations analyzed, and the residual variance is also the largest. Three artifacts explain only 40 percent of the observed variance; sampling error alone can explain only 34 percent. This large residual suggests that there may be situational moderators affecting this relationship, and the inclusion of zero within the 90 percent credibility interval casts doubt on the sign and magnitude of the true correlation.

Percentage Workflow Supervisors

Artifacts explain all of the variance observed among seven correlations ranging from r = -.21 (Study 22) to r = +.13 (Study 5). See Table IV-2 and Appendix C Studies 3, 4h, 5, 18 & 4i, 22, 38 & 4k, and 39 & 4j.

All studies included in this category measured the variable as the percentage of workflow supervisors to total personnel in the organization.

The average sample size of 30 results in a high expected variance due to sampling error. The value of the true correlation for these studies is the corrected correlation of -.11. No situational moderators affect this relationship.

Percentage Nonworkflow Personnel

Artifacts also explain all of the observed variance in this analysis. Nine studies with a total sample size of 369 resulted in a mean correlation of $\bar{r}$ = +.13, corrected to +.17. Correlations range from r = -.02 (Study 3) to r = +.29 (Study 5). See Table IV-2 and Appendix C Studies 3, 4h, 5, 12, 18 & 4i, 38 & 4k, 39 & 4j, 41, and 77 & 78.

Most studies included here used the percentage of total personnel who are engaged in nonworkflow activities (Studies 3, 4h, 5, 12, 18 & 4i, 38 & 4k, and 39 & 4j). One study measured the percentage of labor hours spent in nonworkflow activities (Study 41), and another divided the total number of specialists by the total number of personnel (Study 77 & 78). The small average sample size of 41 results in a high expected variance due to sampling error. Sampling error alone explains all of the observed variance.

Percentage Supervisors

Most studies included here use the Aston-type measure which divides the total number of supervisors by total personnel (Studies 13a, 13c, 18 & 4i, 37, 45, 65, and 81), and another computes the percentage of hours devoted to supervision (Study 41). For two studies it is not clear whether the ratio is based upon total personnel or only production personnel (Studies 12 and 15).

Ten studies ranging from r = -.30 (Study 13a) to r = +.76 (Study 37) result in a sample-weighted mean correlation of $\bar{r}$ = -.10. See Table IV-2 and Appendix C Studies 12, 13a, 13c, 15 & 16, 18 & 4i, 37, 41, 45, 65, and 81. This correlation is approximately the same as that observed above for the percentage workflow supervisors (i.e., $\bar{r}$ = -.09), but unlike that analysis artifacts explain only 23 percent of the variance observed between these 10 correlations. The residual variance of .0192 indicates that factors other than correctable artifacts contribute to the observed variance. The credibility interval includes zero, so we cannot reject the possibility of a true correlation of zero. Further analysis of this relationship is needed.

Percentage Clerical Workers

A very small mean correlation was arrived at for the relationship between technology and the percentage of personnel engaged in clerical activities. Thirteen correlations ranging from r = -.21 (Study 55) to r = +.42 (Study 5) resulted in a mean correlation of $\bar{r}$ = +.002. See Table IV-2 and Appendix C Studies 3, 4h, 5, 11, 12, 13a, 13c, 18 & 4i, 38 & 4k, 39 & 4j, 41, 55, and 81.

Most researchers assess the percentage of clerical workers among total personnel (Studies 3, 4h, 5, 13, 18 & 4i, 38 & 4k, 39 & 4j, and 81), but one computed the ratio of clerks to faculty (Study 11) and another clerks to other personnel (Study 55). Finally, the percentage of labor hours expended in clerical duties was also used by one researcher (Study 41).

These different operational measures of the clerical ratio have little effect on the variation in study outcomes. The correlations from Studies 11 and 41 (i.e., r = .16 and r = .08) are near the middle of the distribution of these 13 correlations. The correlation for Study 55 is an extreme value in that distribution (i.e., r = -.21) but it should be noted that the ratio of clerks to other (i.e., non-clerical) personnel is generally a very close approximation of the ratio of clerks to total personnel. Thus, the deviance in this correlation is not caused by the difference in ratio calculation.

Artifacts explain 59 percent of the observed variance with variance expected due to sampling error accounting for all of that. The absolute value of the residual variance is not extremely large (i.e., .0044), but it does warrant further investigation. It is possible that there are situational moderators affecting the relationship between technology and the percentage clerical personnel.

Employment Ratios

The remaining analyses involve variables assessing the relative representation of 16 specialisms within an organization's work force. They are generally measured as the number of employees within a specialism divided by total personnel. The number of studies assessing the relationship between technology and these variables are few in number as can be seen in Table VI-1. In all cases except two, sampling error variance explains all of the observed variance.

Of the 16 employment ratios analyzed, 14 had all residual variance explained by sampling error. The corrected correlations for these 14 ranged from -.13 (percentage workflow planning and control) to .31 (percentage facility maintenance). Corrected correlations between zero and .10 were obtained for percentage work study, percentage financial control, percentage purchasing and stock control, percentage design and development, and percentage personnel. Correlations greater than .10 but less than .20 were found for percentage sales and service, percentage quality evaluation and control, percentage market research, and percentage training and development. Finally, correlations between .20 and .31 were found for percentage legal and insurance, percentage welfare and security, percentage transportation, and percentage facility maintenance. Studies included in these analyses are listed in Tables IV-2 and IV-3, and in Appendix C.

For two additional variables artifacts did not explain all of the variance observed.

Percentage Workflow Planning and Control

Four studies were included in this analysis ranging from r = -.26 (Studies 18 & 4i) to r = +.26 (Studies 77 & 78). See Table IV-3 and Appendix C Studies 3, 18 & 4i, 38 & 4k, and 77 & 78. The sample-weighted mean correlation is $\bar{r}$ = -.10 and artifacts explain over 87 percent of the observed variance. The residual variance of .0036 is quite small, and any attempt to test for moderators would only capitalize on chance. The 90 percent credibility interval indicates that 95 percent of the true correlations will be negative, but small.

Percentage Administration

The meta-analysis of the relationship between technology and the percentage of the work force in administration includes 12 studies providing correlations ranging from r = -.27 (Study 13a) to r = +.51 (Study 96). See Table IV-3 and Appendix C Studies 3, 5, 11, 12, 13a, 18 & 4i, 32, 38 & 4k, 77 & 78, 81, 86, and 96.

Most of the studies included in this category used the total personnel in the organization as a base for calculating this percentage variable (Studies 3, 5, 12, 13a, 18 & 4i, 38 & 4k, 77, 81, and 86). However, one did use the ratio of administrators to faculty (Study 11). Other ratio variables were based upon administrators to other personnel (Study 32), and staff personnel to direct personnel (Study 96).

These last three operational measures of the administrative ratio are variations of A / P, where A is the number of administrators and P is the number of production workers. It should be noted that the correlation from Woodward's study (Study 96) is much larger than the other 11 correlations included in this analysis. However, as will be pointed out in the next chapter, all four of the correlations derived from Woodward's data are extreme values. This suggests that something other than the method used to calculate the administrative ratio causes this correlation to be larger.

The total sample size of 753 yields a sample-weighted mean correlation of $\bar{r}$ = +.07. Artifacts explain only 42 percent of the observed variance. The corrected standard deviation is more than twice as large as the corrected correlation resulting in a large credibility interval. A lot of uncertainty remains. These results indicate that moderators may be affecting this relationship and contributing to the residual variance.

The meta-analyses performed in this chapter have addressed the problem of sampling error variance among the individual studies included. The next section turns to the issue of second-order sampling error in those meta-analyses.

Second Order Meta-Analysis

Second order sampling error will always have an effect on the outcome of a meta-analysis based on a small number of studies. Just as in primary research, the results depend upon the properties of the individual data points that happen to be available in the sample. This effect is greater on the observed variance than the mean correlation. For example, consider the meta-analysis of division of labor in this chapter. The mean correlation is based upon N = 2,726 and is fairly stable, but the observed variance is based upon only 26 data points. If by chance there are one or two studies with large sampling errors, the observed variance will be greater than the predicted variance.

Hunter and Schmidt (in press) argue that when the same theoretical considerations apply to a number of meta-analyses, the problem of second order sampling error in each can be addressed by performing a meta-analysis of meta-analyses. This is referred to as a second order meta-analysis. If the situation specificity hypothesis is true then it can be assumed that situational moderators operate in the same way for all relationships between technology and the various structural variables (i.e., same amount and same direction). The alternative hypothesis is that all of the variance observed, for all relationships studied, is due to artifacts. If the variance of the population correlations is really zero for all structural relationships with measures of technology, and all relevant artifacts are corrected for (rare indeed), then by chance alone we could expect half of the studies to have over 100 percent of the variance explained, and half to have less than 100 percent explained. As previously noted, 13 of the 30 analyses performed here have less than

100 percent of the observed variance explained by artifacts; 17 of the 30 analyses show more than 100 percent. This is essentially the situation expected due to second order sampling error. Second order meta-analysis removes the effect of that second order sampling error.

Second order meta-analysis assumes that the several meta-analyses being included are independent studies. Since most of these 30 meta-analyses contain correlations from the same individual samples this assumption is not met. However, a recent meta-analysis of the intercorrelation between structural measures indicated that the mean intercorrelation seldom exceeds .30 (Wagner, Buchko, & Gooding, 1988). Given this relatively low intercorrelation and the fact that several independent studies are not duplicated from one meta-analysis to the next it is not believed that violation of this assumption is a significant factor.

Table VI-2 presents the results of a second order meta-analysis of the 30 meta-analyses discussed earlier in this chapter. The technical procedure involves the calculation of the reciprocal of the percentage of variance explained for each of the 30 individual analyses. This reciprocal is then averaged across all 30 studies. Finally, the reciprocal is calculated for that average reciprocal to yield "an unbiased estimate" of the average percentage of variance explained across the 30 analyses (Hunter & Schmidt, in press). The average variance explained by artifacts in this analysis is 87.2 percent. This result indicates that situational factors have a very small effect on the relationship between technology and organization structure. Only 13 percent of the observed variance remains unexplained after taking second order sampling error into account. The small proportion of unexplained variance also indicates that moderator tests must be critically evaluated to avoid capitalization on chance.

Conclusion

The results of these meta-analyses indicate that the empirical findings are more consistent than previously believed. On average, sampling error alone explains nearly 70 percent of the variance observed between studies. Other artifacts such as variation in measurement reliability and differences in the extent of range restriction explains another 17 percent for an average variance explained by artifacts of 87 percent as indicated by the second order meta-analysis performed in this chapter.

Table VI-3 presents the results of the 30 meta-analyses performed in this chapter in a summary format. The structural variables are listed in descending order according to absolute value of the corrected mean correlation. The table includes, from left to right, the variable title, the number of correlations analyzed (k), the total sample size (n), the mean correlation after correction for artifacts, the corrected standard deviation, the standard error of the corrected correlation (s.e.), and the 95 percent confidence interval around the corrected correlation.

Several conclusions can be drawn from these results, and are discussed below.

Statistical Significance

First, we can be very certain that the first 12 mean correlations listed on Table VI-3 are statistically significantly different from zero. This statement is also true for percentage nonworkflow personnel, percentage supervisors, and supervisor's span of control.

For the other 15 variables we cannot reject the hypothesis that the correlation is really zero unless we use a narrower confidence interval, for example, 90 percent. These 95 percent confidence intervals can be narrowed by adding additional studies to the meta-analyses. These variables need to be included in more primary research efforts. As more studies are performed, confidence in the meta-analytic results will increase.

Statistical Power

A second conclusion we can draw is that the relationship between technology and these structural variables is not large. The corrected correlations range from -.265 to .423. The average magnitude of these 30 correlations is .181. This raises the issue of statistical power to detect such a small correlation in a research area dominated by sample sizes of less than 100.

For example, if a researcher wants to have a 90 percent chance of detecting a population correlation of .18 at a significance level of .05 that researcher should have a sample size of 250. The power to detect a population correlation of .18 with a sample size of 100 is right at .50, and declines as sample size gets smaller (Cohen & Cohen, 1983: 529). The implication here is that the failure of past researchers to obtain statistically significant results in studies of technology and structure is the result of small sample sizes and small effect sizes (i.e., low statistical power).[2]

Hickson's Hypothesis

Recall that Hickson et al. (1969) argued that the effect of technology will be stronger for structural variables centered on the workflow, such as job counts, than for the more remote administrative and hierarchical structural variables. Specifically they identified seven structural characteristics that are related to technology: (a) supervisor's span of control, (b) percentage quality evaluation and control, (c) percentage facility maintenance, (d) percentage workflow planning and control, (e) percentage transportation, (f) percentage personnel, and (g) percentage purchasing and stock control (Hickson et al., 1969). This was Hypothesis 2 in Chapter III. The results of these meta-analyses do not support this hypothesis. While percentage facility maintenance and percentage transportation have relatively high mean correlations (i.e., $\bar{r} = +.31$ and $\bar{r} = +.27$, respectively), the strongest correlations are found between technology and a cluster of variables referred to as "structuring of activities", that is, division of labor, functional specialization, standardization, and formalization.

These results suggest that organizational technology does have an effect on the more remote administrative and hierarchical structural variables. In fact, this effect seems stronger than that observed for any of the workflow-related job count variables suggested by Hickson and his colleagues. Hickson's hypothesis further states that the effect of technology will be greater in small organizations than in large organizations (Hickson et al., 1969). That hypothesis will be tested in Chapter IX.

Notes

[1]Some readers may find these average correlations to be conceptually ambiguous. However, it should be noted that the various measures of technology were driven by an effort to capture a common underlying construct. In most cases they were developed in an effort to replicate the findings of Joan Woodward and to improve on her original measure. Whether these different measures do, in fact, measure the same construct is not the issue in this analysis however. The issue is whether these different measures of technology result in significantly different correlations with structure and therefore contribute to the observed variation between studies. Variation between measures, within a single study, is not the primary concern of these analyses.

[2]The problem of low statistical power was alluded to in an earlier chapter as part of a critique of the Fry (1982) review of the technology-structure literature. Fry classified studies based upon whether the results obtained were statistically significant or not statistically significant.

Table VI-1. Overall Results: Technology-Structure Correlations

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Variance Expected due to Sampling Error	Variance due to Range Differ- ence	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structur
Division of Labor	26	2726	.291	.0418	.0079	.0053	.0025	.0016
Functional Specialization	44	2378	.239	.0372	.0156	.0038	.0016	.0002
Standardization	15	902	.227	.0287	.0148	.0034	.0015	.0032
Overall Formalization	43	2853	.173	.0303	.0134	.0021	.0009	.0004
Role Formalization	25	1013	.218	.0372	.0209	.0032	.0015	.0010
Vertical Span	29	2964	.268	.0292	.0080	.0046	.0019	n.a.
Centralization	56	3423	.025	.0496	.0153	.0000	.0000	.0000
CEO Span of Control	20	2081	.189	.0116	.0090	.0025	.0009	n.a.
Supervisor's Span of Control	22	2592	.078	.0132	.0083	.0004	.0002	n.a.
% Direct Workers	12	497	-.207	.0654	.0224	.0029	.0011	n.a.
% Workflow Supervisors	7	210	-.088	.0132	.0344	.0006	.0002	n.a.
% Nonworkflow Personnel	9	369	.131	.0100	.0244	.0012	.0004	n.a.
% Supervisors	10	1813	-.096	.0251	.0050	.0007	.0002	n.a.
% Clerical Personnel	13	1996	.002	.0106	.0064	.0000	.0000	n.a.
% Public Relations	3	148	.121	.0164	.0199	.0010	.0004	n.a.
% Sales and Service	5	186	.097	.0046	.0276	.0007	.0002	n.a.
% Transportation	5	180	.212	.0104	.0272	.0030	.0012	n.a.
% Personnel	3	142	.062	.0150	.0211	.0003	.0001	n.a.
% Training and Development	4	155	.143	.0075	.0267	.0014	.0005	n.a.
% Welfare and Security	4	153	.202	.0104	.0264	.0028	.0011	n.a.
% Purchasing & Stock Control	5	180	.049	.0039	.0292	.0002	.0001	n.a.
% Facility Maintenance	7	310	.239	.0190	.0206	.0038	.0015	n.a.
% Financial Control	5	188	.034	.0063	.0278	.0001	.0000	n.a.
% Workflow Planning and Control	4	160	-.099	.0257	.0240	.0007	.0003	n.a.
% Quality Evaluation and Control	5	180	.126	.0213	.0279	.0011	.0004	n.a.
% Work Study	3	140	.000	.0017	.0219	.0000	.0000	n.a.
% Design and Development	5	167	.059	.0045	.0314	.0002	.0001	n.a.
% Administration	12	753	.066	.0367	.0150	.0003	.0001	n.a.
% Legal and Insurance	2	122	.180	.0038	.0153	.0022	.0008	n.a.
% Market Research	3	148	.128	.0146	.0199	.0012	.0004	n.a.

[a]Numbers may not sum across due to rounding.

ture Correlations

ed ce	Variance Expected due to Sampling Error	Variance due to Range Differ- ence	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structure	Residual[a] Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation: Mean	Corrected Correlation: s.d.	90 % Credibility Interval
8	.0079	.0053	.0025	.0016	.0244	41.6	.156	.423	.228	.049 to .798
2	.0156	.0035	.0016	.0002	.0160	57.0	.126	.338	.179	.044 to .632
7	.0148	.0034	.0015	.0032	.0057	80.1	.076	.332	.111	.150 to .514
3	.0134	.0021	.0009	.0004	.0135	55.6	.116	.254	.171	-.027 to .535
2	.0209	.0032	.0015	.0010	.0106	71.5	.103	.334	.158	.074 to .594
2	.0050	.0046	.0019	n.a.	.0146	49.8	.121	.342	.154	.088 to .596
6	.0153	.0000	.0000	.0000	.0342	31.0	.185	.036	.266	-.401 to .474
6	.0090	.0025	.0009	n.a.	-.0009	100+	0	.244	0	.244
2	.0083	.0004	.0002	n.a.	.0043	67.7	.065	.101	.084	-.038 to .240
4	.0224	.0029	.0011	n.a.	.0390	40.4	.197	-.265	.254	-.683 to .152
2	.0344	.0006	.0002	n.a.	-.0220	100+	0	-.113	0	-.113
0	.0244	.0012	.0004	n.a.	-.0160	100+	0	.169	0	.169
1	.0050	.0007	.0002	n.a.	.0192	23.4	.139	-.124	.179	-.419 to .171
5	.0064	.0000	.0000	n.a.	.0044	59.4	.066	.003	.086	-.138 to .144
4	.0199	.0010	.0004	n.a.	-.0050	100+	0	.157	0	.157
6	.0276	.0007	.0002	n.a.	-.0239	100+	0	.126	0	.126
4	.0272	.0030	.0012	n.a.	-.0210	100+	0	.272	0	.272
0	.0211	.0003	.0001	n.a.	-.0064	100+	0	.080	0	.080
5	.0267	.0014	.0005	n.a.	-.0212	100+	0	.184	0	.184
4	.0264	.0028	.0011	n.a.	-.0199	100+	0	.259	0	.259
9	.0292	.0002	.0001	n.a.	-.0255	100+	0	.064	0	.064
0	.0206	.0038	.0015	n.a.	-.0069	100+	0	.306	0	.306
3	.0275	.0001	.0000	n.a.	-.0216	100+	0	.044	0	.044
7	.0240	.0007	.0003	n.a.	.0036	87.3	.060	-.128	.078	-.257 to .000
3	.0279	.0011	.0004	n.a.	-.0081	100+	0	.163	0	.163
7	.0219	.0000	.0000	n.a.	-.0202	100+	0	.000	0	.000
5	.0314	.0002	.0001	n.a.	-.0273	100+	0	.076	0	.076
7	.0150	.0003	.0001	n.a.	.0213	41.9	.146	.085	.189	-.226 to .396
8	.0153	.0022	.0008	n.a.	-.0146	100+	0	.232	0	.232
6	.0199	.0012	.0004	n.a.	-.0070	100+	0	.166	0	.166

Table VI-2. Second-Order Meta-Analysis of the Relationship Between Technology and Structure

Variable	k	N	Corrected Mean r	% Variance Explained	Reciprocal
Division of Labor	26	2726	.423	41.6	.0240
Functional Specialization	44	2378	.338	57.0	.0175
Standardization	15	902	.332	80.1	.0125
Overall Formalization	43	2853	.254	55.6	.0180
Role Formalization	25	1013	.334	71.5	.0140
Vertical Span	29	2964	.342	49.8	.0201
Centralization	56	3423	.036	31.0	.0322
CEO Span of Control	20	2081	.244	107.5	.0093
Supervisor's Span of Control	22	2592	.101	67.7	.0148
% Direct Workers	12	497	-.265	40.4	.0248
% Workflow Supervisors	7	210	-.113	267.0	.0037
% Nonworkflow Personnel	9	369	.169	259.9	.0038
% Supervisors	10	1813	-.124	23.4	.0427
% Clerical Personnel	13	1996	.003	59.4	.0168
% Public Relations	3	148	.157	130.6	.0076
% Sales & Service	5	188	.126	616.1	.0016
% Transportation	5	180	.272	300.9	.0033
% Personnel	3	142	.080	142.9	.0070
% Training & Development	4	155	.184	382.7	.0026
% Welfare & Security	4	153	.259	290.9	.0034
% Purchasing & Stock Control	5	180	.064	754.2	.0013
% Facility Maintenance	7	310	.306	136.3	.0073
% Financial Control	5	188	.044	444.9	.0022
% Workflow Planning & Control	4	160	-.128	87.3	.0115
% Quality Evaluation & Control	5	180	.163	137.9	.0072
% Work Study	3	140	.000	1279.3	.0008
% Design & Development	5	167	.076	707.4	.0014
% Administration	12	753	.085	41.9	.0238
% Legal & Insurance	2	122	.232	482.1	.0021
% Market Research	3	148	.166	147.7	.0068
Average Reciprocal of Explained Percentage					.0115
Average Variance Explained (Inverse of Average Reciprocal)					87.2%

Table VI-3. Overall Results for Technology-Structure Correlations: 95% Confidence Interval

Variable	Corrected Correlation k	n	Mean	s.d.	s.e.	95% Confidence Interval
Division of Labor	26	2726	.423	.228	.0515	.32 to .52
Vertical Span	29	2964	.342	.154	.0361	.27 to .41
Functional Specialization	44	2378	.338	.179	.0385	.26 to .41
Role Formalization	25	1013	.334	.158	.0562	.22 to .44
Standardization	15	902	.332	.111	.0546	.22 to .44
% Facility Maintenance	7	310	.306	.000	.0694	.17 to .44
% Transportation	5	180	.272	.000	.0927	.09 to .45
% Direct Workers	12	497	-.265	.254	.0920	-.44 to -.08
% Welfare and Security	4	153	.259	.000	.1010	.06 to .46
Overall Formalization	43	2853	.254	.171	.0374	.18 to .33
CEO Span of Control	20	2081	.244	.000	.0273	.19 to .30
% Legal and Insurance	2	122	.232	.000	.1137	.01 to .45
% Training and Development	4	155	.184	.000	.1028	-.02 to .38
% Nonworkflow Personnel	9	369	.169	.000	.0669	.04 to .30
% Market Research	3	148	.166	.000	.1054	-.04 to .37
% Quality Evaluation and Control	5	180	.163	.000	.0960	-.02 to .35
% Public Relations	3	148	.157	.000	.1057	-.05 to .36
% Workflow Planning and Control	4	160	-.128	.078	.1097	-.34 to .09
% Sales and Service	5	188	.126	.000	.0946	-.06 to .31
% Supervisors	10	1813	-.124	.179	.0642	-.25 to .00
% Workflow Supervisors	7	210	-.113	.000	.0901	-.29 to .06
Supervisor's Span of Control	22	2592	.101	.084	.0311	.04 to .16
% Administration	12	753	.085	.189	.0722	-.06 to .23
% Personnel	3	142	.080	.000	.1094	-.13 to .29
% Design and Development	5	167	.076	.000	.1013	-.12 to .28
% Purchasing and Stock Control	5	180	.064	.000	.0976	-.13 to .26
% Financial Control	5	188	.044	.000	.0956	-.14 to .23
Centralization	56	3423	.036	.266	.0433	-.05 to .12
% Clerical Personnel	13	1996	.003	.086	.0376	-.07 to .08
% Work Study	3	140	.000	.000	.1107	-.22 to .22

CHAPTER VII

FACTORS CONTRIBUTING TO OVERESTIMATES OF RESIDUAL STANDARD DEVIATION

Based upon the outcomes of the 30 meta-analyses discussed in the previous chapter the conclusion could be drawn that in those cases where all of the variance is explained by artifacts (i.e., 17 of the 30 analyses) the situation specificity hypothesis is rejected. No moderating variables affect the relationship. For the remaining 13 analyses the percentage of variance explained ranges from 23 percent for percentage supervisors to 87 percent for percentage workflow planning and control. Residual variances range from .0390 for percentage direct workers down to .0036 for percentage workflow planning and control. However, before concluding that these residual variances are nonartifactual and represent the affect of situational moderators other factors that contribute to an overestimation of the residual should be considered.

Uncorrected Artifacts

In an earlier chapter several sources of artifactual error were discussed. Meta-analysis can correct for only four of those artifacts: (a) error variance due to differences between studies in the reliability of the dependent variable measure, (b) error variance due to difference between studies in the reliability of the independent variable measure, (c) error variance due to differences between studies in the degree of range restriction, and (d) error variance due to sampling error. The first three can only be corrected for if the reliability of measures is known and the extent of range restriction is known. In the last chapter it was noted that the reliability for many of the dependent variables could not be determined so no correction could be made for that artifact. Therefore the residual standard deviation may be slightly overstated due to the effect of that artifact.

However, there are other sources of artifactual error that cannot be corrected for at all. These are: (a) variance due to a difference between studies in the extent of departure from perfect construct validity in the measures of the independent and the dependent variables, and (b) error variance due to computational and typographical errors. Both of these sources of error are at work in the technology literature. The proliferation of operational measures of both technology and the various structural variables suggests something less than perfect construct validity exists. The extent to which this artifact results in an overestimate of residual standard deviation is not certain, but it must be recognized as a source. Computational and typographical errors are also a virtual certainty, but no correction can be made for them.

Other Factors

Hunter and Schmidt (in press) discuss four factors that cause an overestimation of the corrected residual standard deviation (SD_p). They include: (a) the presence of non-Pearson correlations in the meta-analysis, (b) the use of study observed correlations in the formula for sampling error variance (i.e., versus using an average correlation for several studies as done in these analyses), (c) failure to allow for the non-linearity in range correction in meta-analyses based on artifact distributions, and (d) presence of outliers in the correlations included in the meta-analysis.

The Presence of Non-Pearson Correlations

Non-Pearson r's have larger standard errors than do Pearson r's. The formula used in meta-analysis assumes the standard error for Pearson r's so it underestimates sampling error for non-Pearson r's. More accurate estimates are possible if non-Pearson r's are removed. While there are some point-biserial correlations included in the current analyses, these are Pearson r's so they present no problem.

Use of Observed r in Computation of Sampling Error

Observed correlations in these studies will differ from the true correlation in both directions, and since sample sizes are small this deviation can be significant. If the observed correlation is used as an estimate for the population correlation in the formula for sampling error variance, there will be an underestimate of the sampling error variance.

For example, if the true correlation in the population is .20, the sampling error variance with a sample size of 50 would be .0188. If an observed correlation is $r = .00$ (i.e., negative sampling error of .20) the estimate of sampling error variance would be .0204, or 8.5 percent higher. But, if an observed correlation of $r = .40$ is used (i.e., positive sampling error of .20) the estimate is .0104, or 44.7 percent lower than that for the true correlation. On average, the use of observed correlations in the formula for sampling error will underestimate the amount of sampling error variance for the true correlation.

Hunter and Schmidt (in press) state that the use of the mean correlation ($\bar{r}$) in the formula for computing sampling error variance is more accurate than using the study observed correlation, because it has less sampling error. This factor is not a problem in the analyses presented here because $\bar{r}$ was used to compute sampling error variance.

Correction for Range Restriction

The correction for range restriction is greater for small correlations than it is for large correlations. This means that the standard deviation of individually corrected correlations is less than that where the same constant is used to correct all correlations. However, the artifact distribution approach used in these analyses does not correct each correlation individually, instead it corrects the mean correlation ($\bar{r}$) for range restriction. This implicitly assumes linearity in the correction for range restriction and results in an overestimate of the residual standard deviation.

Presence of Outlier Studies

Outlier studies can have a significant impact on the variance observed between correlations. This can be particularly true when the number of studies is small as in the meta-analyses presented here. However, it is this same condition of having a small number of studies that makes outlier analysis unfeasible. Tukey (1960) recommends the deletion of the most extreme values before analysis of any data set; the top 5 percent and the bottom 5 percent is recommended. However, this procedure also requires a fairly large data set to start with. Frank Schmidt suggests, as a rule of thumb, that outlier analysis should not be attempted when there are fewer than 50 data points (F. L. Schmidt, personal communication, June 22, 1989).

However, before conducting moderator tests in the following chapters it is important that the characteristics of studies contributing extremely large or extremely small correlations be determined. Since moderators will be tested by forming subgroups of studies, the identification of extreme values is even more important. The presence of an extremely large or small correlation in these subgroups will have a more significant impact on the mean and variance of that subgroup than it does on the total sample. Identification of these studies will temper the moderator analyses; what appears to be a moderator effect could be caused by a single study.

The next section will examine the range and physical distribution of correlations included in those meta-analyses in which less than 90 percent of the observed variance was explained by artifacts.

Description of Distributions of Correlations

Beginning in the next chapter, and continuing for the next five chapters, tests will be conducted to determine whether or not moderator variables contribute to the observed variance between study correlations. This will involve the formation of subgroups of correlations on the basis of moderator categories. If extreme correlations have a significant impact on the results of analyses combining all correlations, they have a potentially greater impact on the smaller subgroups formed for moderator tests.

Consider, for example, a situation where a moderator subgroup includes a single large sample correlation from either extreme of the combined group. If there is a true moderator effect, other correlations in that subgroup will gather closer together (i.e., have a narrower range) than did the correlations in the combined study, and the subgroups will tend not to overlap each other and therefore yield different mean correlations. However, if the correlation that was extreme in the combined group is also extreme in the moderator subgroup, and it has a larger than average sample size, it will have two effects. First, the mean correlation for the subgroup will be biased toward the extreme value. Second, the residual variance of the subgroup may be higher than that for the combined studies. Reliance solely on the difference between mean correlations of the subgroups ignores the large variance within subgroups.

This section will focus on the distribution of study correlations for those 13 variables with less than 90 percent of the observed variance explained by artifacts.

Figure VII-1 through Figure VII-13 provide a visual representation of those distributions. The horizontal axis in each of these figures represents the observed correlation. The vertical axis represents the sample sizes associated with the observed correlations. The existence of extreme positive or negative correlations has a significant impact on both the observed variance and the mean correlation of these distributions. This impact is particularly strong if the sample size for these extreme correlations is larger than the average sample size. Familiarity with these distributions will be helpful during the discussion of moderator tests in the following chapters.

Figures VII-1 through VII-13 demonstrate graphically that, as a general rule, the sample sizes are smaller at the extreme ends of the distribution. Stated another way, the greatest deviation from the mean value comes from small samples (i.e., sampling error). The following discussions will concentrate on the exceptions to this general rule (i.e., larger samples in the extreme areas of the distribution).

Division of Labor

Figure VII-1 shows the distribution of the 26 correlations included in the analysis of division of labor. As stated earlier, the mean correlation is $\bar{r} = +.30$ which is in the right half of the distribution. Several samples cluster near this area: r = .36 and n = 110 (Study 42), r = .37 and n = 1,201 (Study 13c), r = .29 and n = 142 (Study 20), r = .38 and n = 123 (Study 50), and r = .39 and n = 295 (Study 91). These studies appear to have very little in common except that the first two were conducted by Peter Blau.

The studies that are of more interest are the ones with larger than average sample sizes that deviate from the mean correlation. In Figure VII-1 there are three studies with sample sizes greater than 70 that have negative correlations. The study second furthest from the left in Figure VII-1 (r = -.39 and n = 77) operationalized technology as the variety of possible customer needs that the retail firms could satisfy through products and services sold (i.e., task scope). Division of labor was operationalized as the number of occupational specialities that represent distinctive types of knowledge and training (Study 70). This study was designed to be a replication of the study that is furthest to the left in Figure VII-1 (r = -.42 and n = 16) which was conducted by Dewar and Hage in 16 social service agencies (Study 25). Both studies found that as the scope of the organization's task increased, so did the division of labor. The sign of the correlations were reversed for these meta-analyses to indicate a correlation with reduced task scope (i.e., reduced variety and uncertainty).

Moving toward the center of the distribution we find a correlation of r = -.106 for a sample of 75 subunits of various types (Study 31), and a correlation of r = -.009 for a sample of 71 federal government organizations (Study 10). In the first study technology was operationalized as the type of interdependence, and the extent of task variety. Division of labor was measured as the number of occupational specialities (Study 31). In the other study technology was measured as task routineness, and division of labor as the number of job titles (Study 10).

Functional Specialization

The distribution of 44 correlations displayed in Figure VII-2 shows far less variation than was seen in the previous figure for division of labor. The mean correlation for this distribution is $\bar{r}$ = .24. The effect of sampling error can be seen by observing that the sample sizes tend to become smaller as we move away from the mean correlation in either direction. The one exception is to the far left in Figure VII-2 (i.e., r = -.25 and n = 77). This is the same study that was at the extreme for division of labor (Study 70).

Standardization

Figure VII-3 displays the distribution of 15 correlations between measures of technology and standardization. Only three studies result in negative correlations: Kieser's study of 51 German manufacturers (Studies 14 & 17); the Conaty, Mahmoudi and Miller sample of 64 Iranian firms (Study 21b); and the Loveridge sample of 62 nursing care units (Study 57). With these exceptions all other correlations are greater than zero and fall into a fairly narrow range. The distribution of correlations displayed in Figure VII-3 represents no more deviation than would be expected due to sampling error. As Table

VI-1 showed in the previous chapter, there is a very small residual variance for these 15 studies (i.e., .0057) and artifacts account for over 80 percent of the observed variance.

Overall Formalization

Forty-three correlations are displayed in Figure VII-4. All 43 tend to fall within a fairly narrow band around the mean correlation of $\bar{r} = +.19$. There is one larger-sample study at the extreme left side of the distribution that warrants some special attention. This is the Sutton and Rousseau study of 155 individuals in 14 northern California organizations (Study 85). The unit of analysis for this study is the individual but technology was measured as the level of interdependence at the organization level.

This study, with its correlation of r = -.12, will be a significant factor in Chapter XI where the effect of level of analysis will be assessed, and in Chapter XII where the effect of type of measure is tested.

Role Formalization

Figure VII-5 displays the 25 correlations analyzed under role formalization. Generally speaking, the correlations at the extreme ends of this distribution are representative of smaller sample sizes. One exception is the Harvey study of 43 manufacturers with a correlation of r = +.71 (Study 37). If the Harvey study is removed from the meta-analysis leaving 24 studies, the mean correlation ($\bar{r}$) declines only slightly from +.22 to +.20, but the observed variance drops from .0372 to .0275 and sampling error explains 83 percent of that variance. Other artifacts would explain the balance.

In short, there would be no residual variance in the analysis of role formalization if Harvey's study is excluded. However, it is not the goal of these analyses to artificially explain all variance by selectively removing extreme values as outliers. Nevertheless, it will be important to remember where the Harvey study falls during the moderator tests.

Vertical Span

Thirty correlations are displayed in Figure VII-6. The mean correlation of $\bar{r}$ = +.26 falls approximately midway between the correlations from the two largest samples, and in an area of white space that seems to separate the correlations into two groups. The study to the extreme right is that conducted by Woodward (1965). The large positive correlation of r = +.77 was calculated from Woodward's data (Study 96). Woodward did not provide correlations for her study, but she did provide tables in which she distributed her sample organizations into cells. These cell values and frequencies were used to calculate this correlation coefficient (Woodward, 1965: 52).

Centralization

The analysis of centralization included 56 correlations which are displayed in Figure VII-7. One characteristic that stands out is the very tight clustering of studies around the zero-point.

The largest sample in this display also yields a correlation near the extreme end of the distribution. This is a study conducted by Mills, Turk and Margulies (Study 66) of 337 lower level employees in four organizations. This study has a significant effect on the observed variance and a lesser effect on the mean correlation. It is one of only three studies using the individual as the level of analysis, and uses a perceptual (questionnaire) measure. The other two studies are those of Hrebiniak involving 174 workers in one hospital (Study 40) and the Sutton and Rousseau study of 155 managers in 14 organizations (Study 85). The Sutton and Rousseau study is near the left hand extreme of Figure VII-7 with a correlation of r = -.33. Note that this study also appeared to be an exception in the case of overall formalization (Figure VII-4). Thus, we find two of the three individual level studies providing significantly different correlations, and their relatively large sample sizes multiply the impact they have on the results of these meta-analyses. During moderator tests in upcoming chapters these three studies may have an effect in the test of both level of analysis (Chapter XI) and type of measure (Chapter XII) as potential moderators.

Supervisor's Span of Control

Figure VII-8 displays the distribution of 23 correlations included in the meta-analysis of the relationship between technology and the supervisor's span of control. Twelve of these studies form a tight cluster around the zero point, and the small positive mean correlation of $\bar{r}$ = +.08 is pulled away from zero due to the presence of the Blau and Schoenherr studies of 1,201 local offices of employment security (Study 13c), and 416 municipal finance departments (Study 13b). The largest positive correlation is r = +.47 from Bell's study of 30 departments in a single community hospital (Study 9), but this deviation from the mean is no more than would be expected due to the sampling error associated with this small sample size.

However, there does appear to be an exception at the other extreme of the scale. This is the Woodward (1965) study of 78 British manufacturers (Study 96) with a correlation of r = -.231. This study also appeared to be an exception in the distribution of correlations with vertical span (Figure VII-6), and it will appear two more times in the following sections.

Percentage Direct Workers

Figure VII-9 shows that the 12 correlations included in the meta-analysis of percentage direct workers are widely dispersed, but generally have a negative relationship with technology. The largest negative correlation is from the Woodward study of British manufacturers (Study 96). It is worthy of note that eight of the studies support Woodward's original findings with respect to the direction of the relationship to percentage direct workers, but not with the size of the effect.

Percentage Supervisors

Only 10 correlations were found for the relationship between technology and the percentage supervisors as shown in Figure VII-10. With the exception of 1 extreme positive correlation most of the other 9 correlations tend to be negative in sign and are confined to a fairly narrow band of values.

The extreme positive correlation is from Harvey's study of 43 industrial organizations (Study 37). Note that this study was also identified as an exception in the analysis of role formalization (Figure VII-5). The one unique thing about this study is Harvey's operationalization of technical diffuseness as the number of product changes over a 10 year period. The correlation included in these meta-analyses relates percentage supervisors to increasing technical specificity (i.e., decreasing number of product changes). The reasoning for this is that increased technical specificity is associated with more routine technology and increased certainty. Harvey's results would indicate that as the number of product changes declines (i.e., reduced diffuseness, and increased routineness), the percentage of the total work force that are supervisors increases. This seems counter-intuitive, but no other study was found that used this operationalization of technology.

Removal of Harvey's study from the meta-analysis reduces the amount of observed variance from .0251 to .0075 and variance explained by sampling error increases from 20 percent to over 66 percent. Other artifacts explain an additional 18 percent. The mean correlation, with Harvey's study removed, only changes slightly from $\bar{r} = -.096$ to $\bar{r} = -.117$.

Percentage Clerical Personnel

Figure VII-11 provides the distribution of 13 correlations between technology measures and the percentage of organizational personnel performing clerical duties. Ten of these correlations group together around the mean correlation of $\bar{r} = +.002$. The largest sample of 1,201 local offices of the U.S. Employment Service (Study 13c) falls within this grouping.

One study stands out as an exception to the general finding that extreme correlations are derived from the smaller samples. That is the Leatt and Schneck study of 148 subunits of hospitals in Canada with $r = -.212$ (Study 55). The researchers used a questionnaire measure to assess nurses' perceptions of the subunit's technological uncertainty, instability, and variability. This is the only study that used a questionnaire measure of technology, and related it to percentage clerical personnel. This study will have a significant impact on the outcome of the moderator test in Chapter XII where the effect of the type of measure will be assessed.

Percentage Workflow Planning and Control

Four studies were included in the meta-analysis of the percentage of an organization's personnel engaged in workflow planning and control. These four, displayed in Figure VII-12, are Al-Jibouri's study of 27 manufacturers in Iraq (Study 3), Child's study of 82 mixed type organizations in England (Study 18), Pugh's study of 52 mixed type organizations in England (Study 38), and Reimann's study of 20 manufacturers in Ohio (Study 77 & 78). All of these studies were conducted at the organization level of analysis using the Aston measurement scales (Aston Data Bank, 1977). Reimann's study provides the only positive correlation. As noted in the previous chapter, any attempt to test for moderators in this relationship is subject to chance. This is because the very small residual variance observed in Chapter VI (i.e., .004) leaves little room for a moderator to operate. These moderator tests will be performed, but any indication that a moderator does exist should be viewed with skepticism.

Percentage Administration

Figure VII-13 displays the distribution of 12 correlations included in the meta-analysis of the administrative ratio. Only 42 percent of the observed variance was explained by artifacts, and the mean correlation is $\bar{r} = .07$. The one study at the extreme right hand side in Figure VII-13 is Woodward's study (Study 96). She found that as the organization technology changed from unit and small batch production to continuous process production, the proportion of personnel in administration increased.

Summary

In this chapter the distribution of correlations was discussed for each of the 13 relationships to be tested for moderators. In several of those relationships one or two extreme values have a significant impact on the observed variance. In the next several chapters these distributions will be divided into subgroups to test for moderators. If there is a real moderator effect the correlations within a particular subgroup will be more homogeneous and display less residual variance than observed in the more heterogeneous combined group of correlations. There should also be a significant difference between the mean correlations of these subgroups. Outliers within a subgroup can have an impact on both the mean and the variance observed.

One other observation is worth noting. That is the frequency with which the same studies were identified as exceptions in Figures VII-1 through VII-13. For example, the Woodward (1965) study was identified four times: vertical span, supervisor's span, percentage direct workers, and percentage administration. In fact, every correlation that could be derived from Woodward's data appears to be extreme. Paulson (Study 70) was identified as an exception for both division of labor, and functional specialization, while Sutton and Rousseau (Study 85) were noted in the case of overall formalization, and for centralization. Finally, the Harvey study had a very significant impact on the meta-analyses of both role formalization, and percentage supervisors (Study 37).

Figure VII-1. Distribution of Correlations Observed for Division of Labor

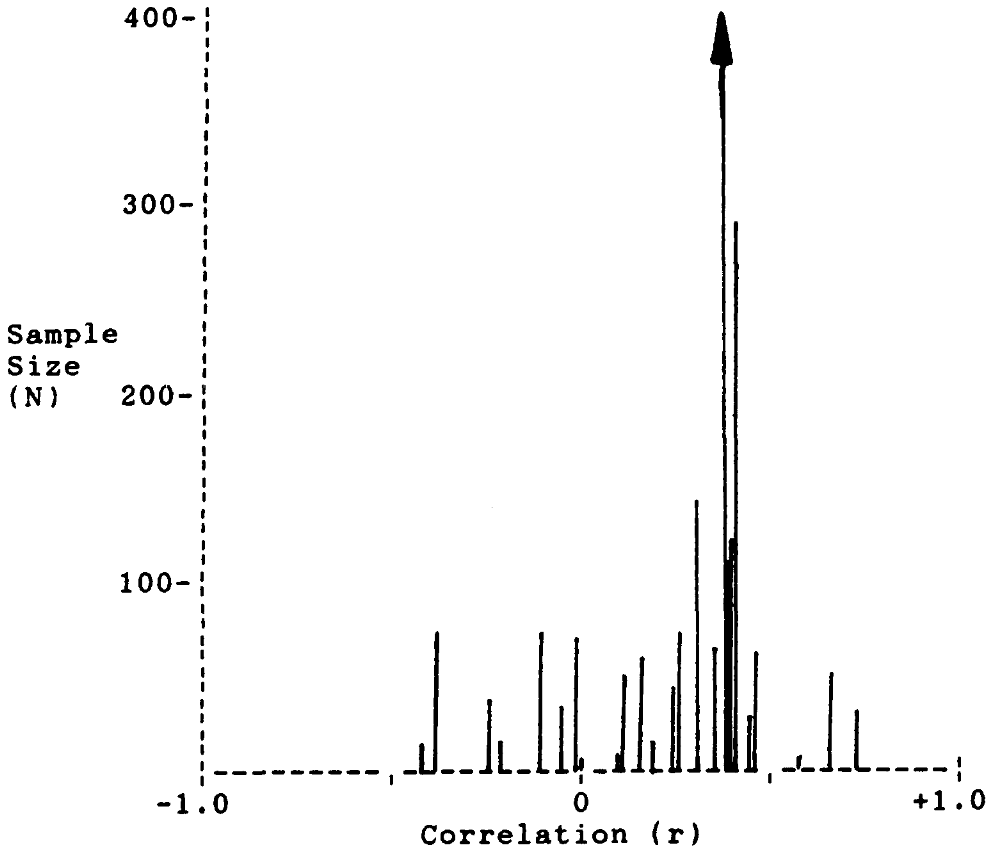


Figure VII-2. Distribution of Correlations Observed for Functional Specialization

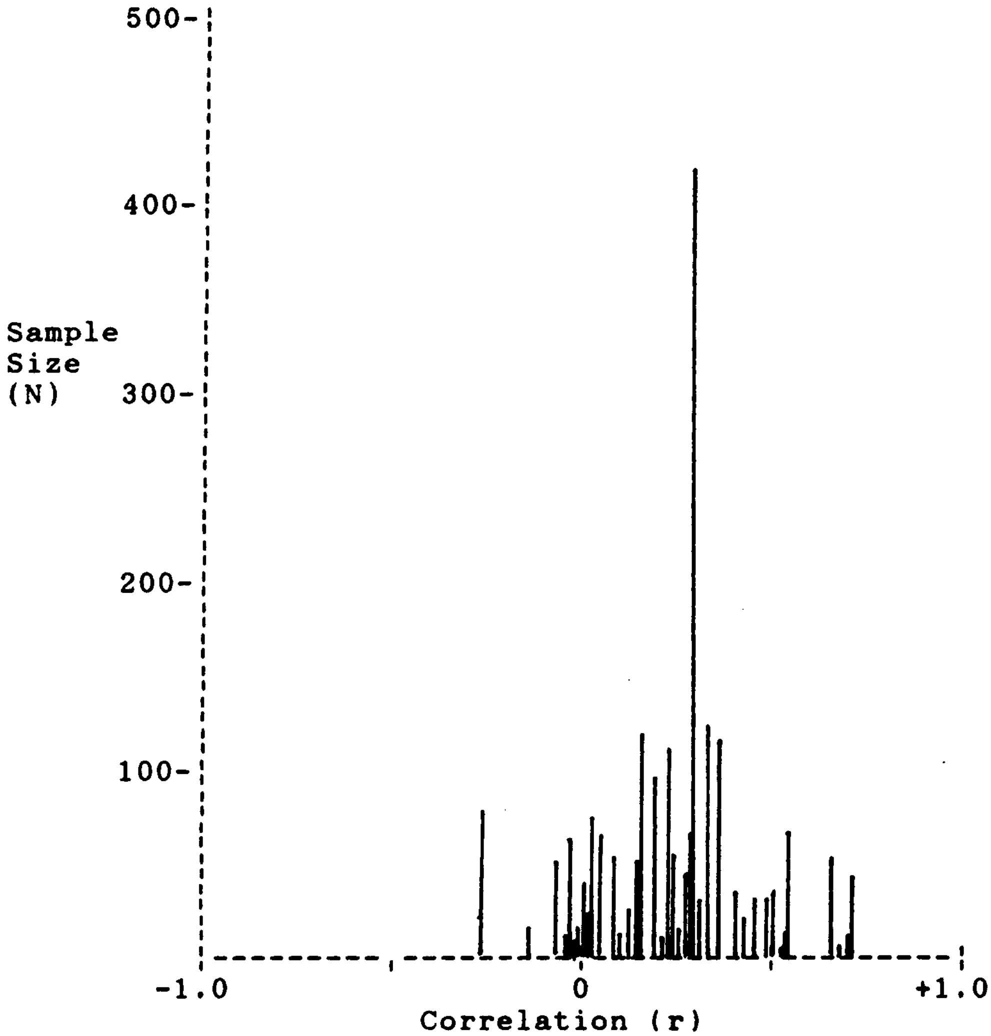


Figure VII-3. Distribution of Correlations Observed for Standardization

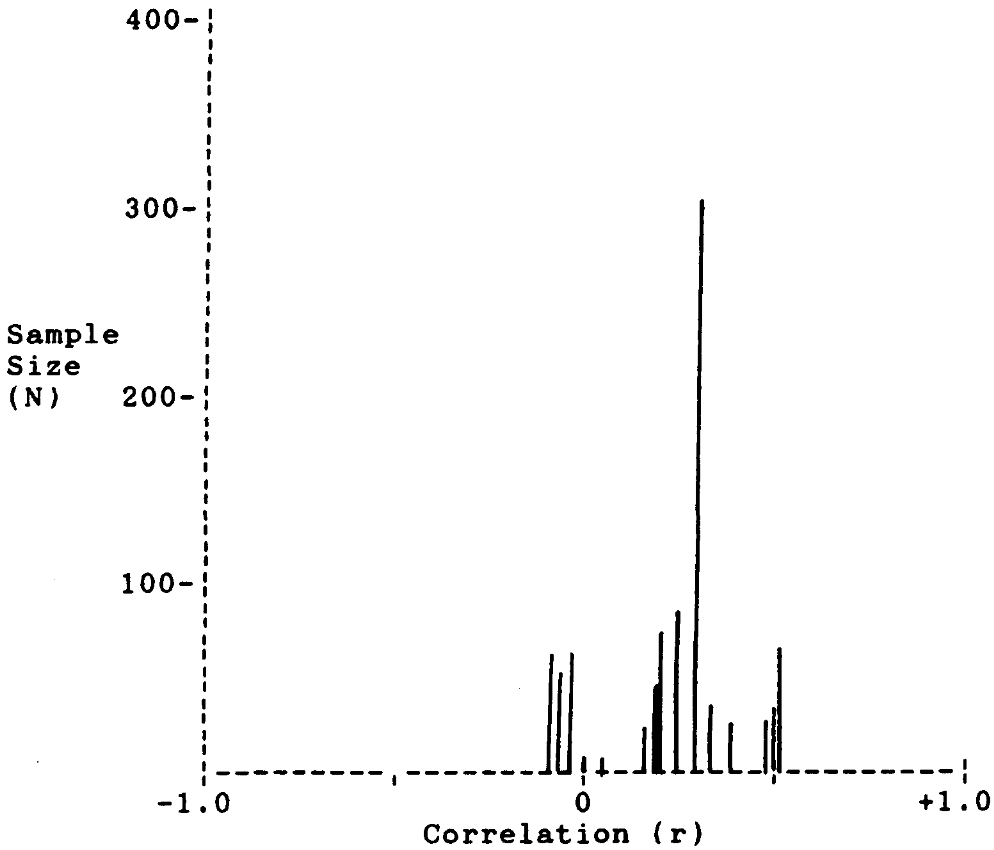


Figure VII-4. Distribution of Correlations Observed for Overall Formalization

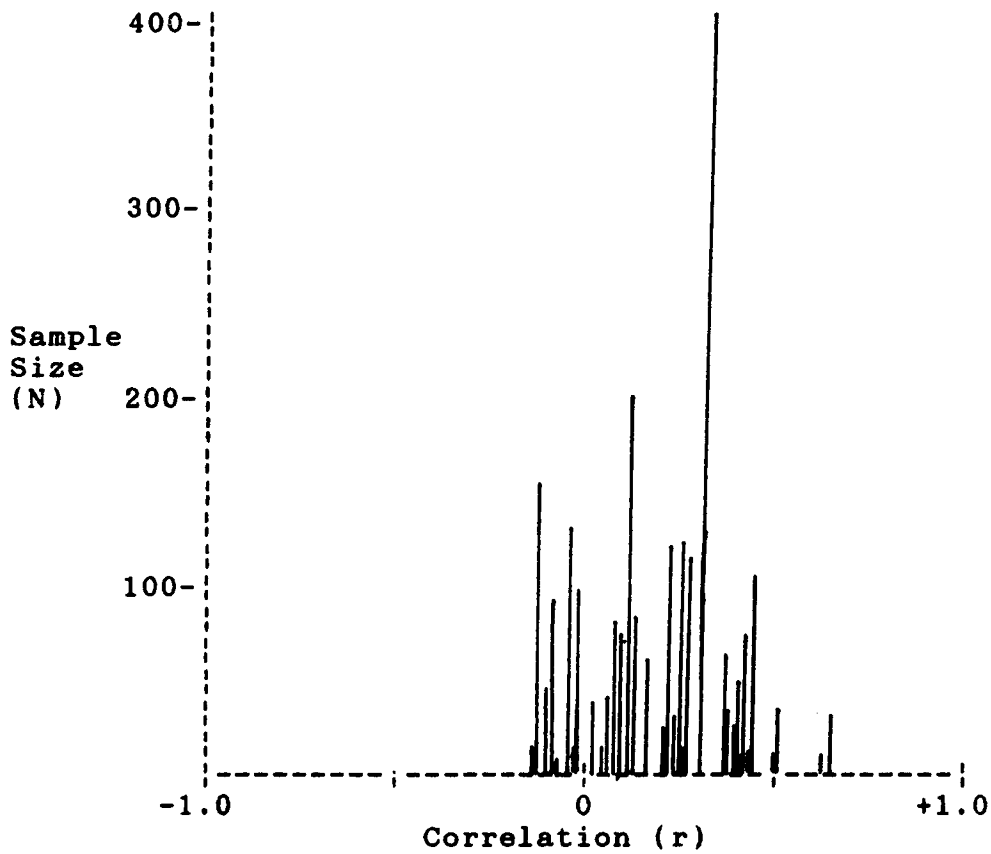


Figure VII-5. Distribution of Correlations Observed for Role Formalization

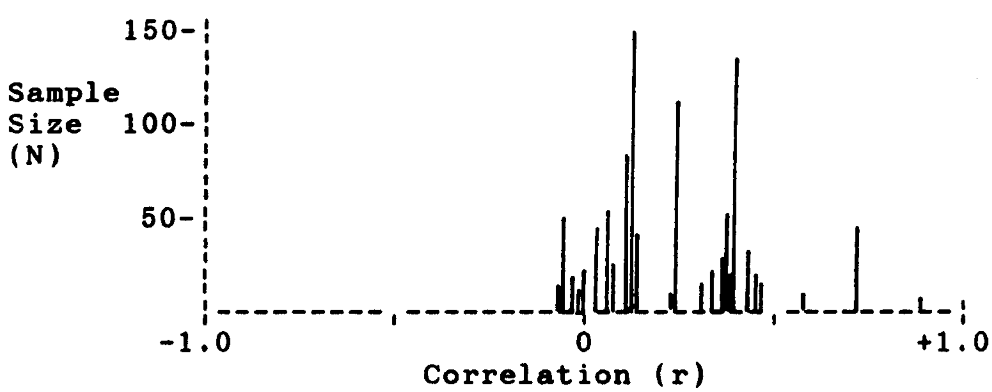


Figure VII-6. Distribution of Correlations Observed for Vertical Span

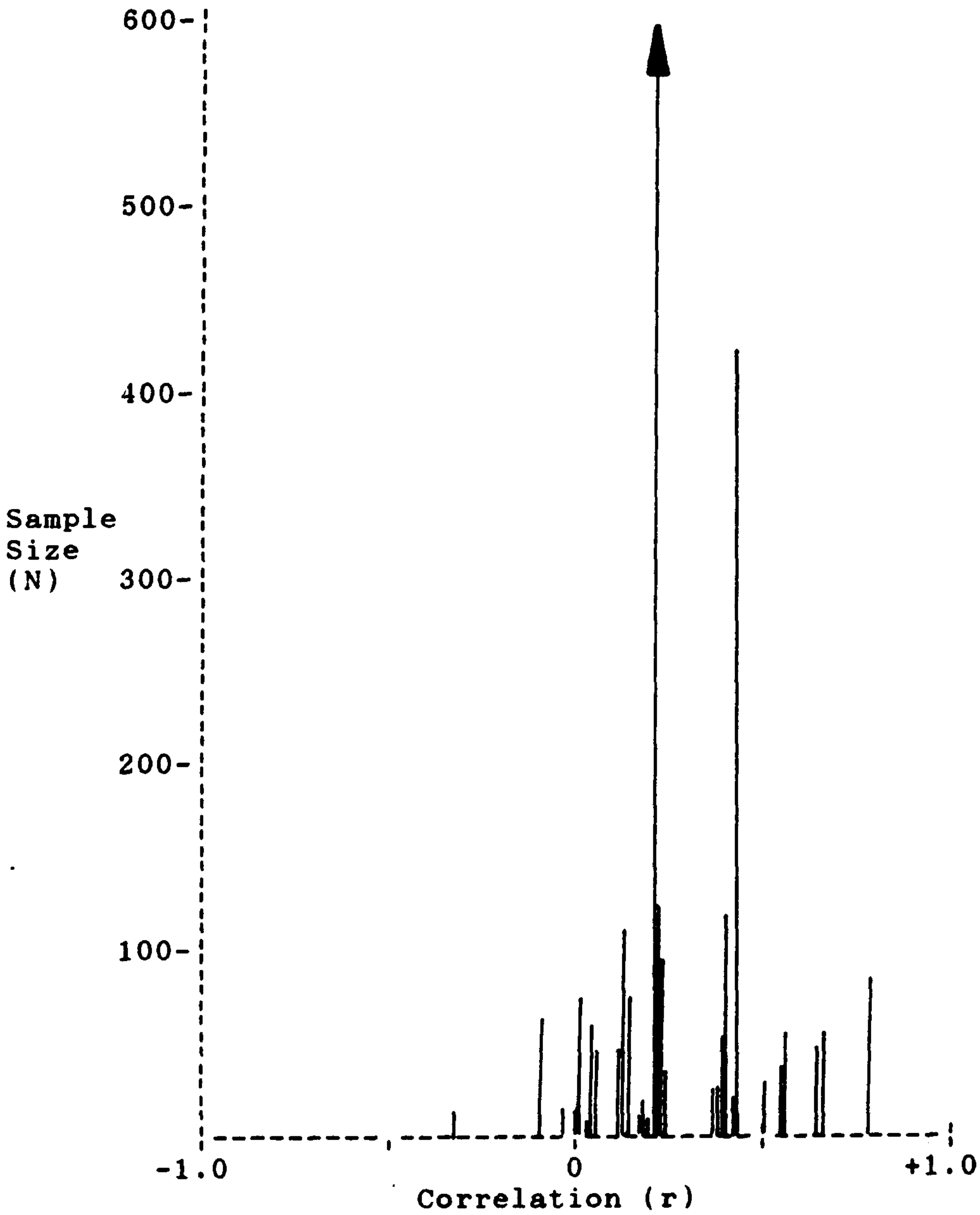


Figure VII-7. Distribution of Correlations Observed for Centralization

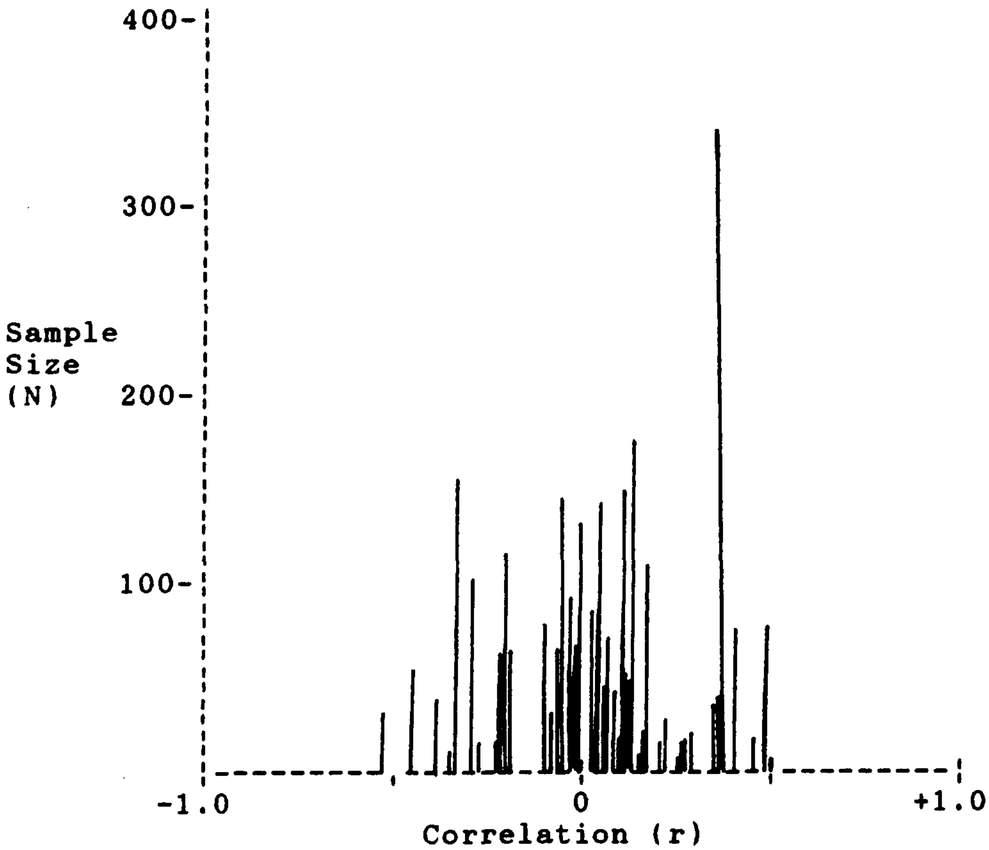


Figure VII-8. Distribution of Correlations Observed for Supervisor's Span of Control

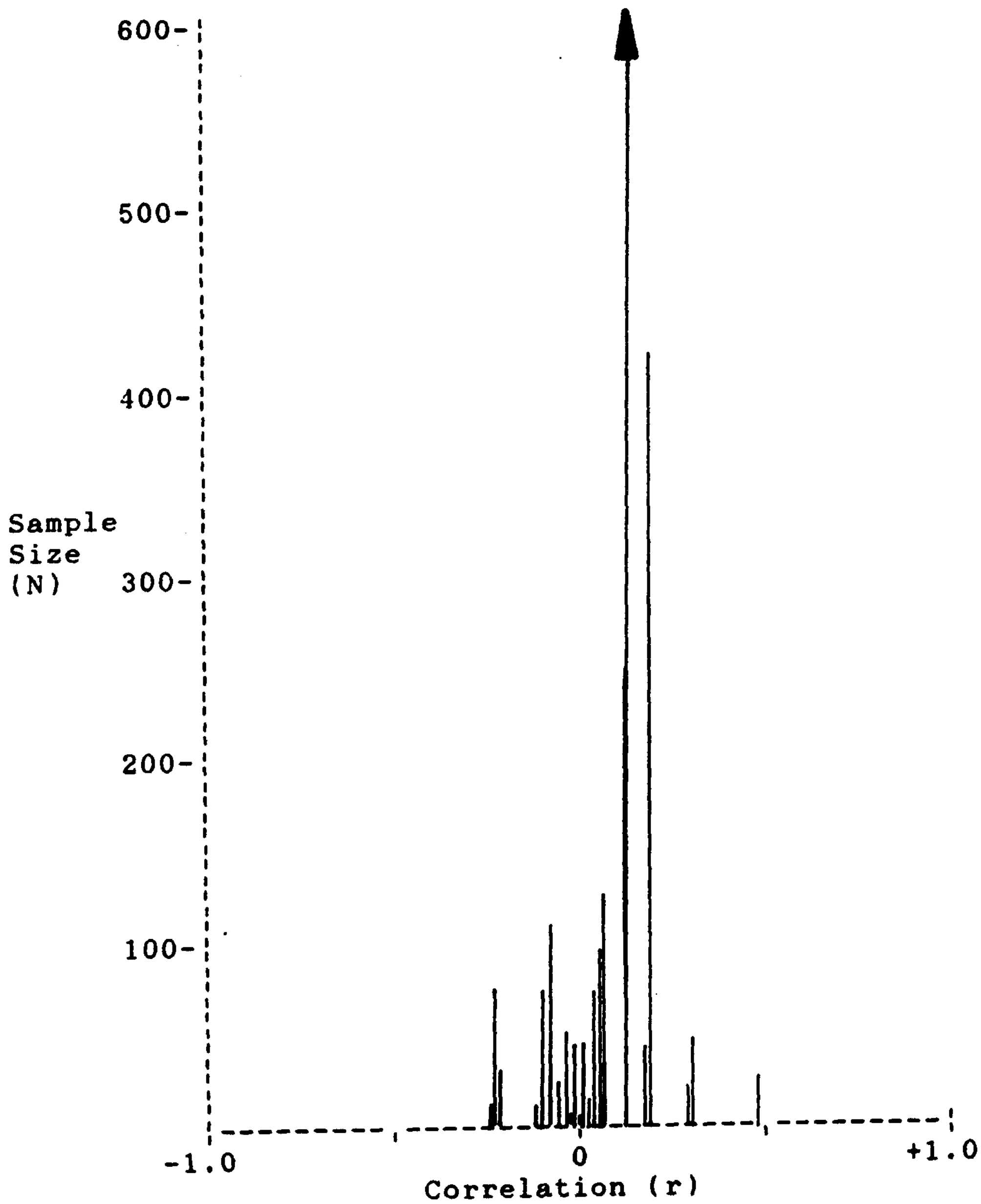


Figure VII-9. Distribution of Correlations Observed for % Direct Workers

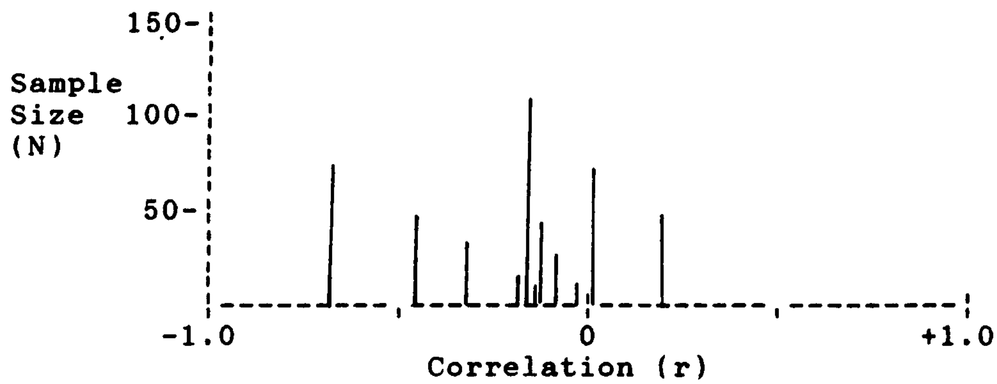


Figure VII-10. Distribution of Correlations Observed for % Supervisors

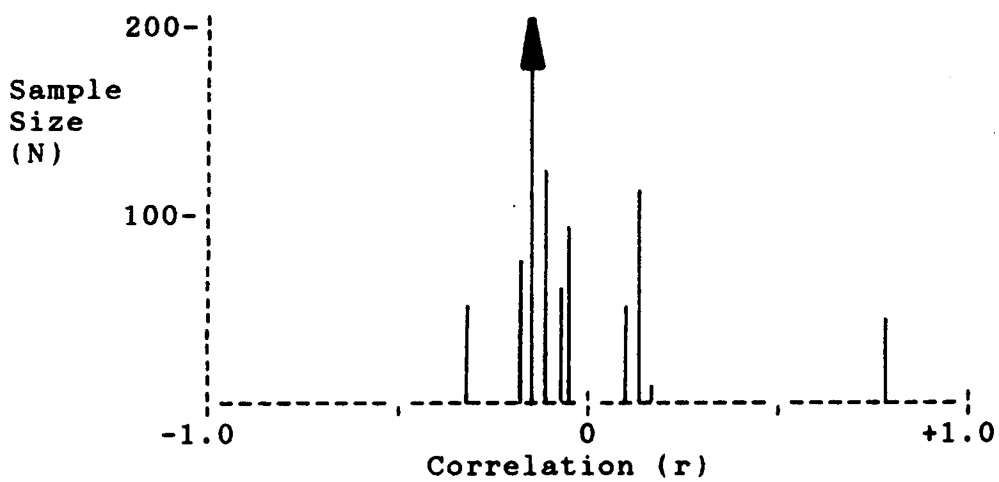


Figure VII-11. Distribution of Correlations Observed for % Clerical Personnel

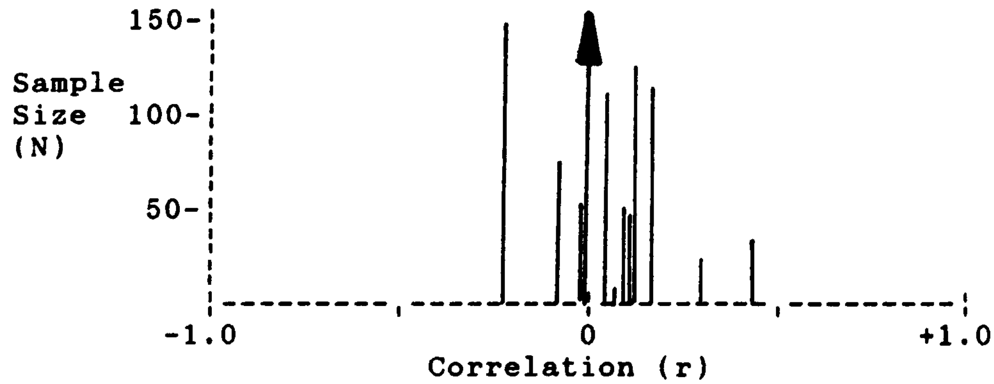


Figure VII-12. Distribution of Correlations Observed for % Workflow Planning and Control

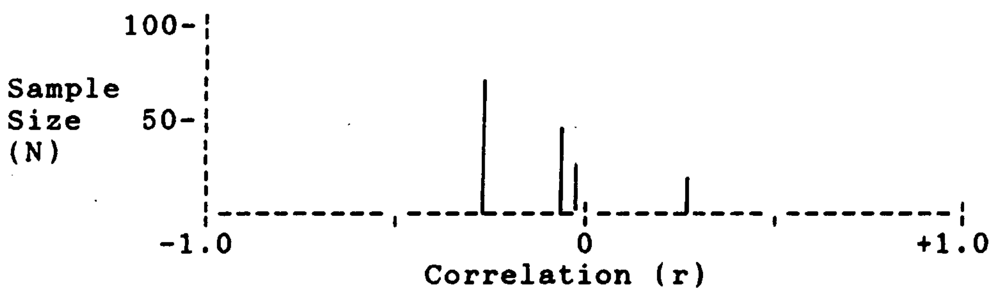
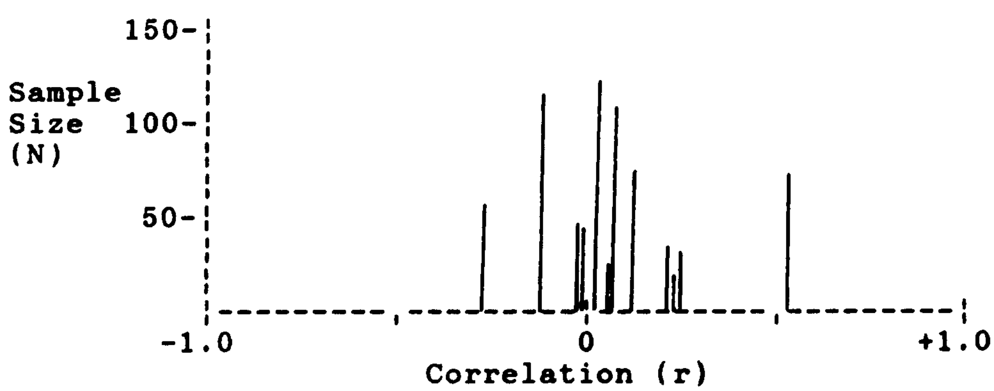


Figure VII-13. Distribution of Correlations Observed for % Administration



CHAPTER VIII

MODERATOR TEST: TECHNOLOGY OPERATIONALIZATION

The proliferation of operational definitions for technology has been suggested as one of the reasons why there is a lack of consistency across studies (Fry, 1982; Reimann & Inzerilli, 1979). Cooper believes that the existence of multiple operational definitions is "the most important source of variance in the conclusions of different reviews meant to address the same topic" (1984: 24). Cooper's comment is not limited to technology-structure research, but applies to integrative research reviews in general.

The hypothesis being tested in this chapter is:

Hypothesis 3: Different operational definitions of technology result in significantly different correlations with measures of structure thus contributing to the variance observed between studies.

Four broad conceptual definitions of technology are used to categorize studies for these analyses. They are workflow continuity, workflow integration and automation, task routineness, and information technology. Workflow continuity includes all versions of Woodward's (1965) scale of unit, mass, and continuous process production. Hickson et al. (1969) considered this to be a subcategory of operations technology, but as the original scale of technology reported in the literature (Woodward, 1965), it has been set apart as a separate category for these analyses.

Workflow integration and automation includes all measures of operations or production technology other than continuity measures. This category is dominated by the workflow integration scale developed by the Aston researchers (Hickson et al., 1969), scales measuring automation of the production process, and measures of interdependence between workflow segments (Thompson, 1967).

Task routineness includes all scales operationalizing Perrow's (1967) concept of routineness. These include scales of task analyzability, exceptions, variety, uncertainty, predictability, and difficulty. The decision rule used to classify studies in this category is the same as that used by Fry in his review (1982). Fry stated that while the definitions used by individual researchers were not exactly the same, they did share common "conceptual underpinnings" (Fry, 1982: 538). An effort was made during the data collection phase to insure that the signs of all correlations were consistent with a measure of increasing routineness, increasing certainty, and so forth.

Finally, information technology includes measures of the extent to which administrative activities are mechanized through the application of computer technology and other forms of electronic data processing. This particular technology concept has not been singled out in previous reviews of the literature, but Blau et al. (1976) suggest that the relationship between measures of information technology and organization structure is stronger than that observed for other measures of technology.

Methodological Considerations

Table VIII-1 presents the results of 13 meta-analyses assessing the difference between four technology concepts. The structural variables being analyzed in this chapter are the 13 variables for which less than 90 percent of the observed variance was explained by artifacts in Chapter VI. Before proceeding with a discussion of the results there are some methodological considerations to be aware of.

Number of Studies Included

Note that the "Total" line for each analysis in Table VIII-1 is copied from the overall analysis reported in Table VI-1 in Chapter VI. Also, note that the total number of studies on this line is less than the sum of the studies for the four technology concepts (e.g., the total line for division of labor says there are 26 correlations, but the four technology subgroups sum to 38 correlations). The reason for this is quite simple. Recall that in Chapter VI a mean correlation was computed for studies that provided correlations with more than one measure of technology. In this chapter, those average correlations have been disaggregated and their component correlations have been assigned to the appropriate subgroup. These individual correlations are shown in Tables IV-1 through IV-3.

Independence of Studies

The average correlations within studies were computed in Chapter VI in order to preserve the assumption of independence in the meta-analyses. The assumption of independence is also met within each of the four subanalyses conducted in this chapter. No single study, or sample, provides more than one correlation to any of the individual meta-analyses in Table VIII-1. However, the assumption of independence is not fully met for comparisons between the subcategories of technology because some studies provide correlations for more than one technology measure with a single structural dimension.

However, for the purpose of the analysis in this chapter, this partial lack of independence between subgroups can be seen as an advantage. To the extent that correlations are derived by the same researchers, or the same sample, an element of control is introduced for many situational factors that may affect the relationship between technology and structure. Differences observed between the various measures of technology within a common setting are not caused by differences in the organization's size, the type of organization under study, or the level of analysis of the study because these are all controlled within studies. After adjustment for artifacts in these correlations, remaining differences are more likely to be due to differences in the underlying characteristics of the different technology measures. It is exactly this difference that is the ultimate concern of this chapter.

Criterion for Moderator Tests

Earlier it was stated that two criteria must be met before a conclusion will be drawn that a true moderator effect is present. The first is a significant difference between the meta-analytic results of two subgroups. The second is a reduction in the residual variance for the subgroups relative to that observed for the analysis of the combined studies. These are not actually separate criteria because one will generally occur with the other. If there is a difference between the mean correlations for different subcategories of studies, the mean residual variance will be lower than the residual variance of the combined subcategories.

However, in this chapter, that general rule does not apply. The formation of the four subcategories of technology concepts involves the disaggregation of the average correlations used in other analyses.

It is entirely possible that these four technology subgroups will yield different mean correlations, while the mean residual variance does not decline. In fact, as will be seen, the mean residual variance may actually increase.

Several situations will be discussed in the following section in which the variance between studies within some subgroups will be much higher than the variance seen in the combined analysis, while other subgroups display a much lower variance. The calculation of average correlations within studies tends to mitigate the effect of those measures that yield more variable correlations. The variance among the average correlations may be less than the mean variance of the individual correlations in the four subcategories.

In this chapter, the analysis will rely primarily upon the differences between subgroups, and will relax the criterion for reduced residual variance.

Simultaneous Tests for Many Comparisons

When several comparisons are made at significance level α, and the differences are in fact zero (i.e., the null hypothesis is true), the chance of incorrectly declaring at least one of the contrasts to be significant will be greater than α. Hedges and Olken suggest that "the simplest simultaneous test procedure is the method of Bonferroni inequalities. If l comparisons are to be tested simultaneously, then each comparison is made at the $\alpha / 2l$ level of significance. . . . Using this procedure, the simultaneous significance level of all comparisons is less than or equal to α" (1985: 161). Note that this describes the procedure for a two-tailed test.

Use of the Bonferroni inequalities method increases the size of the difference that must be observed in order to declare statistical significance. For example, when four subcategories are to be compared, there are six possible paired comparisons (i.e., 4 (4 - 1) / 2). If an alpha level of .05 is set for each of the six comparisons, a z-value of 1.96 is required for a two-tailed test. However, if the alpha level is set so that the probability that only one of the six comparisons would be significant by chance at alpha level .05, a z-value of 2.65 is required for each of the six comparisons.

The results of statistical significance test displayed in Table VIII-2 identify the significance levels associated with both the Bonferroni inequalities method for simultaneous comparisons, and the significance level for each individual comparison. The discussion of results will begin with those five variables that meet the criterion for the Bonferroni inequalities, and then address those that meet the more liberal criterion of individual comparisons.

Results

Meta-analytic results of 13 moderator tests are presented in Table VIII-1. The corrected mean correlations, its standard deviation, the standard error of the corrected mean, and the 95 percent confidence intervals are presented in Table VIII-2. At the far right hand side of Table VIII-2 are the results of statistical significance tests assessing the differences between the mean correlations for each technology category after correction for measurement error and range restriction in the technology measure.

Statistically Significant Differences

For 9 of the 13 variables, at least one comparison results in a statistically significant difference. However, when the Bonferroni inequalities method is applied no significant difference is detected for 4 of those 9 variables (i.e., standardization, role formalization, supervisor's span of control, and percentage direct workers). Thus, only 5 of the 13 variables tested meet the conditions of the Bonferroni inequalities method at the .05 level of significance. Those 5 are division of labor, functional specialization, overall formalization, centralization, and percentage workflow planning and control. However, in only 2 of 9 cases does the mean residual variance for the four subgroups decline from the residual variance of the combined measures.

Division of Labor

All of the technology types show a positive mean correlation but only workflow integration and information technology differ significantly from zero; task routineness approaches significance. Meta-analytic results indicate that information technology has a statistically significantly stronger relationship to the division of labor than do either workflow continuity or task routineness. Table VIII-1 shows that the residual variance declines for both workflow integration and information technology, but the variance for both workflow continuity and task routineness is quite high. In fact, artifacts explain all of the variance within the information technology category.

These results suggest that other situational factors do not moderate the relationship of information technology to division of labor. However, the increase in residual variance for workflow continuity and task routineness suggests a strong likelihood that other situational factors do have an impact on the results of studies included within each of these two categories.

Functional Specialization

Table VIII-2 indicates that, with the exception of workflow continuity and task routineness, all of the corrected mean correlations differ significantly from one another. Table VIII-1 shows that residual variance is lower for both workflow continuity measures and measures of information technology. However, the residual variance for both workflow integration and task routineness increased substantially. As was the case so often, information technology has the largest correlation, followed by workflow integration and then workflow continuity. All three of these measures are significantly greater than zero based upon the 95 percent confidence interval. On the other hand, task routineness does not differ significantly from zero and also has a large residual variance.

Overall Formalization

Table VIII-2 shows that the mean correlation for information technology is significantly higher than any of the other three measures of technology, and those other three measures are nearly identical in magnitude. All four correlations are significantly greater than zero based upon the 95 percent confidence interval. However, Table VIII-1 shows that only information technology shows a reduction in the residual variance when compared to the overall analysis.

Centralization

The results displayed in Table VIII-1 suggest that both workflow integration, and information technology are associated with increased decentralization of decision making authority, while workflow continuity and task routineness are associated with increased centralization. Information technology shows a statistically significant difference from both workflow continuity and task routineness. Task routineness is significantly different from both workflow continuity and workflow integration, and workflow continuity differs significantly from all of the other three. It should also be noted in Table VIII-2 that the confidence intervals for both task routineness, and for information technology do not include zero. This cannot be said for either workflow continuity or workflow integration.

From these results it may be concluded that previous research indicates no relationship between operations technology (i.e., workflow continuity, and workflow integration) and centralization of decision making. On the other hand, the use of computers is associated with greater decentralization, while increased routineness and predictability of the organization's task is associated with greater centralization. The reduction in residual variance seen in Table VIII-1 supports the finding of a moderator effect. The residual, across-study, variance for the combined measures was .0342. The weighted average of the residual variances of the four subgroups is .0205. The residual variance for each subgroup is lower than the combined measures.

Blau and his colleagues obtained similar findings in a study of 110 New Jersey manufacturing firms. However, they went on to show that the decentralization associated with use of computers was confined to operational decisions and not to policy. They concluded that use of a "computer to automate support functions promotes decentralization, though primarily in the form of granting autonomy to the plant manager" (Blau et al., 1976: 35). These findings with regard to computer use do not support Whisler's (1970) contention that the introduction of computers will lead to recentralization of decision making authority.

<u>Percentage Workflow Planning and Control</u>

In this relationship only information technology has a positive correlation. Workflow continuity and task routineness are both significantly less than zero based upon the 95 percent confidence intervals in Table VIII-2. The observed variance between studies for task routineness and information technology is less than that seen for the overall analysis. However, the variance between studies for measures of workflow continuity and workflow integration are more than double that observed in Table VIII-1 for the overall analysis of combined studies.

<u>Standardization</u>

The pattern of correlations for standardization is identical to that found above for division of labor. Information technology has a significantly higher correlation than does either workflow continuity or task routineness. Also, as found with division of labor, workflow integration and information technology are both significantly greater than zero, while task routineness approaches significance (Table VIII-2). However, the residual variance for all four types of technology is higher than that found for the combined studies (Table VIII-1). This indicates that there may be other situational moderators operating within each type of technology measure, or that outliers exist within each type of measure to cause the statistically significant difference observed in Table VIII-2.

Role Formalization

Only workflow integration and task routineness differ significantly in the analysis of role formalization in Table VIII-2. The residual variance for all of these technology measures decreases except for task routineness, and task routineness showed a four fold increase in residual variance.

Artifacts explain all of the variance observed within the workflow continuity and the information technology category, and they can explain nearly 90 percent for workflow integration. The 95 percent confidence intervals for both workflow integration and information technology are above zero, while the confidence intervals for both workflow continuity and task routineness include zero.

Supervisor's Span of Control

In Table VIII-2 it is indicated that information technology is significantly different from workflow continuity. However, none of the four correlations are large enough to be of practical importance, and only the information technology correlation of $\bar{r}$ = +.10 is significantly different from zero. The results displayed in Table VIII-1 show that only information technology shows a lower observed variance than observed in the overall analysis. It does not appear that the operational measure of technology has a very significant effect on the variance observed across studies.

Percentage Direct Workers

Only one comparison in this analysis was significant. Workflow continuity is significantly different from task routineness. The 95 percent confidence intervals in Table VIII-2 show that both workflow continuity and information technology are significantly less than zero, while neither workflow integration nor task routineness differ significantly from zero. These results support Woodward's (1965) findings regarding the relationship between workflow continuity and the percentage of workers engaged in direct labor. However, the residual variance for workflow continuity (Table VIII-1) is quite high. This suggests that other factors within the workflow continuity subgroup are contributing to the residual variance.

Table VIII-1 shows that artifacts explain all of the variance for task routineness and information technology. However, task routineness does not differ significantly from zero, while information technology does (Table VIII-2).

The results of analyzing only three studies with a total sample size of 218 clearly support a negative relationship between the use of computers and the percentage of the work force in direct labor. However, there is no clear reason why this should occur. Blau argued that "since automation of plant functions enlarges the white-collar support component, it must necessarily reduce the proportion of workers engaged in direct and indirect production activities" (Blau et al., 1976: 33). However, this increase in the white-collar support component is not borne out in the current analyses. Notice in Table VIII-2 that percentage clerical personnel and percentage administration both show only a small, though positive, correlation with information technology. One could also speculate that the use of computers leads to greater efficiency in operations and leaner production work forces. This is an empirical question that can be tested in future research studies.

Nonsignificant Differences

Pair-wise comparisons were conducted for all corrected correlations using a z statistic. Since there is no predicted direction for differences between the various measures of technology, two-tailed tests were performed. For the percentage clerical workers and percentage administration no comparison of any of the six pairs was significant.

However, in the case of percentage administration two of the subgroups of technology operationalizations have all of the between study variation explained by artifacts (i.e., workflow integration and task routineness). Neither correlation is significantly different from zero, nor are any of the four subgroups significantly different from any other. Nevertheless, the mean residual variance for these four subgroups is less than the residual variance of the combined measures (e.g., .0171 versus .0213).

These results indicate two things. First, the operational measure used does contribute to the variance observed between correlations. Second, however, the difference between mean correlations is not large. Table VIII-2 shows that only workflow continuity results in a correlation significantly greater than zero. Workflow continuity is also the only measure that approaches a significant difference from the other three types. However, before concluding that workflow continuity is more highly correlated with percentage administration than other operationalizations are, the large residual variance should be noted (i.e., .0336 in Table VIII-1). Other situational factors appear to be contributing to the residual variance.

The z-test also indicates no significant differences for vertical span, or percentage supervisors. A visual inspection of these results indicates that the small differences between the subgroup correlations are not large enough to be of any practical or theoretical significance either. The differences can be attributed entirely to sampling error.

Nevertheless, the results of the analyses for percentage supervisors are very worth noting. Table VIII-1 shows that one group of three studies in the task routineness category contributes most of the residual variance. These three are Child's National Study (Studies 4i and 18) of a mixed sample in England ($r = -.24$ and $n = 80$), Harvey's (Study 37) study of 43 manufacturers ($r = .76$ and $n = 43$), and Jester's thesis sample of 8 groups of probation and parole officers ($r = .15$ and $n = 8$; Study 45). The measure used by Child assessed the degree to which the firm's product is standardized (e.g., not made to customer specifications). Harvey (1968) operationalized technological specificity by counting the number of product changes over a 10 year period. Few changes in the product indicates a more specific technology. Jester (1982) assessed the variability in case load as a measure of task variety. Operationalization of the dependent variable was basically identical in all three studies; the proportion of supervisors and managers to total personnel.

Recall that in the last chapter the study by Harvey appeared as an outlier in the distribution of correlations with percentage supervisors. In the present analysis neither the Child study nor the Jester study are statistically significantly different from each other, but the Harvey study is significantly greater than either Child or Jester. The Harvey correlation ($r = .76$) is the cause of all of the residual variance for task routineness and percentage supervisors.

If the Harvey correlation is removed from the analysis, the mean correlation for the remaining two studies is $\bar{r}$ = -.21 and sampling error would explain all of the observed variance. However, this study will not be removed from analyses at this time. Instead, its presence will be noted in moderator tests presented in later chapters. For the four variables discussed above (i.e., vertical span, percentage supervisors, percentage clerical personnel, and percentage administration) the conclusion is that the conceptual measure of technology used has no significant effect on the correlation observed.

Information Technology

For six of the variables discussed above, information technology is significantly different from at least one of the other technology categories, and in five of those cases information technology is the only technology type that is significantly different from any others. In other words, had there been no analysis performed on a separate category of information technology five more variables would have shown no significant difference between technology measures. Measures of information technology make a difference in the results and warrant separate discussion.

Table VIII-2 shows that for division of labor, standardization, overall formalization, supervisor's span of control, and percentage workflow planning and control information technology is the only type of technology that differs from any other type based upon the z-test. In each of these cases except percentage workflow planning and control, the corrected correlation for information technology is significantly different from zero. In fact for the 13 variables analyzed in this chapter, the correlation for information technology was significantly different from zero 10 times and approached significance in 2 other cases.

Table VIII-3 lists the corrected correlations and standard deviations for each of the 13 variables analyzed in this chapter. In addition it indicates whether the variance observed within a technology type was greater (+), less than (-), or did not change (0) from the variance observed in the overall results with all studies combined into one meta-analysis. It shows that the observed variance for information technology studies increased in only 2 cases: percentage clerical personnel and percentage administration. This comparison was quite different for the other three measures of technology (e.g., workflow continuity increased 10 times, workflow integration increased 8 times, and task routineness increased 9 times). This illustrates a higher than average level of homogeneity among the studies of information technology.

The mean correlation, and the mean absolute value of the correlation across 13 structural variables is also shown in Table VIII-3. These values are conceptually ambiguous but they do provide a simple index of the overall effect of the different technology operationalizations on the correlations obtained. These indices support the conclusion that information technology measures generate higher correlations than the other three measures, and that the other measures of technology yield generally similar results. Table VIII-3 also indicates that the average standard deviation for the information technology category is much smaller than that for the other three categories. However, none of the four technology types appears to have very large effect on structure in general.

Summary

The results of analyses conducted in this chapter indicate that the operational measure used in studies of technology and structure does have a limited impact on the variation observed between study outcomes. A clear moderator effect is indicated only for correlations with centralization and the percentage of an organization's members who are engaged in direct labor.

The results also indicate that studies that assess the use of computers in support functions obtain more consistent results, and those results tend to differ significantly from those obtained with other measures. With the exception of information technology no other technology measure demonstrates a consistent pattern of relationships with other measures. The randomness in the direction of differences between workflow continuity, workflow integration, and task routineness suggests that these differences may be due to chance. The increase in variance observed within some technology categories suggests the presence of moderators within those categories, and/or the presence of extreme values within those categories.

Table VIII-1. Moderator Analyses: Technology Concept Operationalized

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Variance Expected due to Sampling Error	Variance due to Range Differ- ence	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structui
Division of Labor								
Total	26	2726	.291	.0418	.0079	.0053	.0025	.0016
Workflow Continuity	5	122	.077	.1098	.0315	.0006	.0001	.0001
Workflow Integration	11	602	.225	.0460	.0150	.0036	.0027	.0011
Task Routineness	16	833	.117	.0817	.0162	.0002	.0002	.0002
Information Technology	6	1759	.384	.0024	.0022	n.a.	.0007	.0019
Functional Specialization								
Total	44	2378	.239	.0372	.0156	.0038	.0016	.0002
Workflow Continuity	16	559	.156	.0305	.0263	.0022	.0004	.0001
Workflow Integration	32	1401	.221	.0465	.0184	.0035	.0025	.0002
Task Routineness	18	689	.048	.0759	.0231	.0000	.0000	.0000
Information Technology	15	1336	.406	.0204	.0071	n.a.	.0007	.0004
Standardization								
Total	15	902	.227	.0287	.0148	.0034	.0015	.0032
Workflow Continuity	6	147	.057	.0832	.0355	.0003	.0001	.0001
Workflow Integration	12	528	.220	.0441	.0190	.0035	.0026	.0034
Task Routineness	7	342	.132	.0341	.0188	.0002	.0003	.0008
Information Technology	5	537	.334	.0236	.0061	n.a.	.0005	.0045
Overall Formalization								
Total	43	2853	.173	.0303	.0134	.0021	.0009	.0004
Workflow Continuity	16	628	.174	.0682	.0192	.0028	.0005	.0003
Workflow Integration	25	1804	.111	.0441	.0118	.0010	.0007	.0002
Task Routineness	23	1233	.173	.0640	.0167	.0004	.0005	.0003
Information Technology	9	938	.339	.0140	.0067	n.a.	.0005	.0011
Role Formalization								
Total	25	1013	.218	.0372	.0209	.0032	.0015	.0010
Workflow Continuity	3	52	.209	.0475	.0525	.0039	.0008	.0005
Workflow Integration	20	719	.230	.0343	.0229	.0038	.0029	.0012
Task Routineness	16	601	.122	.0710	.0219	.0002	.0003	.0002
Information Technology	2	71	.328	.0000	.0233	n.a.	.0005	.0014
Vertical Span								
Total	29	2964	.268	.0292	.0080	.0046	.0019	n.a.
Workflow Continuity	15	628	.274	.0687	.0201	.0062	.0011	n.a.
Workflow Integration	16	925	.136	.0310	.0181	.0014	.0009	n.a.
Task Routineness	9	329	.182	.0671	.0232	.0004	.0005	n.a.
Information Technology	12	2312	.285	.0163	.0038	n.a.	.0003	n.a.
Centralization								
Total	56	3423	.025	.0496	.0153	.0000	.0000	.0000
Workflow Continuity	19	785	.049	.0328	.0234	.0002	.0000	.0000
Workflow Integration	33	2222	-.060	.0402	.0139	.0003	.0002	.0000
Task Routineness	27	1705	.167	.0323	.0148	.0004	.0004	.0002
Information Technology	12	842	-.150	.0466	.0127	n.a.	.0001	.0001
Supervisor's Span of Control								
Total	22	2592	.078	.0132	.0083	.0004	.0002	n.a.
Workflow Continuity	14	497	-.075	.0411	.0255	.0005	.0001	n.a.
Workflow Integration	14	688	-.029	.0308	.0187	.0001	.0000	n.a.
Task Routineness	10	483	.070	.0368	.0196	.0001	.0001	n.a.
Information Technology	8	2028	.095	.0102	.0038	n.a.	.0000	n.a.

ncept Operationalized

Variance Expected due to Sampling Error	Variance due to Range Difference	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structure	Residual Variance[a]	Percent Variance Explained	Residual s.d.	Corrected Correlation: Mean	Corrected Correlation: s.d.	90 % Credibility Interval
.0079	.0053	.0025	.0016	.0244	41.6	.156	.423	.228	.049 to .798
.0315	.0006	.0001	.0001	.0776	29.4	.278	.092	.330	-.452 to .636
.0150	.0036	.0027	.0011	.0236	48.7	.154	.341	.233	-.042 to .725
.0162	.0002	.0002	.0002	.0649	20.5	.255	.147	.320	-.380 to .674
.0022	n.a.	.0007	.0019	-.0024	100+	0	.464	0	.464
.0156	.0038	.0016	.0002	.0160	57.0	.126	.338	.179	.044 to .632
.0263	.0022	.0004	.0001	.0015	95.0	.039	.178	.045	.104 to .252
.0184	.0035	.0025	.0002	.0221	52.7	.149	.324	.218	-.034 to .682
.0231	.0000	.0000	.0000	.0526	30.6	.229	.059	.276	-.399 to .517
.0071	n.a.	.0007	.0004	.0122	40.3	.110	.473	.129	.261 to .684
.0148	.0034	.0015	.0032	.0057	80.1	.076	.332	.111	.150 to .514
.0355	.0003	.0001	.0001	.0471	43.3	.217	.067	.257	-.355 to .490
.0190	.0035	.0026	.0034	.0157	64.4	.125	.333	.190	.021 to .645
.0188	.0002	.0003	.0008	.0139	59.2	.118	.165	.148	-.078 to .409
.0061	n.a.	.0005	.0045	.0125	46.9	.112	.403	.135	.181 to .625
.0134	.0021	.0009	.0004	.0135	55.6	.116	.254	.171	-.027 to .535
.0192	.0028	.0005	.0003	.0454	33.3	.213	.206	.253	-.210 to .621
.0118	.0010	.0007	.0002	.0304	31.0	.174	.170	.266	-.268 to .608
.0167	.0004	.0005	.0003	.0460	28.0	.214	.217	.270	-.226 to .660
.0067	n.a.	.0005	.0011	.0057	59.4	.075	.410	.091	.260 to .559
.0209	.0032	.0015	.0010	.0106	71.5	.103	.334	.158	.074 to .594
.0525	.0039	.0008	.0005	-.0102	100+	0	.254	0	.254
.0229	.0038	.0029	.0012	.0035	89.7	.059	.403	.104	.209 to .519
.0219	.0002	.0003	.0002	.0484	31.8	.220	.161	.289	-.315 to .637
.0233	n.a.	.0005	.0014	-.0253	100+	0	.414	0	.414
.0080	.0046	.0019	n.a.	.0146	49.8	.121	.342	.154	.088 to .596
.0201	.0062	.0011	n.a.	.0412	40.1	.203	.284	.211	-.062 to .631
.0181	.0014	.0009	n.a.	.0106	65.9	.103	.182	.137	-.044 to .408
.0232	.0004	.0005	n.a.	.0429	36.0	.207	.201	.228	-.174 to .575
.0038	n.a.	.0003	n.a.	.0122	25.2	.110	.301	.117	.109 to .493
.0153	.0000	.0000	.0000	.0342	31.0	.185	.036	.266	-.401 to .474
.0234	.0002	.0000	.0000	.0091	72.1	.096	.056	.110	-.125 to .238
.0139	.0003	.0002	.0000	.0258	35.8	.161	-.089	.240	-.483 to .305
.0148	.0004	.0004	.0002	.0165	48.9	.128	.204	.157	-.054 to .462
.0127	n.a.	.0001	.0001	.0336	27.8	.183	-.176	.215	-.530 to .178
.0083	.0004	.0002	n.a.	.0043	67.7	.065	.101	.084	-.038 to .240
.0255	.0005	.0001	n.a.	.0150	63.6	.122	-.078	.127	-.287 to .131
.0187	.0001	.0000	n.a.	.0120	61.1	.110	-.039	.147	-.281 to .203
.0196	.0001	.0001	n.a.	.0190	50.9	.138	.077	.152	-.173 to .326
.0038	n.a.	.0000	n.a.	.0064	37.4	.080	.100	.084	-.039 to .238

Table VIII-1--continued

Variable	Number of Corre-lations	Total Sample	Mean r Observed	Observed Variance	Variance Expected due to Sampling Error	Variance due to Range Differ-ence	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structure
% Direct Workers								
Total	12	497	-.207	.0654	.0224	.0029	.0011	n.a.
Workflow Continuity	12	453	-.257	.0929	.0198	.0056	.0010	n.a.
Workflow Integration	11	436	-.056	.0532	.0224	.0002	.0002	n.a.
Task Routineness	6	214	.015	.0239	.0272	.0000	.0000	n.a.
Information Technology	3	218	-.160	.0079	.0133	n.a.	.0001	n.a.
% Supervisors								
Total	10	1813	-.096	.0251	.0050	.0007	.0002	n.a.
Workflow Continuity	4	307	-.006	.0128	.0129	.0000	.0000	n.a.
Workflow Integration	5	423	-.030	.0195	.0113	.0001	.0000	n.a.
Task Routineness	3	131	.110	.2153	.0165	.0002	.0002	n.a.
Information Technology	6	1626	-.120	.0100	.0035	n.a.	.0001	n.a.
% Clerical Personnel								
Total	13	1996	.002	.0108	.0064	.0000	.0000	n.a.
Workflow Continuity	8	326	.042	.0278	.0223	.0002	.0000	n.a.
Workflow Integration	10	606	.020	.0410	.0144	.0000	.0000	n.a.
Task Routineness	4	291	-.085	.0434	.0107	.0001	.0001	n.a.
Information Technology	7	1709	.042	.0150	.0036	n.a.	.0000	n.a.
% Workflow Planning and Control								
Total	4	160	-.099	.0287	.0240	.0007	.0003	n.a.
Workflow Continuity	4	118	-.350	.0739	.0261	.0092	.0019	n.a.
Workflow Integration	3	155	-.142	.0758	.0169	.0015	.0010	n.a.
Task Routineness	2	131	-.190	.0025	.0145	.0005	.0005	n.a.
Information Technology	3	126	.138	.0283	.0204	n.a.	.0001	n.a.
% Administration								
Total	12	753	.066	.0367	.0150	.0003	.0001	n.a.
Workflow Continuity	7	355	.176	.0545	.0175	.0028	.0005	n.a.
Workflow Integration	10	637	.007	.0083	.0156	.0000	.0000	n.a.
Task Routineness	3	177	.028	.0094	.0169	.0000	.0000	n.a.
Information Technology	7	527	.048	.0552	.0114	n.a.	.0000	n.a.

[a]Numbers may not sum across due to rounding.

ariance xpected ue to ampling rror	Variance due to Range Differ- ence	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structure	Residual[a] Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation: Mean	Corrected Correlation: s.d.	90 % Credibility Interval
.0224	.0029	.0011	n.a.	.0390	40.4	.197	-.265	.254	-.683 to .152
.0198	.0056	.0010	n.a.	.0665	28.5	.258	-.267	.268	-.708 to .174
.0224	.0002	.0002	n.a.	.0304	42.8	.174	-.076	.234	-.461 to .309
.0272	.0000	.0000	n.a.	-.0033	100+	0	.016	0	.016
.0133	n.a.	.0001	n.a.	-.0055	100+	0	-.169	0	-.169
.0050	.0007	.0002	n.a.	.0192	23.4	.139	-.124	.179	-.419 to .171
.0129	.0000	.0000	n.a.	-.0001	100+	0	-.006	0	-.006
.0113	.0001	.0000	n.a.	.0081	55.7	.091	-.040	.121	-.239 to .158
.0165	.0002	.0002	n.a.	.1954	7.5	.445	.121	.490	-.655 to .927
.0035	n.a.	.0001	n.a.	.0064	35.7	.080	-.127	.084	-.266 to .012
.0064	.0000	.0000	n.a.	.0044	59.4	.066	.003	.086	-.138 to .144
.0223	.0002	.0000	n.a.	.0052	81.1	.072	.044	.075	-.080 to .168
.0144	.0000	.0000	n.a.	.0265	35.4	.0163	.027	.218	-.332 to .386
.0107	.0001	.0001	n.a.	.0325	24.7	.180	-.093	.198	-.420 to .233
.0036	n.a.	.0000	n.a.	.0114	24.0	.107	.045	.113	-.141 to .231
.0240	.0007	.0003	n.a.	.0036	87.3	.060	-.128	.078	-.257 to .000
.0261	.0092	.0019	n.a.	.0366	50.4	.191	-.364	.199	-.691 to -.036
.0169	.0015	.0010	n.a.	.0564	25.5	.238	-.190	.318	-.713 to .332
.0145	.0005	.0005	n.a.	-.0130	100+	0	-.208	0	-.208
.0204	n.a.	.0001	n.a.	.0078	72.5	.086	.146	.093	-.007 to .299
.0150	.0003	.0001	n.a.	.0213	41.9	.146	.085	.189	-.226 to .396
.0175	.0028	.0005	n.a.	.0336	38.2	.183	.183	.190	-.131 to .496
.0156	.0000	.0000	n.a.	-.0073	100+	0	.009	0	.009
.0169	.0000	.0000	n.a.	-.0075	100+	0	.031	0	.031
.0114	n.a.	.0000	n.a.	.0438	20.7	.209	.050	.221	-.313 to .414

Table VIII-2. Technology Concept: 95% Confidence Interval and Statistical Significance Tests

Variable	Corrected Correlation					95% Confidence Interval	Z-Test		
	k	n	Mean	s.d.	s.e.		WI	TR	IT
Division of Labor									
Workflow Continuity	5	122	.092	.330	.1836	-.27 to .45	-1.21	-.27	-2.01***
Workflow Integration	11	602	.341	.233	.0919	.16 to .52		1.50	-1.29
Task Routineness	16	833	.147	.320	.0911	-.03 to .32			-3.36**@
Information Technology	6	1759	.464	.000	.0246	.42 to .51			
Functional Specialization									
Workflow Continuity	16	559	.178	.045	.0492	.08 to .27	-2.00***	1.26	-4.53*@
Workflow Integration	32	1401	.324	.218	.0538	.22 to .43		2.73**@@	-2.17***
Task Routineness	18	689	.059	.278	.0806	-.10 to .22			-4.54*@
Information Technology	15	1336	.473	.129	.0427	.39 to .56			
Standardization									
Workflow Continuity	6	147	.067	.257	.1445	-.22 to .35	-1.59	-.58	-2.06***
Workflow Integration	12	528	.333	.190	.0838	.17 to .50		1.38	-.62
Task Routineness	7	342	.165	.148	.0876	-.01 to .34			-2.05***
Information Technology	5	537	.403	.135	.0761	.25 to .55			
Overall Formalization									
Workflow Continuity	16	628	.206	.253	.0784	.05 to .36	.36	-.11	-2.24***
Workflow Integration	25	1804	.170	.266	.0642	.04 to .30		-.51	-3.03**@@
Task Routineness	23	1233	.217	.270	.0662	.09 to .35			-2.39***
Information Technology	9	938	.410	.091	.0463	.32 to .50			
Role Formalization									
Workflow Continuity	3	52	.254	.000	.1655	-.07 to .58	-.84	.49	-.75
Workflow Integration	20	719	.403	.104	.0606	.24 to .48		2.23***	-.07
Task Routineness	16	601	.161	.289	.0900	-.02 to .34			-1.55
Information Technology	2	71	.414	.000	.1357	.15 to .68			

Table VIII-2--continued

	Corrected Correlation					95% Confidence Interval	Z-Test		
Variable	k	n	Mean	s.d.	s.e.		WI	TR	IT
Vertical Span									
Workflow Continuity	15	628	.284	.211	.0669	.15 to .42	1.16	.71	-.22
Workflow Integration	16	825	.182	.137	.0575	.07 to .29		-.17	-1.71
Task Routineness	9	329	.201	.228	.0964	.01 to .39			-.96
Information Technology	12	2312	.301	.117	.0393	.22 to .38			
Centralization									
Workflow Continuity	19	785	.056	.110	.0486	-.04 to .15	2.03***	-2.31***	2.62**
Workflow Integration	33	2222	-.089	.240	.0524	-.19 to .01		-4.37*@	.96
Task Routineness	27	1705	.204	.157	.0418	.12 to .28			4.48*@
Information Technology	12	842	-.176	.215	.0738	-.32 to -.03			
Supervisor's Span of Control									
Workflow Continuity	14	497	-.078	.127	.0579	-.19 to .04	-.45	-1.71	-2.57***
Workflow Integration	14	688	-.039	.147	.0649	-.17 to .09		-1.22	-1.85
Task Routineness	10	483	.077	.152	.0696	-.06 to .21			-.29
Information Technology	8	2028	.100	.084	.0378	.03 to .17			
% Direct Workers									
Workflow Continuity	12	453	-.267	.268	.0901	-.44 to -.09	-1.45	-2.40***	-.86
Workflow Integration	11	436	-.076	.234	.0959	-.26 to .11		-.75	.78
Task Routineness	6	214	.016	.000	.0763	-.13 to .16			1.78
Information Technology	3	218	-.169	.000	.0702	-.31 to -.03			
% Supervisors									
Workflow Continuity	4	307	-.006	.000	.0596	-.12 to .11	.33	-.42	1.64
Workflow Integration	5	423	-.040	.121	.0849	-.21 to .13		-.52	.91
Task Routineness	3	131	.121	.490	.2988	-.46 to .71			.82
Information Technology	6	1626	-.127	.084	.0431	-.21 to -.04			

Table VIII-2--continued

Variable	Corrected Correlation					95% Confidence Interval	Z-Test		
	k	n	Mean	s.d.	s.e.		WI	TR	IT
% Clerical Personnel									
Workflow Continuity	8	326	.044	.075	.0639	-.08 to .17	.16	1.02	-.01
Workflow Integration	10	606	.027	.218	.0883	-.14 to .20		.81	-.18
Task Routineness	4	291	-.093	.198	.1183	-.32 to .14			-1.08
Information Technology	7	1709	.045	.113	.0498	-.05 to .14			
% Workflow Planning and Control									
Workflow Continuity	4	118	-.364	.199	.1312	-.62 to -.11	-.70	-.97	-3.00**@@
Workflow Integration	3	155	-.190	.318	.2119	-.61 to .22		.08	-1.41
Task Routineness	2	131	-.208	.000	.0934	-.39 to -.02			-2.48***
Information Technology	3	126	.146	.093	.1078	-.06 to .36			
% Administration									
Workflow Continuity	7	355	.183	.190	.0900	.01 to .36	1.66	1.24	1.01
Workflow Integration	10	637	.009	.000	.0536	-.10 to .11		-.22	-.37
Task Routineness	3	177	.031	.000	.0833	-.13 to .19			-.15
Information Technology	7	527	.050	.221	.0955	-.14 to .24			

*p < .001, two-tailed. **p < .01, two-tailed. ***p < .05, two-tailed.

@p < .01 using Bonferroni inequality method. @@p < .05 using Bonferroni inequality method.

Table VIII-3. Summary Comparison of Technology Operationalizations

	Corrected Correlations											
	Workflow Continuity			Workflow Integration			Task Routineness			Information Technology		
Structural Variable	Mean r	s.d.	res	Mean r	s.d.	res	Mean r	s.d.	res	Mean r	s.d.	res
Division of Labor	.092	.330	+	.341	.233	+	.147	.320	+	.464	.000	-
Functional Specialization	.178	.045	-	.324	.218	+	.059	.278	+	.473	.129	-
Standardization	.067	.257	+	.333	.190	+	.165	.148	+	.403	.135	-
Overall Formalization	.206	.253	+	.170	.266	+	.217	.270	+	.410	.091	-
Role Formalization	.254	.000	+	.403	.104	-	.161	.289	+	.414	.000	-
Vertical Span	.284	.211	+	.182	.137	+	.201	.228	+	.301	.117	-
Centralization	.056	.110	-	-.089	.240	-	.204	.157	-	-.176	.215	0
Supervisor's Span of Control	-.078	.127	+	-.039	.147	+	.077	.152	+	.100	.084	-
% Direct Workers	-.267	.268	+	-.076	.234	-	.016	.000	-	-.169	.000	-
% Supervisors	-.006	.000	-	-.040	.121	-	.121	.490	+	-.127	.084	-
% Clerical Personnel	.044	.075	+	.027	.218	+	-.093	.198	+	.045	.113	+
% Workflow Planning and Control	-.364	.199	+	-.190	.318	+	-.208	.000	-	.146	.093	-
% Administration	.183	.190	+	.009	.000	-	.031	.000	-	.050	.221	+
Mean r	.050			.104			.084			.180		
Mean Absolute Value	.160	.159		.171	.187		.131	.195		.252	.099	
Observed Variance:												
Increase		10			8			9			2	
Decrease		3			5			4			10	
No Change		0			0			0			1	

CHAPTER IX

MODERATOR TEST: ORGANIZATION SIZE

The predominant theoretical moderator of the relationship between technology and organization structure is the size of the organization. The relative importance of these two contextual variables has been a subject of debate for over 30 years.

Woodward stated "no significant relationship was revealed between size of the firm and the system of production. . . . Moreover, although no relationship was found between organization and size in the general classification of firms, some evidence of a relationship emerged when each of the production groups was considered separately" (1958/1966: 20). What this means is that Woodward observed a relationship between organization size and organization structure only when the technology variable was controlled for.

Later, the results of the original Aston study of 52 diverse British firms suggested it was the size of the organization that was the primary variable related to structure. Hickson and his colleagues found that in their manufacturing subsample size "correlated 0.47 with the technology measure (production continuity)" and when the size of the organization was partialled out the relationship between production technology and organization structure became nonsignificant (Hickson et al., 1969: 390-391). In an effort to reconcile their findings to those of Woodward these researchers pointed out that "there is an important difference in the size range of the organizations" (Hickson et al, 1969: 391). The organizations in the

Woodward study were generally small. Only 17 of her 92 firms had over 1,000 personnel (Woodward, 1965: 41), while the firms in the Aston sample had an average size of over 3,000 personnel (Hickson et al., 1969: 381). They therefore hypothesized that technology has a greater impact on structure in small organizations than in large organizations.

The hypothesis being tested in this chapter is therefore:

Hypothesis 4: The correlation between technology and organization structure is stronger in small organizations than in large organizations.

If size of the organization has this moderating effect then the difference between the mean correlation obtained for studies of small organizations should be larger than the mean correlation for studies of large organizations. Likewise, the variance between correlations should be less for studies within the "small" and "large" subgroups than for the combined group of studies.

Formation of Subgroups

For these analyses small is defined as an average firm size of less than 1,000 personnel. Large is defined as an average firm size of 1,000 personnel or more. This cut off of 1,000 was selected so that it would place the Woodward (1965) study within the small category, and also the Harvey (1968) study. Both found no relationship between size and structure. This cut off also places the Aston study in the large category (Hickson et al., 1969).

A third size category was employed to include those studies for which no determination of the organization size could be made either because it was not addressed, or because some index other than number of personnel was used to measure size (e.g., Khandwalla, 1977, used annual sales to measure size). This category of "Unknown Size" is theoretically meaningless, and no comparisons will be made between it and the "Small" and "Large" categories.

Results

The results of 13 meta-analyses testing the effect of organization size on the relationship between technology and structure are presented in Table IX-1. As described in the previous chapter, the "Total" line for each structural variable has been carried forward from Table VI-1 in Chapter VI.

These results clearly show that when a cutoff of 1,000 personnel is used to divide studies into small and large subgroups there is very little indication that size of the organization has a moderating effect. Only two tests in Table IX-2 yield a statistically significant difference. Those are functional specialization and the percentage direct workers, and only percentage direct workers is in the direction hypothesized by Hickson et al. (1969).

Functional Specialization

Table IX-2 shows that the correlation between technology and functional specialization is significantly higher for 15 studies in the large subgroup ($\bar{r}$ = +.45) than for 27 studies in the small subgroup ($\bar{r}$ = +.32). Studies included in the large subgroup are Studies 4b; 4f; 4g; 7; 13a; 18 & 4i; 38 & 4k; 39 & 4j; 44 & 4n; 71 & 41; 77, 78 & 4m; 83; 95; 98b; and 98c. Studies in the small subgroup are Studies 3, 4a, 4c, 4d, 4e, 4h, 5, 10, 11, 12, 13b, 14 & 17, 15, 21a, 21b, 25, 31, 37, 41, 46, 54, 62, 65, 70, 73, 81, and 98a. Table

IX-1 shows the residual variance for each of these subgroups. The mean residual variance for these two groups is .0133 which is less than the .0160 in residual variance in the analysis of all studies combined.

The 95 percent confidence intervals in Table IX-2 indicate that the corrected correlations for both small firms and large firms are significantly greater than zero, and as previously noted the large firms yield the higher correlation.

There is a clear indication that organization size does moderate the relationship between technology and functional specialization. However, the hypothesis that the effect will be stronger in small organizations is not supported.

A possible explanation for why larger organizations show larger correlations with functional specialization is that large organizations have greater range in the dependent variable than do small organizations. Generally, the organizations with the greatest number of departments, divisions, or distinct functional areas will require more personnel to staff those functions. Within a small organization there is a physical limit to the number of distinct functions that can be performed in-house. The correlation observed in small organizations may therefore be attenuated by range restriction in the dependent variable.

Percentage Direct Workers

Organization size also moderates the relationship between technology and the percentage of the organization's personnel engaged in direct labor. Table IX-2 shows that the corrected correlation for three studies in the large subgroup (i.e., $\bar{r}$ = -.05) is significantly lower than that for nine studies of small organizations (i.e.,

$\bar{r}$ = -.34). The three studies in the large subgroup are Studies 4i, 4j, and 4k. The nine studies in the small subgroup are Studies 3, 4c, 4d, 4e, 4h, 5, 12, 41, and 96. This moderator effect supports the hypothesis that technology has a stronger effect in small organizations.

The residual variance in Table IX-1 for all of the studies combined is .0390. The mean residual for the large- and small-firm subgroups is only .0291. This reduction in residual variance, coupled with the size of the difference between the two corrected correlations, supports the hypothesis that size does moderate the effect of technology on percentage direct workers.

These findings are consistent with those obtained by Woodward (1965) in her sample of small firms and those of Hickson et al., (1960) in a sample of large firms. Hickson and his colleagues reported a nonsignificant correlation of r = -.18 between percentage direct worker and workflow integration for a mixed sample of 46 firms, and r = -.14 between workflow continuity and percentage direct workers for a subsample of 31 manufacturing firms (Hickson et al., 1969: 386). Woodward observed a strong negative trend in the relationship between the percentage direct labor and her scale of technology types (Woodward, 1965: 59).

The 95 percent confidence interval in Table IX-2 indicates that the negative correlation for small firms differs significantly from zero, but the very small correlation for large firms does not differ significantly from zero. These results suggest that technology is associated with a reduction in the percentage of the work force engaged in direct labor in small firms (i.e., less than 1,000 personnel). However, in large firms (i.e., more than 1,000 personnel) technology is not associated with the proportion of personnel in direct labor.

The implication of the findings is that small firms are more inclined to respond to changes in technology through corresponding changes in the allocation of human resources than are their larger counterparts. Whether this is the result of inefficiency in larger organizations or some other factors is a question beyond the scope of this analysis. However, it may be proposed that factors other than technology determine human resources allocation decisions in large organizations, while technology is a more important consideration in smaller organizations.

Other Structural Variables

None of the other 11 variables analyzed revealed a significant difference between small and large organizations. Examination of the results displayed in Table IX-2 reveals that none of the differences even approaches statistical significance with an alpha level of .10 or less, with the exception of percentage supervisors. For that variable two correlations from studies of large organizations (Studies 13a and 18 & 4i) result in a larger negative correlation than observed for eight studies of small organizations (Studies 12, 13c, 15, 37, 41, 45, 65, and 81). However, this difference is no greater than should be expected due to sampling error in the correlations, so the hypothesis that there is no difference between the two groups must be retained.

Summary Results

Table IX-3 summarizes the results of the 13 tests performed in this chapter. In the top half are those variables for which small organizations had a larger mean correlation than did large organizations. Just below that group are the variables for which large organizations had larger correlations, and finally there are two variables for which the signs of the correlations are different. Across Table IX-3 the columns indicate the corrected mean correlation and standard deviation for small and large organizations. Symbols are also provided to indicate whether the residual variance (res) for the subgroup is greater than (+), or less than (-) the residual for the combined studies. The second column from the right shows the statistical significance of the difference between the corrected mean correlation in the large and the small categories. Finally, the last column indicates whether the mean residual variance for the two subgroups is less than (decrease) or greater than (increase) the residual variance among the combined studies.

<u>Small ≥ Large</u>

Only 6 of the 13 variables tested indicated that the correlation is larger for small organizations than for large organizations (i.e., percentage direct workers, division of labor, standardization, overall formalization, role formalization, and vertical span). However, only the percentage direct workers showed a statistically significant difference and also resulted in a reduction in residual variance. Three of the other variables (i.e., standardization, overall formalization, and vertical span) also demonstrated a reduction in residual variance, but did not indicate a significant difference between mean correlations. Both division of labor and role formalization show no change in residual variance, coupled with no statistically significant difference between small and large organizations.

Large $\geq$ Small

Five of the 13 variables analyzed yield results counter to the hypothesis that technology has a stronger effect in small organizations than in large organizations. Those 5 variables are functional specialization, centralization, supervisor's span of control, percentage supervisors, and percentage workflow planning and control. Only functional specialization suggests a clear moderator effect with both a significant difference between corrected mean correlations, and a reduction in residual variance. Centralization, supervisor's span of control, and percentage supervisors also show a reduced residual variance while percentage workflow planning and control has an increase. However, none of these variables show a significant difference between large and small organizations.

Reversed Sign

Both the percentage clerical personnel and the percentage administration variables indicate a positive correlation in small organizations and a very small negative correlation in large organizations. None of these correlations is significantly different from zero, nor does organization size appear to make a significant difference in the size of these correlations. These results suggest that technology has very little relationship to the proportion of personnel in clerical and administrative jobs regardless of the size of the organization.

At the bottom of Table IX-3 the mean correlation, and the mean absolute value of the correlations, for all 13 variables is calculated for small and large organizations. These serve as overall indicators of the relative size of the correlation between technology and organization structure within small and large organizations. Whether one looks at the mean r (small = .14 and large = .12), or the mean absolute value (small = .22 and large = .21) the same conclusion is reached. That conclusion is that there is no difference between the correlation of technology with structure in small and large organizations.

Discussion

The results of these 13 analyses have important implications for organization researchers. The most important of these is that the failure to observe a moderator effect suggests that technology is independent of organization size as a determinant of organization structure. Both contextual variables make unique contributions to the determination of the most efficient organization structure. The inconsistency in research findings regarding the relative dominance of organization size and technology as determinants of structure may be the result of sampling error.

Hickson's Hypothesis

In 1969 Hickson and his colleagues proposed the following hypothesis to reconcile the results of the Aston study to those obtained by Woodward (1965):

> Structural variables will be associated with operations technology only where they are centered on the workflow. The smaller the organization the more its structure will be pervaded by such technological effects: the larger the organization the more these effects will be confined to variables such as job-counts of employees on activities linked with the workflow itself, and will not be detectable in variables of the more remote administrative and hierarchical structure (Hickson et al., 1969: 394-395).

The results of meta-analyses conducted in Chapter VI did not support the first part of this hypothesis. The association of technology was not restricted to structural variables "centered on the workflow". On the contrary, it was noted in Chapter VI that the largest correlations were observed among a cluster of variables that Hickson and his colleagues included under the rubric of "Structuring of Activities", that is, division of labor, functional specialization, standardization, and formalization (1969: 384). However, rejection of the Hickson hypothesis was deferred until the effect of organization size could be determined.

Based upon the results obtained in this chapter, Hickson's hypothesis cannot be supported. First, Table IX-3 reveals that only 6 of the 13 variables tested resulted in a higher correlation for small organizations than large organizations, and only 1 of those differences is significant. Second, only 1 of those 6 variables is centered on the workflow. The percentage of personnel in direct labor is centered on the workflow and does have a significant difference in the predicted direction. However, the other 5 variables would qualify as "the more remote administrative and hierarchical structure" (Hickson et al., 1969: 395). The correlation of technology with these variables is not significantly lower for large organizations. Contrary to Hickson's hypothesis, the correlation with functional specialization is significantly higher for large organizations than for small organizations. In conclusion, only 1 of the 13 tests performed lends support to Hickson's hypothesis. The other 12 tests refute it. Organization size does not appear to exercise any significant influence over the relationship between technology and structure.

Reduced Residual Variance

As previously noted, Table IX-3 indicates that while only 2 of the 13 comparisons resulted in a statistically significant difference (i.e., percentage direct workers, and functional specialization), there were 8 other situations in which the residual variance was reduced. Clearly then, grouping the studies into small and large subgroups does help explain some of the residual variance in the combined analyses. But, the differences between subgroups that contributes to this variance is not significant in either a statistical sense or a theoretical/practical sense. For example, there is little to be gained from the knowledge that the correlation between technology and supervisor's span is .05 higher in large organizations than in small organizations. On the other hand a difference of .28 in the correlation with percentage direct workers is significant in both a statistical sense and for the purpose of theory development.

It should also be pointed out that the reduction in residual variance observed in these tests is related primarily to those studies in the large subgroup. Note at the bottom of Table IX-3 that residual variance in the small subgroup declined in only 3 cases and increased in 9, while in the large subgroup 11 of 13 variables had a lower residual variance than exists among the combined studies. In fact, in 7 of the 13 meta-analyses performed on the large subgroup, artifacts explain all of the observed variance.

These results are not sufficient to conclude that size is the moderator variable though. The possibility cannot be ignored that large size is correlated with another moderator. If this is the case then the homogeneity seen among studies in the large category may be due to some factor other than size.

Conclusion

The results of analyses presented in this chapter generally reject the hypothesis that organization size is a significant moderator in the relationship between technology and structure. The correlations observed in studies of small organizations differ very little from those observed in studies of large organizations.

The evidence also indicates that the effect of technology is not restricted to structural variables centered on the workflow but that significant relationships also exist among variables related to the hierarchical structure.

Only two variables tested indicated that organization size was a significant moderator, but several others demonstrated a reduction in residual variance. The conclusion drawn here is that organization size has a limited moderating effect. While it can help explain some of the observed variance across studies the effect has little practical or theoretical significance.

These findings tend to support Woodward's (1965) conclusion that size was not related to technology. They generally reject the Hickson et al. (1969) hypothesis that technology will have a stronger impact on structure in small organizations than in large organizations.

Table IX-1. Moderator Analyses: Organization Size (Small < 1,000; Large > 1,000)

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Variance Expected due to Sampling Error	Variance due to Range Differ- ence	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structure
Division of Labor								
Total	26	2726	.291	.0418	.0079	.0053	.0025	.0016
Small	17	2349	.286	.0425	.0059	.0052	.0024	.0016
Large	7	224	.275	.0568	.0281	.0048	.0022	.0015
Unknown Size	2	153	.386	.0004	.0094	.0083	.0043	.0028
Functional Specialization								
Total	44	2378	.239	.0372	.0156	.0038	.0016	.0002
Small	27	1733	.224	.0372	.0135	.0034	.0014	.0002
Large	15	502	.324	.0350	.0230	.0064	.0030	.0004
Unknown Size	2	143	.118	.0021	.0140	.0010	.0004	.0000
Standardization								
Total	15	902	.227	.0287	.0148	.0034	.0015	.0032
Small	9	658	.256	.0254	.0118	.0043	.0020	.0041
Large	4	155	.243	.0164	.0233	.0039	.0018	.0037
Unknown Size	2	89	-.017	.0091	.0226	.0000	.0000	.0000
Overall Formalization								
Total	43	2853	.173	.0303	.0134	.0021	.0009	.0004
Small	28	1949	.185	.0321	.0124	.0024	.0010	.0000
Large	8	246	.124	.0297	.0315	.0011	.0005	.0002
Unknown Size	7	658	.154	.0236	.0098	.0016	.0007	.0004
Role Formalization								
Total	25	1013	.218	.0372	.0209	.0032	.0015	.0010
Small	11	340	.220	.0673	.0265	.0032	.0015	.0009
Large	12	394	.202	.0224	.0265	.0028	.0012	.0007
Unknown Size	2	279	.238	.0205	.0061	.0037	.0017	.0010
Vertical Span								
Total	29	2964	.266	.0292	.0060	.0046	.0019	n.a.
Small	22	2708	.271	.0285	.0065	.0047	.0019	n.a.
Large	7	256	.236	.0356	.0243	.0037	.0015	n.a.
Unknown Size	0	0						
Centralization								
Total	56	3423	.025	.0496	.0153	.0000	.0000	.0000
Small	30	1660	-.003	.0461	.0170	.0000	.0000	.0000
Large	15	512	-.058	.0624	.0270	.0002	.0001	.0000
Unknown Size	11	1251	.097	.0400	.0083	.0007	.0003	.0001
Supervisor's Span of Control								
Total	22	2592	.078	.0132	.0063	.0004	.0002	n.a.
Small	16	2377	.075	.0127	.0066	.0004	.0001	n.a.
Large	6	215	.112	.0171	.0277	.0009	.0003	n.a.
Unknown Size	0	0						

ze (Small < 1,000; Large > 1,000)

Variance Expected due to Sampling Error	Variance due to Range Differ- ence	Variance due to Reliability Difference: Technology	Structure	Residual[a] Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation: Mean	s.d.	90 % Credibility Interval
.0079	.0053	.0025	.0016	.0244	41.6	.156	.423	.228	.049 to .798
.0059	.0052	.0024	.0016	.0274	35.6	.165	.417	.241	.020 to .813
.0261	.0048	.0022	.0015	.0201	64.6	.142	.401	.207	.061 to .741
.0094	.0083	.0043	.0028	-.0244	100+	0	.554	0	.554
.0156	.0038	.0016	.0002	.0160	57.0	.126	.338	.179	.044 to .632
.0135	.0034	.0014	.0002	.0167	49.5	.137	.317	.193	.000 to .635
.0230	.0064	.0030	.0004	.0023	93.5	.048	.454	.067	.344 to .563
.0140	.0010	.0004	.0000	-.0134	100+	0	.168	0	.168
.0148	.0034	.0015	.0032	.0057	80.1	.076	.332	.111	.150 to .514
.0118	.0043	.0020	.0041	.0033	87.0	.057	.373	.084	.236 to .511
.0233	.0039	.0018	.0037	-.0162	100+	0	.354	0	.354
.0226	.0000	.0000	.0000	-.0135	100+	0	-.025	0	-.025
.0134	.0021	.0009	.0004	.0135	55.6	.116	.254	.171	-.027 to .535
.0124	.0024	.0010	.0000	.0158	50.8	.126	.272	.185	-.031 to .576
.0315	.0011	.0005	.0002	-.0036	100+	0	.183	0	.183
.0098	.0016	.0007	.0004	.0110	53.1	.105	.226	.155	-.028 to .481
.0209	.0032	.0015	.0010	.0106	71.5	.103	.334	.158	.074 to .594
.0265	.0032	.0015	.0009	.0352	47.7	.188	.329	.281	-.133 to .791
.0265	.0028	.0012	.0007	-.0089	100+	0	.302	0	.302
.0061	.0037	.0017	.0010	.0079	61.4	.089	.355	.133	.136 to .574
.0080	.0046	.0019	n.a.	.0146	49.8	.121	.342	.154	.088 to .596
.0065	.0047	.0019	n.a.	.0154	46.1	.124	.346	.158	.085 to .606
.0243	.0037	.0015	n.a.	.0061	82.8	.078	.303	.100	.138 to .468
.0153	.0000	.0000	.0000	.0342	31.0	.185	.036	.266	-.401 to .474
.0170	.0000	.0000	.0000	.0291	36.8	.171	-.004	.245	-.408 to .400
.0270	.0002	.0001	.0000	.0350	43.8	.187	-.083	.269	-.526 to .359
.0083	.0007	.0003	.0001	.0306	23.5	.175	.140	.251	-.274 to .553
.0083	.0004	.0002	n.a.	.0043	67.7	.065	.101	.084	-.038 to .240
.0066	.0004	.0001	n.a.	.0056	56.1	.075	.097	.097	-.062 to .256
.0277	.0009	.0003	n.a.	-.0118	100+	0	.145	0	.145

Table IX-1--continued

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Variance Expected due to Sampling Error	Variance due to Range Differ- ence	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structu
% Direct Workers								
Total	12	497	-.207	.0654	.0224	.0029	.0011	n.a.
Small	9	373	-.262	.0737	.0214	.0044	.0018	n.a.
Large	3	124	-.041	.0037	.0251	.0001	.0000	n.a.
Unknown Size	0	0						
% Supervisors								
Total	10	1813	-.096	.0251	.0050	.0007	.0002	n.a.
Small	8	1688	-.066	.0253	.0043	.0005	.0002	n.a.
Large	2	125	-.225	.0044	.0144	.0034	.0013	n.a.
Unknown Size	0	0						
% Clerical Personnel								
Total	13	1996	.002	.0108	.0064	.0000	.0000	n.a.
Small	8	1665	.023	.0078	.0046	.0000	.0000	n.a.
Large	4	183	-.008	.0055	.0226	.0000	.0000	n.a.
Unknown Size	1	148	-.212					
% Workflow Planning and Control								
Total	4	160	-.099	.0287	.0240	.0007	.0003	n.a.
Small	1	27	-.024					
Large	3	133	-.115	.0331	.0211	.0009	.0004	n.a.
Unknown Size	0	0						
% Administration								
Total	12	753	.066	.0367	.0150	.0003	.0001	n.a.
Small	7	516	.099	.0383	.0125	.0007	.0003	n.a.
Large	5	237	-.007	.0256	.0204	.0003	.0000	n.a.
Unknown Size	0	0						

[a]Numbers may not sum across due to rounding.

Variance Expected due to Sampling Error	Variance due to Range Difference	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structure	Residual[a] Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation: Mean	Corrected Correlation: s.d.	90 % Credibility Interval
.0224	.0029	.0011	n.a.	.0390	40.4	.197	-.265	.254	-.683 to .152
.0214	.0044	.0018	n.a.	.0460	37.6	.214	-.335	.274	-.785 to .116
.0251	.0001	.0000	n.a.	-.0216	100+	0	-.052	0	-.052
.0050	.0007	.0002	n.a.	.0192	23.4	.139	-.124	.179	-.419 to .171
.0043	.0005	.0002	n.a.	.0203	19.5	.142	-.112	.154	-.415 to .191
.0144	.0034	.0013	n.a.	-.0147	100+	0	-.288	0	-.288
.0064	.0000	.0000	n.a.	.0044	59.4	.066	.003	.086	-.138 to .144
.0046	.0000	.0000	n.a.	.0031	60.1	.056	.029	.072	-.090 to .148
.0226	.0000	.0000	n.a.	-.0171	100+	0	-.011	0	-.011
							-.297	n.a.	
.0240	.0007	.0003	n.a.	.0036	87.3	.060	-.128	.078	-.257 to .000
							-.034	n.a.	
.0211	.0009	.0004	n.a.	.0107	67.7	.103	-.148	.134	-.368 to .072
.0150	.0003	.0001	n.a.	.0213	41.9	.146	.085	.189	-.226 to .396
.0125	.0007	.0003	n.a.	.0248	35.1	.158	.128	.204	-.207 to .463
.0204	.0003	.0000	n.a.	.0052	79.7	.072	-.010	.093	-.163 to .144

Table IX-2. Organization Size: 95% Confidence Interval and Statistical Significance Tests

Variable	k	n	Mean	s.d.	s.e.	95% Confidence Interval	Z-Test Small-Large
	Corrected Correlation						
Division of Labor							
Small (< 1000)	17	2349	.417	.241	.0647	.29 to .54	
Large (> 1000)	7	224	.401	.207	.1203	.16 to .64	.12
Unknown Size	2	153	.554	.000	.0996	.36 to .75	
Functional Specialization							
Small (< 1000)	27	1733	.317	.193	.0494	.22 to .41	
Large (> 1000)	15	502	.454	.067	.0592	.34 to .57	-1.78***
Unknown Size	2	143	.168	.000	.1183	-.06 to .40	
Standardization							
Small (< 1000)	9	658	.373	.084	.0603	.25 to .49	
Large (> 1000)	4	155	.354	.000	.1118	.14 to .57	.15
Unknown Size	2	89	-.025	.000	.1583	-.33 to .28	
Overall Formalization							
Small (< 1000)	28	1949	.272	.185	.0476	.18 to .36	
Large (> 1000)	8	246	.183	.000	.0941	-.00 to .37	.84
Unknown Size	7	658	.226	.155	.0812	.07 to .38	
Role Formalization							
Small (< 1000)	11	340	.329	.281	.1155	.10 to .56	
Large (> 1000)	12	394	.302	.000	.0736	.16 to .45	.20
Unknown Size	2	279	.355	.133	.1265	.11 to .60	
Vertical Span							
Small (< 1000)	22	2708	.346	.158	.0407	.26 to .42	
Large (> 1000)	7	256	.303	.100	.0855	.14 to .47	.45
Centralization							
Small (< 1000)	30	1660	-.004	.245	.0572	-.12 to .11	
Large (> 1000)	15	512	-.083	.269	.0946	-.27 to .10	.71
Unknown Size	11	1251	.140	.251	.0858	-.03 to .31	
Supervisor's Span of Control							
Small (< 1000)	16	2377	.097	.097	.0358	.03 to .17	
Large (> 1000)	6	215	.145	.000	.0882	-.03 to .32	-.50
% Direct Workers							
Small (< 1000)	9	373	-.335	.274	.1106	-.55 to -.12	
Large (> 1000)	3	124	-.052	.000	.1175	-.28 to .18	-1.75***
% Supervisors							
Small (< 1000)	8	1688	-.112	.184	.0723	-.25 to .03	
Large (> 1000)	2	125	-.288	.000	.1097	-.50 to -.07	1.34

Table IX-2--continued

Variable	k	n	Mean	s.d.	s.e.	95% Confidence Interval	Z-Test Small-Large
% Clerical Personnel							
Small (< 1000)	8	1665	.029	.072	.0408	-.05 to .11	
Large (> 1000)	4	183	-.011	.000	.0968	-.20 to .18	.38
Unknown Size	1	148	-.297	n.a.	.0747	-.44 to -.15	
% Workflow Planning and Control							
Small (< 1000)	1	27	-.034	n.a.	.1966	-.42 to .35	
Large (> 1000)	3	133	-.148	.134	.1358	-.41 to .12	.48
% Administration							
Small (< 1000)	7	516	.128	.204	.0956	-.06 to .32	
Large (> 1000)	5	237	-.010	.093	.0947	-.20 to .18	1.03

*p < .001, one-tailed. **p < .01, one-tailed. ***p < .05, one-tailed.

Table IX-3. Summary of Results for Effect of Organization Size

Structural Variable	Small (< 1,000) Mean r	s.d.	res	Large (> 1,000) Mean r	s.d.	res	Significance	Residual Variance
Small > Large:								
% Direct Workers	-.335	.274	+	-.052	.000	-	$p < .05$	Decrease
Division of Labor	.417	.241	+	.401	.207	-	n.s.	No Change
Standardization	.373	.084	-	.354	.000	-	n.s.	Decrease
Overall Formalization	.272	.185	+	.183	.000	-	n.s.	No Change
Role Formalization	.329	.281	+	.308	.000	-	n.s.	Increase
Vertical Span	.346	.158	+	.303	.100	-	n.s.	Decrease
Large > Small:								
Functional Specialization	.317	.193	+	.454	.067	-	$p < .05$	Decrease
Centralization	-.004	.245	-	-.083	.269	+	n.s.	Decrease
Supervisor's Span of Control	.097	.097	+	.145	.000	-	n.s.	Decrease
% Supervisors	-.112	.142	+	-.288	.000	-	n.s.	Decrease
% Workflow Planning and Control	-.034	n.a.	n.a.	-.148	.134	+	n.s.	Increase
Small (positive) & Large (negative):								
% Clerical Personnel	.029	.072	-	-.011	.000	-	n.s.	Decrease
% Administration	.128	.204	+	-.010	.093	-	n.s.	Decrease
Mean r	.140			.120				
Mean Absolute Value	.215	.181		.211	.067			
Residual Variance:								
Increase		9			2			
Decrease		3			11			
No Change		0			0			
n.a.		1						

CHAPTER X

MODERATOR TEST: ORGANIZATION TYPE

It may seem trite to say that manufacturing organizations are different from service organizations. However, these differences have often been ignored as a potential source of variance in the outcomes of studies. At the conclusion of one review of the literature it was stated "we must also take into consideration the possibility of fundamental differences in the transformation technologies between organizations with different purposes (e.g., people-processing versus material processing)" (Reimann & Inzerilli, 1979: 190).

In a factor analysis performed on the mixed sample of 46 organizations in the Aston study, it was observed that the manufacturing-service dichotomy loaded on a common factor that was labeled "operating variability" (Pugh, Hickson, Hinings, & Turner, 1969). Other variables loading on this factor were the type of output (consumer-producer) and the degree of customer orientation (the degree to which products are made to customer specifications). These researchers determined that the organizations studied fell on a continuum ranging from manufacturers of producer goods to providers of consumer services. They suggested that "the manufacturing producer end of the scale was linked with an organizational emphasis on self-image, whereas the consumer service end emphasized outputs" (Pugh et al., 1969: 100). These differences in emphases may have significant implications for organization design (i.e., structure).

Researchers from the Aston school found that when the manufacturing firms were singled out for analyses from their mixed samples the correlation between technology and structure declined (Child & Mansfield, 1972; Hickson et al., 1969), and Aldrich (1972) found that the Aston scale of workflow integration yields an almost perfect dichotomy between manufacturing and service organizations. Manufacturers score higher than do service providers. This agreed with the findings in both the Aston Study (Hickson et al., 1969) and the National Study (Child & Mansfield, 1972).

However, it must be pointed out that Aldrich's (1972) conclusions refer to differences between mean scores for service organizations and manufacturing organizations. Differences in mean scores do not imply differences in correlations. Mean scores are important as indicators of whether service and manufacturing organizations possess relatively equal levels of a particular trait (e.g., automation, or routineness of the task), but it is the correlation coefficient that indicates the relative change in organization structure corresponding to a given change in technology. The slope of regression lines for manufacturing and service samples may be identical even though the intercepts differ.

On the other hand, this condition suggests that the correlation observed in a mixed sample may be significantly different due to at least two factors. The first is the relative representation of manufacturing and service firms in the mixed sample. The correlation observed in the mixed sample will tend to be biased toward the dominant subgroup. Second, the sign of the correlation can be significantly influenced by whether the organization type that scores low (high) on the independent measure (technology) also scores low (high) on the dependent measure. If they do, then the correlation for the mixed sample will tend to be positive. If they do not, the correlation can be negative for the mixed group even though the correlation within the manufacturing and service subsamples is really identical and positive. The correlation in the mixed sample may also be larger than that for either the service subsample or the manufacturing subsample.

Adjustment for Differences in Range Restriction

An alternative explanation for the findings obtained for manufacturing subsamples of the Aston Study and the National Study (Child & Mansfield, 1972; Hickson et al., 1969) is that the manufacturing firms were fairly homogeneous with regard to the workflow integration measure, and this lack of variance in the independent measure caused the reduction in correlation for the manufacturing firms. The correlation observed for these subsamples may have been attenuated by range restriction in the independent variable. To the extent that this is true, the correction for range restriction will restore the observed correlation to its higher unrestricted level.

Tables IV-4, IV-5, and IV-6 in Chapter IV displayed the artifact distributions for range restriction in measures of workflow continuity, workflow integration and automation, and task variability. Tables IV-5 and IV-6 displayed separate artifact distributions for manufacturing, service, and total. All of these distributions use the same studies as a reference so that correlations from mixed, manufacturing, and service samples may be adjusted to a common reference standard deviation. These distributions indicate that the manufacturing and service samples have approximately the same degree of range restriction. The mean restricted standard deviation (i.e., U = sample standard deviation divided by the reference standard deviation) is .825 for manufacturing, and .818 for service organizations. These are only slightly lower than the mean restricted standard deviation for all types of samples combined (i.e., service, manufacturing, and mixed) which is .843. The similarity of these mean restricted standard deviations indicates that differences between service and manufacturing samples, if they exist, are not caused by differences in the degree of range restriction.

For the meta-analyses performed in this chapter the artifact distributions in Tables IV-4, IV-5 and IV-6 for range restriction in manufacturing samples are used to make this correction in the manufacturing subgroups, and the artifact distributions in Tables IV-5 and IV-6 for range restriction in service samples are used to make the correction in the service subgroups. Finally, the correction for range restriction in the subgroup of mixed samples uses the artifact distribution for range restriction in all types of samples combined.

Division of Mixed Samples

Several of the correlations displayed in Tables IV-1 through IV-3 are calculated on mixed samples for which the correlation in the manufacturing subsample and the service subsample can be calculated from the original data (Aston Data Bank, 1976), or are in published articles. Specifically these are the Aston Study (Studies 38 and 4k), the National Study (Studies 18 and 4i), the Hickson and Inkson replication of the Aston Study (Study 4b), and the Pugh and Loveridge study of 15 manufacturers and one service provider (Study 4g). The actual data collected for all of these studies are stored in computer readable format in the Aston Data Bank (1976). Appendix F of this study provides a breakdown of these four mixed samples into the manufacturing and service subsamples for each of the 13 variables analyzed in this chapter. The average correlations for these subsamples, as shown in Appendix F, were used in the analyses performed in this chapter. Many of the correlations for the manufacturing subsamples for the Aston Study and the National Study are published elsewhere (Child & Mansfield, 1972; Hickson et al., 1969). However, none of the correlations for the service subsamples have been included in publications before.

Hypotheses

There are two issues of concern in this chapter. A methodological issue is whether mixed samples yield significantly different correlations than do pure manufacturing or pure service organizations. The second issue, which is more theoretical, is whether the correlation observed in manufacturing samples is significantly different from that found in service samples.

The moderator effect of organization type is not deduced from any directional theory. Rather, it is based upon an inductive process grounded in empirical findings. As such, some researchers may find a fault in labelling them as hypotheses. It is a suspected difference; an expectation. Nevertheless, for the purpose of exposition they will be referred to as hypotheses.

The null hypothesis tested in this chapter is therefore:

Hypothesis 0: The correlation between technology and organization structure is the same for manufacturing, service, and mixed samples.

The alternative hypothesis is:

Hypothesis 5: The correlation between technology and structure is affected by whether the sample includes manufacturing organizations, service providers, or a combination of these two.

Support for the alternative hypothesis has obvious implications for future research efforts and for the interpretation of past findings.

If manufacturing firms and service firms do display significantly different relationships between technology and structure then future research efforts should avoid the use of mixed samples. This finding would also suggest that the interpretation of the results of past research efforts using mixed samples may be dubious. More importantly, it could signal a need for a modified theory of the technology-structure relationship in which the propositions differ for manufacturing organizations and service providers.

Results

Table X-1 and Table X-2 display the results of moderator tests performed on 13 structural variables. At least one significant difference was observed between pairs of subgroups for 8 of the 13 variables, and the mean residual variance declines for 4 others. This section will discuss the results obtained for those variables.

Functional Specialization

Forty-four studies were included in the overall analysis of functional specialization. For this analysis three of those studies were split into their manufacturing and service subsamples (Studies 4b, 18 and 38).

The manufacturing subgroup includes 27 correlations ranging from r = -.07 (Study 4e) to r = .70 (Study 37). The 27 studies included in this subgroup are 3, 4b, 4c, 4d, 4e, 4f, 4g, 5, 12, 14, 18, 37, 38, 39, 41, 44, 46, 54, 62, 71, 73, 77, 81, 83, 98a, 98b, and 98c. The total sample size of 1,000 results in a mean correlation of $\bar{r}$ = .31.

Fourteen studies are included in the service subgroup (Studies 4a, 4b, 4h, 10, 11, 13a, 13b, 18, 24, 25, 38, 53, 70, and 95). The range of values included is r = -.25 (Study 70) to r = .35 (Study 11). The total sample size of 1,004 results in a mean correlation of $\bar{r}$ = .17.

Only six studies are included in the mixed subgroup (Studies 7, 15, 21a, 21b, 31, and 65) with a total sample size of 381. The mean observed correlation is $\bar{r}$ = .18.

<u>Manufacturing Versus Service</u>

The results of the pair-wise comparisons in Table X-2 indicate that the corrected mean correlation for manufacturing samples is significantly higher than that for the service samples (i.e., .445 and .252, respectively). It should also be noted that the manufacturing subsample approaches being significantly higher than the mixed sample (i.e., .445 and .263, respectively).

The residual variance for all three of the subgroups is lower than the residual variance for the combined set of correlations. The combination of the reduced residual variance and the differences between the mean correlations indicates that the type of organization included in the sample probably does have an impact on the correlation observed. At least part of the variance observed between studies of functional specialization and technology can be attributed to this factor. For the manufacturing subgroup and the mixed subgroup, the residual variance shown in Table X-1 is quite small (i.e., less than .01), and the proportion of variance explained by artifacts in each case is 76 and 74 percent, respectively.

A tentative interpretation of these results is that manufacturing organizations are more likely to differentiate horizontally through functional specialization in response to technology becoming more automated, routine, and predictable. The 95 percent confidence intervals in Table X-2 allow a relatively high certainty that functional specialization is positively correlated with technology.

Role Formalization

Twenty-five studies were included in the overall analysis of role formalization. For this moderator analysis 3 of those studies were separated into the manufacturing and service subsamples (Studies 4b, 18 & 4i, and 38 & 4k). The details of this split are provided in Appendix F.

The manufacturing subgroup includes 18 studies (Studies 4b, 4c, 4d, 4e, 4f, 4g, 18 & 4i, 34, 37, 38 & 4k, 39 & 4j, 42, 44 & 4n, 46, 62, 71 & 4l, 77 & 4m, and 86). Correlations range from $r = -.06$ (Study 4e) to $r = .71$ (Study 37). The total sample size of 558 yields a sample-weighted mean correlation of $\bar{r} = .21$.

Seven studies are included in the service subgroup which range from $r = -.07$ (Study 4a) to $r = .87$ (Study 4h). This extremely high positive correlation is based upon only six organizations and therefore has little influence on the results. The next highest correlation comes from Blau's and Schoenherr's study of 53 state employment agencies with a correlation of $r = .33$ (Study 13a). The total sample size of 273 results in a mean correlation of $\bar{r} = .15$.

The mixed subgroup includes only three studies. These are r = -.036 from Rousseau's study of 19 departments of an electronics firm and a local radio station (Study 80), r = .39 from Kmetz's study of 131 departments in 53 firms (Study 51), and r = .42 from Ford's study of 82 subunits from 2 manufacturing and 6 service firms in Ohio (Study 31). The total sample size of 181 for these three studies results in a mean correlation of $\bar{r} = .35$.

Mixed Versus Service

The results of pair-wise comparisons in Table X-2 indicate that the corrected mean correlation for the mixed subgroup is significantly larger than the corrected mean for the service subgroup. The mixed group also approaches being significantly larger than the manufacturing subgroup (i.e., $p < .10$, two-tailed). However, the manufacturing and service subgroups do not differ significantly from one another. The 95 percent confidence intervals in Table X-2 indicate that the corrected correlations in all three subgroups are significantly greater than zero.

The mean residual variance for these three subgroups is much lower than was observed for the combined studies. In fact, as can be seen in Table X-1, artifacts explain all of the observed variance for both the service subgroup and the mixed subgroup, and artifacts explain approximately 79 percent in the manufacturing subgroup. These results lend support to the hypothesis that mixed samples yield different results than do pure manufacturing samples or pure service samples. On the other hand, we cannot reject the null hypothesis that there is no difference between service organizations and manufacturers in the relationship between technology and the degree of role formalization. The type of organization sampled does seem to contribute to the variance observed in the results of these studies.

Centralization

Fifty-six studies were included in the overall analysis of centralization. Two of these were divided into the service and manufacturing subgroups for this analysis (Studies 18 & 4i, and 38 & 4k).

The manufacturing subgroup includes 24 correlations ranging from r = -.35 (Study 54) to r = .32 (Study 83). See Table IV-1 in Chapter IV and Appendix C for a description of Studies 4c, 4d, 4e, 5, 12 & 61, 14, 18 & 4i, 38 & 4k, 39 & 4j, 41, 46, 47, 54, 69, 75a, 75b, 75c, 77, 81, 83, 97, 98a, 98b, and 98c. The total sample size of 973 results in a mean observed correlation of $\bar{r}$ = .02, and sampling error explains all of the observed variance.

The 23 studies included in the service subgroup range from r = -.46 (Study 13a) to r = .48 (Study 30). Study references are 4h, 8, 11, 13a, 18 & 4i, 20, 30, 33, 35, 36, 38 & 4k, 40, 45, 53, 55, 57, 60, 66, 67, 68, 84, 93, and 95. The total sample size for these 23 studies is 1,613, and the mean observed correlation is $\bar{r}$ = .095. Artifacts explain only 32 percent of the variance observed. However, the residual variance in this subgroup (i.e., .0296) is lower than the residual in the combined studies (i.e., .0342).

The mixed subgroup consists of 11 studies that range from r = -.52 (Study 7) to r = .473 (Study 31). This wide range of values is evident in the large residual variance shown in Table X-1 for this subgroup (i.e., .0688). The 11 studies included in this category are 7, 15, 21a, 21b, 31, 43, 49, 51, 65, 80, and 85. The mean observed correlation of $\bar{r}$ = -.097 is based on a total sample size of 845.

<u>Mixed Versus Service</u>

The 95 percent confidence intervals in Table X-2 indicate that only the corrected correlation for the service subgroup differs significantly from zero. The pattern of correlations could be interpreted as follows: Technology has no effect on the level of centralization in manufacturing firms, but it does have a small effect in service organizations. However, the large residual variance in the service subgroup, and the inclusion of zero within the confidence interval for the manufacturing subgroup do not support this interpretation. The more appropriate interpretation is that there is no difference between the manufacturing and the service sector.

The interpretation of the correlation for the mixed subgroup is more of a problem. The pair-wise comparison in Table X-2 indicates that the negative correlation in the mixed subgroup is significantly different from the positive correlation in the service subgroup. The negative correlation in the mixed category could be expected if, as Aldrich (1972) has suggested, service organizations score lower on technology scales and if, at the same time, they score higher on the centralization dimension. This would result in manufacturing firms in the upper-left quadrant, and service organizations in the lower-right quadrant. Even though no correlation may exist within each group, the mixed sample results in a negative correlation. While this interpretation is speculative, it does suggest the potential distortion inherent in the use of mixed samples.

The results of this analysis indicate that the type of organization included in the sample does affect the results obtained, and at least part of the variance observed between study outcomes is caused by these differences.

Supervisor's Span of Control

Twenty-two correlations were included in the overall analysis of supervisor's span of control. Two of those (Studies 18 & 4i, and 38 & 4k) were divided into their manufacturing and service components for inclusion in this present analysis.

Fifteen studies included in the manufacturing subgroup range from two studies with a correlation of r = -.23 (Studies 4d and 96) to r = .284 (Study 22). The 15 studies included here are Studies 3, 4c, 4d, 4e, 5, 12, 18 & 4i, 19, 22, 38 & 4k, 39 & 4j, 41, 78, 81, and 96. The total sample size is 719 and the mean observed correlation is $\bar{r}$ = -.053. Sampling error explains all of the observed variance.

Eight studies are included in the service subgroup (Studies 4h, 9, 13a, 13b, 13c, 18 & 4i, 33, and 38 & 4k). These correlations range from r = -.106 for the 15 service organization in the Aston Study (Study 38 & 4k) to r = .47 for Bell's study of 30 departments in a single hospital (Study 9). The total sample size of 1,807 results in a sample-weighted mean correlation of $\bar{r}$ = .134. Sampling error explains all of the observed variance in this subgroup, as it does in the manufacturing subgroup.

There is only one study in the mixed subgroup. That is Ford's (Study 31) dissertation sample of 86 subunits from eight Ohio organizations; two manufacturers and six service organizations. The average correlation for two measures of technology used in Ford's study is r = -.096.

<u>Service Versus Mixed</u>

The 95 percent confidence intervals in Table X-2 indicate that only the corrected mean correlation for the service subgroup is significantly different from zero. The z-test also indicates that the corrected correlation for the service subgroup (i.e., $\bar{r}$ = .178) is significantly different from the corrected correlation of the single mixed sample (i.e., $\bar{r}$ = -.136).

<u>Service Versus Manufacturing</u>

The results of the statistical significance tests in Table X-2 also indicate a statistically significant difference between the corrected mean correlation for the service subgroup (i.e., $\bar{r}$ = .178) and the corrected correlation for the manufacturing subgroup (i.e., $\bar{r}$ = -.071). The mean correlation for manufacturers is not significantly different from zero.

The significant difference between manufacturing and service subgroups, coupled with the finding that sampling error can explain all of the observed variance in both groups, supports the interpretation that as technology becomes more automated, predictable or routinized the span of control for supervisors in manufacturing firms declines slightly but in service organizations it increases.

Percentage Direct Workers

Twelve correlations were included in the overall analysis of percentage direct workers. For this moderator analysis 2 of those studies were divided into correlations for the manufacturing subsample and the service subsample (Studies 18 & 4i, and 38 & 4k).

Eleven correlations in the manufacturing subgroup range from r = -.68 for Woodward's study (Study 96) to r = .19 for the McMillan study of Japanese manufacturers (Study 4e). These are Studies 3, 4c, 4d, 4e, 5, 12, 18 & 4i, 38 & 4k, 39 & 4j, 41, and 96. The total sample size is 458, and the mean observed correlation is $\bar{r}$ = -.246.

Artifacts explain approximately 45 percent of the observed variance; sampling error explains 35 percent.

The three correlations included in the service subgroup are from the Tauber study of six general and mental hospitals (Study 4h) which is r = .00, the service organizations in the Aston Study (Study 38 & 4k) which is r = .08, and the service subsample from the National Study (Study 18 & 4i) which is r = .26. The total sample size for these three studies is only 47 so the sampling error for the mean correlation (i.e., $\bar{r}$ = .17) is more than enough to explain all observed variance between these three.

Service Versus Manufacturing

The confidence intervals in Table X-2 indicate that the corrected mean correlation for the 11 manufacturing studies is statistically significantly greater than zero, but the corrected correlation for the service organizations is not statistically significantly less than zero. This suggests a need for further studies of the relationship between technology and percentage direct workers in service organizations. As more studies are added, the confidence interval will narrow, and we will have greater confidence in the mean correlation obtained in future meta-analyses.

The results of the z-test in Table X-2 also indicates that the corrected mean correlation in the manufacturing subgroup (i.e., $\bar{r}$ = -.322) is statistically significantly different from the corrected mean correlation in the service subgroup (i.e., $\bar{r}$ = .225). This difference, coupled with the reduction in residual variance in Table X-1, indicates that whether the sample consists of manufacturing organizations or service organizations does have an impact on the correlation observed between technology and the percentage of the labor force engaged in direct labor.

The implication of these findings is that as technology becomes more automated, and the task more routine, manufacturers experience a reduction in the percentage of their personnel engaged in direct labor activities while service organizations experience an increase in this percentage. When these results are compared with those for supervisor's span of control a consistent pattern begins to emerge. For manufacturers the supervisor's span of control declines and the percentage direct workers also declines. For service organizations the supervisor's span increases and so does the percentage direct workers.

Percentage Supervisors

Only 10 studies were found that assessed the relationship between technology and the percentage of the organization's personnel who are supervisors. For this moderator analysis 1 study was divided into its service and manufacturing components (Study 18 & 4i). This results in a total of 11 correlations divided into three groups.

The five correlations in the manufacturing subgroup represent a total sample size of 380. These correlations range in value from $r = -.105$ from Routamaa's study of 122 shoe and clothing manufacturers in Finland (Study 81) to $r = .76$ from Harvey's study of 43 manufacturers in the United States (Study 37). These five are Studies 12, 4i, 37, 41, and 81. The sample-weighted mean correlation for these five studies is $\bar{r} = .097$. However, artifacts explain only 18 percent of the observed variance. The source of the large residual variance will be addressed later in this section.

The four correlations in the service subgroup come from Studies

4i, 13a, 13c, and 45. The range of these four is r = -.305 (Study 13a) to r = .154 (Study 45). The total sample size for these four is 1,285 and the average observed correlation is $\bar{r}$ = -.20. Sampling error accounts for all of the observed variance.

Only two studies are included in the mixed category. These correlations are r = -.073 from Carter's study of 68 daily newspapers (Study 15), and r = -.06 from the Miller and Droege study of 93 Canadian firms (Study 65). The newspapers were placed in the mixed category due to the nature of the newspaper business. They have elements of production (e.g., printing newspapers) and service (e.g., advertising, communication) and it is not possible to place them clearly into one category versus another. The 93 Canadian firms were about two-thirds manufacturing and one-third service (Miller & Droege, 1986). The total sample size for these two studies is 154 and the mean correlation is $\bar{r}$ = -.065. There is essentially no variance observed between these two correlations so sampling error quite easily explains the small difference between the two.

Sources of Residual Variance

Table X-1 showns that all of the observed variance in the service subgroup and the mixed subgroup is attributable to sampling error, but only a very small portion of the variance is explained in the manufacturing subgroup. The source of the large residual variance in the manufacturing subgroup can be traced directly to the Harvey study (Study 37).

This study was identified in Chapter VII as an extreme value in the distribution of correlations between technology and percentage supervisors (See Figure VII-10 in Chapter VII). It was also demonstrated that if the Harvey study is deleted from the overall analysis of percentage supervisors the percentage of variance explained by sampling error increased from 20 percent to 66 percent. Similar results were obtained in Chapter VIII for the relationship between task routineness and percentage supervisors.

In this moderator analysis the presence of the Harvey study in the manufacturing subgroup has an even greater impact. If the Harvey study is deleted from the manufacturing subgroup, the four remaining studies will constitute a total sample size of 337 and result in a mean correlation of $\bar{r} = .013$. Sampling error explains all of the observed variance just as it does in the service and the mixed subgroups. The corrected mean correlation would be .017 with a standard error of .0725. The significant difference that is seen between manufacturing and service subgroups in Table X-2 remains significant (i.e., $z = 2.68$; $p < .01$, two-tailed). The difference between the mixed subgroup and the manufacturing subgroup remains nonsignificant.

Based upon these findings, the following discussion will use the results obtained for the manufacturing subgroup with the Harvey study removed.

Manufacturing Versus Service

The finding of a statistically significant difference between the manufacturing subgroup and the service subgroup is consistent with the findings for supervisors span and percentage direct workers. For manufacturers it was found that the supervisor's span of control declines and the percentage direct workers also declines (i.e., corrected correlations of -.071 and -.246, respectively). But for the service subgroup supervisor's span of control and percentage direct workers both increase (i.e., corrected correlations of .178 and .170, respectively).

Given this pattern, one would anticipate that the percentage of personnel in supervision would either be unchanged for manufacturers or increase, while that for the service subgroup would remain unchanged or decrease. The results obtained for percentage supervisors are consistent with that relationship. The manufacturing subgroup provides a mean correlation near zero, while the service subgroup indicates a positive correlation.

Percentage Clerical Personnel

Thirteen studies were included in the overall analysis of the correlation between technology and the percentage of personnel engaged in clerical duties. Two mixed studies were split into manufacturing and service subsamples for this analysis (Studies 4i and 4k). This increases the number of correlations distributed between the manufacturing and service subgroups to 15.

Eight studies in the manufacturing subgroup yield correlations ranging from r = .062 (Study 39 & 4j) to r = .415 (Study 5). Note that all eight correlations are positive. These eight studies are references 3, 5, 12, 4i, 4k, 39 & 4j, 41, and 81. The total sample size is 444 and the mean observed correlation is $\bar{r}$ = .12. Sampling error explains all of the variance observed. This indicates that there is one true correlation for all eight studies (i.e., .158), and artifacts explain all of the variance among these studies of manufacturing organizations.

The seven correlations in the service subgroup come from Studies 4h, 4i, 4k, 11, 13a, 13c, and 55. These seven range from r = -.212 (Study 55) to r = .158 (Study 11). The total sample size of 1,564 results in a sample-weighted mean correlation of $\bar{r}$ = -.029, and sampling error explains 70 percent of the observed variance. The residual variance (i.e., .002) is extremely small and is probably also artifactual.

Manufacturing Versus Service

The 95 percent confidence intervals in Table X-2 indicate that the corrected mean correlation in the manufacturing subgroup is significantly greater than zero. However, the confidence interval for the service subgroup includes zero, so we must retain the hypothesis that the true correlation is zero. The statistical significance test also indicates that the corrected correlation for manufacturers is statistically significantly different from that for the service subgroup.

The implication of these results is that manufacturers experience an increase in the proportion of personnel in clerical jobs, while service organizations show no change in this component in response to increased task routineness, predictability, and automation.

Percentage Administration

Twelve studies were included in the overall analysis of the relationship between technology and the percentage of personnel in administration. Two mixed studies were divided into their manufacturing and service subsamples for this analysis (Studies 4i and 4k). This increased the total number of correlations by two.

The 10 correlations in the manufacturing subgroup (Studies 3, 4i, 4k, 5, 12, 32, 77, 81, 86, and 96) range from r = -.044 (Study 4k) to r = .507 (Study 96). The large positive correlation from Woodward's study was identified in Chapter VII as a possible outlier value (See

Figure VII-13 in Chapter VII). The presence of this correlation in the manufacturing subgroup contributes significantly to the residual variance seen in Table X-1 (i.e., .010). Even so, this residual is not large and three artifacts do account for over 65 percent of the variance observed around the mean correlation of $\bar{r}$ = .145.

The four studies in the service subgroup have a total sample size of 209 and a sample-weighted mean correlation of $\bar{r}$ = -.104 (Studies 4i, 4k, 11, and 13a). The range of correlations in this subgroup is r = -.27 (Study 13a) to r = .161 (Study 4i). Sampling error accounts for all of the observed variance.

Manufacturing Versus Service

The 95 percent confidence intervals in Table X-2 indicate that the corrected mean correlation for the manufacturing subgroup is statistically significantly greater than zero. The confidence interval for the service subgroup includes zero, so the mean correlation is not significant at the .05 level of significance. The z-test in Table X-2 also indicates that the manufacturing subgroup is significantly different from the service subgroup.

These results imply that as technology becomes more automated, and the task more routine and predictable, manufacturers experience an increase in the proportion of personnel in administration, but service organizations experience a reduction in that component.

Reduction in Residual Variance

Examination of the results of the 13 moderator tests displayed in Table X-1 will show that in 11 cases the mean residual variance is reduced by forming subgroups according to organization type. The residual variance is also reduced for the percentage supervisors variable if the Harvey study is deleted from the analysis. The only case where the residual increases is percentage workflow planning and control with over 87 percent of its variance already explained. So, it may be said that in 12 of 13 cases the type of organization sampled does affect the variance observed between study outcomes.

For four variables the residual variance was reduced but the difference between the subgroups did not reach statistical significance. Those variables were division of labor, standardization, overall formalization, and vertical span. The following section will address the results of those four analyses.

Division of Labor

The nine studies in the manufacturing subgroup for division of labor range from r = -.206 (Study 75b) to r = .362 (Study 42). See Table IV-1 and Appendix C, Studies 14, 18 & 4i, 38 & 4k, 39 & 4j, 42, 75a, 75b, 75c, and 97. The total sample size of 335 yields a mean correlation of $\bar{r}$ = .18 and artifacts explain all of the variance; sampling error explains over 92 percent.

Sixteen correlations ranging from r = -.423 (Study 25) to r = .70 (Study 74) are included in the service subgroup (Studies 4h, 10, 13a, 13c, 18 & 4i, 20, 25, 30, 33, 35, 38 & 4k, 50, 70, 72, 74, and 91. The two extreme values discussed in Chapter VII in describing the distribution of correlations for division of labor are both in this subgroup. As a result, the residual variance for the service subgroup is slightly higher than that seen for all of the studies combined. The total sample size of 2,195 results in a mean correlation of $\bar{r}$ = .311. Artifacts explain only 36.5 percent of the observed variance and sampling error alone explains only 13.5 percent.

Only three studies are included in the mixed subgroup. These three are r = -.106 from Ford's study of 86 subunits in eight Ohio organizations (Study 31), and two studies published in Conaty et al. (1983). These correlations were r = .33 for 65 U.S. firms, and r = .44 for 64 Iranian firms (Studies 21a and 21b). These three correlations have a sample-weighted mean of $\bar{r}$ = .204, but artifacts explain only 29 percent of the variance observed.

The mean residual variance for these three groups is lower than for the combined studies (i.e., .0187 versus .0244) and, as Table X-2 shows, the corrected correlation for the service subgroup is 1.8 standard errors higher than the corrected correlation in the manufacturing subgroup. While this did not meet the criterion for a two-tailed significance test it is very close (i.e., p = .066). There is sufficient evidence here to conclude that manufacturing samples result in a lower correlation between technology and division of labor than do samples of service organizations. A moderator effect does exist.

<u>Standardization</u>

The overall meta-analysis of standardization resulted in a very small residual variance (i.e., .0057) and artifacts explain 80 percent of the variance observed. Even so, the separation of these studies into the manufacturing, service, and mixed subgroups does reduce residual variance. All of the variance within the manufacturing subgroup and the service subgroup is explained by artifacts. Only the mixed subgroup has a residual variance.

The manufacturing subgroup includes seven correlations ranging from r = -.07 (Study 14) to r = .468 (Study 34). The total sample size for these seven studies is 230, and the mean correlation is

$\bar{r}$ = .184. Sampling error explains 84 percent of the observed variance, and other artifacts explain the rest. (See Studies 3, 5, 14, 18 & 4i, 34, 38 & 4k, and 39 & 4j.)

The service subgroup ranges from r = -.08 (Study 57) to r = .288 (Study 91). The seven studies included have a total sample size of 520, and an average correlation of $\bar{r}$ = .211. Sampling error explains 85 percent of the observed variance, and other artifacts account for the rest. (Studies included are 4h, 18 & 4i, 38 & 4k, 53, 57, 60, and 91.)

Only three studies are included in the mixed subgroup. Strangely enough, the highest and the lowest of these three are from two studies published in the same article by Conaty et al. (1983). These three correlations are r = -.02 (Study 21b), r = .49 (Study 7), and r = .50 (Study 21a).

Table X-2 indicates that the 95 percent confidence intervals for all three subgroups are greater than zero. None of the pair-wise comparisons made in Table X-2 reveal a significant difference between any of the subgroups. These small differences between the subgroups accompanied by the reduction in residual variance suggest that the type of organization studied does have a small affect on the size of the correlation observed between technology and the degree of standardization.

<u>Overall Formalization</u>

The results obtained for overall formalization are very similar to the results obtained for standardization, except that formalization had a higher unexplained variance to begin with. The initial analysis of overall formalization resulted in a residual variance of .0106;

only 55.6 percent of the observed variance was explained. Separating these correlations into the manufacturing, service, and mixed subgroups results in a mean residual variance of .0083.

The manufacturing subgroup includes 17 correlations (Studies 3, 4c, 4d, 4e, 5, 18 & 4i, 38 & 4k, 39 & 4j, 41, 47, 54, 75a, 75b, 75c, 81, 83, and 97). These range in value from r = -.133 (Study 75b) to r = .50 (Study 83). The total sample size for these 17 studies is 607 and the mean correlation is $\bar{r}$ = .21. Artifacts account for 97 percent of the observed variance; sampling error explains 80 percent by itself. The residual variance is only .0009.

The 20 studies in the service subgroup range from r = -.073 (Study 30) to r = .63 (Study 74). Studies included in this subgroup are 4h, 13b, 18 & 4i, 20, 24, 30, 33, 35, 36, 38 & 4k, 40, 45, 53, 59, 60, 74, 84, 90, 93, and 95. The total sample size of 1,506 results in a mean correlation of $\bar{r}$ = .187 and artifacts account for 85.5 percent of the observed variance; sampling error explains 66 percent by itself. Residual variance for the service subgroup is only .0026.

The eight correlations in the mixed category (Studies 15, 21a, 21b, 31, 49, 51, 65, and 85) range in value from r = -.12 (Study 85) to r = .427 (Study 49). These two extreme values have sample sizes of 155 and 103, respectively, and they are near the extreme end of the distribution of 43 correlations included in the overall analysis reflected in the "Total" line in Table X-1. The mixed sample correlations have a large residual variance; only 22 percent of the observed variance is accounted for by artifacts.

The 95 percent confidence intervals in Table X-2 do not include zero for the manufacturing and the service subgroups. We can have fairly high confidence that the correlation for these two groups is positive. The difference between the corrected correlation for the manufacturing subgroup (i.e., .314) is not significantly different from that for the service subgroup (i.e., .282). Neither is significantly different from the corrected correlation for the mixed subgroup (i.e., .160).

The interpretation of these results for overall formalization is essentially the same as that for standardization. The small difference between the subgroups accompanied by the reduction in residual variance suggests that the type of organization studied does have a small affect on the size of the correlation observed.

Vertical Span

Twenty-nine studies were included in the overall analysis of the relationship between technology and vertical span in Chapter VI. Two mixed samples were divided into their manufacturing and service subsamples for this analysis (Studies 4i and 4k). This increases the total number of correlations by two.

The 17 correlations included in the manufacturing subcategory range from r = -.021 (Study 4d) to r = .772 (Study 96). See Table IV-1 and Appendix C, Studies 3, 4c, 4d, 5, 12, 18 & 4i, 22, 37, 38 & 4k, 39 & 4j, 41, 73, 77 & 78, 81, 96, 97, and 99. The total sample size of 748 yields a mean correlation of $\bar{r}$ = .32 and artifacts explain over 51 percent of the variance; sampling error explains 34.5 percent.

There are 10 studies in the service subcategory with a total sample size of 1,983. These 10 correlations range from r = -.31 (Study 25) to r = .565 (Study 13a) and have a sample-weighted mean correlation of $\bar{r}$ = .26 (Studies 10, 11, 13a, 13b, 13c, 18 & 4i, 25, 38 & 4k, 74, and 95). Artifacts account for 53 percent of the observed variance, but sampling error explains only 24 percent by itself.

There are four studies in the mixed sample subcategory with a total sample of 241. These four have correlations of r = -.085 (Study 21b), r = .043 (Study 80), r = .22 (Study 65), and r = .38 (Study 21a). The mean correlation for these four correlations is $\bar{r}$ = .17. Artifacts explain 58 percent of the observed variance and sampling error accounts for 49 percent by itself.

The 95 percent confidence intervals in Table X-2 do not include zero so we may be fairly certain that the correlation between technology and vertical span is positive. However, these three confidence intervals overlap each other. Even though the corrected mean correlation for the manufacturing subcategory is larger than that for both service organizations and mixed samples none of the differences are statistically significant. The mean residual variance for the three subgroups is only slightly lower than the residual variance of the combined studies (i.e., .0132 versus .0146).

Summary of Results

In 6 of the 13 comparisons made, a statistically significant difference was observed between the manufacturing subgroup and the service subgroup, and a reduction in the mean residual variance was also observed. These results provide support for the hypothesis that type of organization makes a significant difference in the correlation between technology and those 6 variables (i.e., functional specialization, supervisor's span of control, percentage direct workers, percentage supervisors, percentage clerical personnel, and percentage administration).

In three cases the difference between mixed samples and service samples was significant and the residual variance was reduced (i.e., role formalization, centralization, and supervisor's span of control).

In four additional cases (i.e., division of labor, standardization, overall formalization, and vertical span) the mean residual variance declined, but none of the differences between subgroups reached statistical significance.

Table X-3 summarizes the results of the 13 tests performed in this chapter. This table displays the corrected mean correlation and its standard deviation for the manufacturing, service, and mixed subgroup for each of the structural variables. It also indicates whether the residual variance for a subgroup is less than (-) or greater than (+) the residual for the combined analysis. At the bottom of Table X-3 are the mean correlation and the mean absolute value of the correlation and standard deviation of each subgroup.

Perhaps the most significant item in Table X-3 is the summary of the impacts on residual variance. For the manufacturing subgroup the residual variance declined in 10 of the 13 analyses; 11 of 13 if the Harvey (1968) study is deleted from analysis of percentage supervisors. For the service subgroup the residual declined in 10 of the analyses also. However, for the mixed subgroup increases and decreases in residual variance are split 50/50 at the chance level. The average standard deviation for the mixed subgroup is also worth noting. It is nearly double that of the manufacturing and service subgroups (i.e., .188 versus .104 and .098, respectively). There is far more inconsistency in the results obtained with mixed samples than there is for either manufacturing or service samples.

Conclusion

The results of the analyses performed in this chapter suggest that the type of organization included in the sample does have an effect on the correlation observed between technology and the structure of the organization. The only exception was the percentage of organization personnel employed in workflow planning and control. The consistent combination of statistically significant differences and reduced residual variance indicates that type of organization may be a significant cause of variation observed in the results obtained in studies of technology and structure.

Table X-1. Moderator Analyses: Organization Type

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Variance Expected due to Sampling Error	Variance due to Range Differ- ence	Variance due t Reliability Difference	
							Technology	Struct
Division of Labor								
Total	26	2726	.291	.0418	.0079	.0053	.0025	.001
Manufacturing	9	335	.180	.0283	.0262	.0024	.0010	.000
Service	16	2195	.311	.0413	.0056	.0044	.0030	.002
Mixed	3	204	.204	.0579	.0120	.0028	.0012	.000
Functional Specialization								
Total	44	2375	.239	.0372	.0156	.0039	.0016	.000
Manufacturing	27	1000	.312	.0404	.0212	.0062	.0029	.000
Service	14	1004	.172	.0305	.0136	.0015	.0009	.000
Mixed	6	391	.185	.0234	.0138	.0024	.0010	.000
Standardization								
Total	15	902	.227	.0297	.0148	.0034	.0015	.003
Manufacturing	7	230	.184	.0329	.0275	.0025	.0011	.002
Service	7	520	.211	.0157	.0134	.0022	.0014	.003
Mixed	3	160	.290	.0641	.0136	.0053	.0025	.005
Overall Formalization								
Total	43	2553	.173	.0303	.0134	.0021	.0009	.000
Manufacturing	17	607	.210	.0312	.0251	.0032	.0014	.000
Service	20	1506	.187	.0181	.0120	.0018	.0011	.000
Mixed	8	748	.108	.0493	.0095	.0008	.0004	.000
Role Formalization								
Total	25	1013	.218	.0372	.0209	.0032	.0015	.001
Manufacturing	18	556	.208	.0425	.0293	.0031	.0014	.000
Service	7	273	.148	.0223	.0223	.0012	.0007	.000
Mixed	3	151	.350	.0176	.0137	.0072	.0036	.002
Vertical Span								
Total	29	2964	.268	.0292	.0080	.0046	.0019	n.a.
Manufacturing	17	746	.317	.0538	.0186	.0064	.0027	n.a.
Service	10	1983	.260	.0177	.0042	.0033	.0019	n.a.
Mixed	4	241	.168	.0314	.0154	.0020	.0007	n.a.
Centralization								
Total	56	3423	.025	.0496	.0153	.0000	.0000	.0000
Manufacturing	24	973	.020	.0154	.0245	.0000	.0000	.0000
Service	23	1613	.095	.0436	.0132	.0005	.0003	.0001
Mixed	11	545	-.097	.0805	.0107	.0007	.0003	.0001
Supervisor's Span of Control								
Total	22	2592	.078	.0132	.0083	.0004	.0002	n.a.
Manufacturing	15	719	-.053	.0133	.0209	.0002	.0001	n.a.
Service	6	1807	.134	.0042	.0042	.0010	.0005	n.a.
Mixed	1	75	-.096					

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Variance Expected due to Sampling Error	Variance due to Range Difference	Variance due to Reliability Difference		Residual[a] Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation		90 % Credibility Interval
		Technology	Structure				Mean	s.d.	
.0079	.0053	.0025	.0016	.0244	41.6	.156	.423	.228	.049 to .798
.0262	.0024	.0010	.0007	-.0019	100+	0	.270	0	.270
.0056	.0044	.0030	.0020	.0262	36.5	.162	.463	.241	.066 to .860
.0120	.0028	.0012	.0008	.0409	29.3	.202	.300	.297	-.189 to .788
.0156	.0038	.0016	.0002	.0160	57.0	.126	.338	.179	.044 to .632
.0212	.0062	.0029	.0004	.0097	75.9	.099	.445	.141	.213 to .676
.0136	.0015	.0009	.0001	.0143	53.1	.120	.252	.175	-.036 to .539
.0138	.0024	.0010	.0001	.0061	73.9	.078	.263	.111	.080 to .445
.0148	.0034	.0015	.0032	.0057	80.1	.076	.332	.111	.150 to .514
.0275	.0025	.0011	.0022	-.0005	100+	0	.276	0	.276
.0134	.0022	.0014	.0030	-.0043	100+	0	.317	0	.317
.0136	.0053	.0025	.0052	.0375	41.5	.194	.422	.281	-.041 to .884
.0134	.0021	.0009	.0004	.0135	55.6	.116	.254	.171	-.027 to .535
.0251	.0032	.0014	.0007	.0009	97.0	.030	.314	.045	.240 to .389
.0120	.0018	.0011	.0006	.0026	85.5	.051	.282	.077	.155 to .409
.0095	.0008	.0004	.0002	.0385	22.0	.196	.160	.289	-.316 to .636
.0209	.0032	.0015	.0010	.0106	71.5	.103	.334	.158	.074 to .594
.0283	.0031	.0014	.0008	.0090	78.9	.095	.317	.144	.080 to .555
.0223	.0012	.0007	.0004	-.0023	100+	0	.230	0	.230
.0137	.0072	.0036	.0021	-.0090	100+	0	.517	0	.517
.0080	.0046	.0019	n.a.	.0146	49.8	.121	.342	.154	.088 to .596
.0186	.0064	.0027	n.a.	.0261	51.4	.162	.410	.209	.066 to .754
.0042	.0033	.0019	n.a.	.0083	52.9	.091	.342	.120	.145 to .539
.0154	.0020	.0007	n.a.	.0132	57.7	.115	.217	.148	-.027 to .461
.0153	.0000	.0000	.0000	.0342	31.0	.185	.036	.266	-.401 to .474
.0245	.0000	.0000	.0000	-.0092	100+	0	.029	0	.029
.0132	.0005	.0003	.0001	.0296	32.1	.172	.141	.254	-.278 to .560
.0107	.0007	.0003	.0001	.0688	14.6	.262	-.139	.376	-.758 to .480
.0083	.0004	.0002	n.a.	.0043	67.7	.065	.101	.064	-.038 to .240
.0209	.0002	.0001	n.a.	-.0079	100+	0	-.071	0	-.071
.0042	.0010	.0005	n.a.	-.0014	100+	0	.178	0	.178
							-.136	n.a.	

Table X-1--continued

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Variance Expected due to Sampling Error	Variance due to Range Differ- ence	Variance due Reliability Difference: Technology	Variance due Reliability Difference: Struc
% Direct Workers								
Total	12	497	-.207	.0654	.0224	.0029	.0011	n.a
Manufacturing	11	458	-.246	.0612	.0214	.0042	.0016	n.a
Service	3	47	.170	.0108	.0672	.0015	.0008	n.a
Mixed	0	0						
% Supervisors								
Total	10	1813	-.096	.0251	.0050	.0007	.0002	n.a.
Manufacturing	5	350	.097	.0660	.0109	.0007	.0003	n.a.
Without Harvey	(4)	(337)	(.013)	(.0112)	(.0118)	(.0000)	(.0000)	(n.a.
Service	4	1285	-.151	.0016	.0030	.0012	.0006	n.a.
Mixed	2	154	-.065	.0000	.0130	.0003	.0001	n.a.
% Clerical Personnel								
Total	13	1996	.002	.0108	.0064	.0000	.0000	n.a.
Manufacturing	8	444	.120	.0102	.0174	.0011	.0004	n.a.
Service	7	1564	-.022	.0065	.0045	.0000	.0000	n.a.
Mixed	0	0						
% Workflow Planning and Control								
Total	4	160	-.099	.0287	.0240	.0007	.0003	n.a.
Manufacturing	4	126	-.135	.0416	.0292	.0014	.0005	n.a.
Service	2	42	-.062	.1055	.0392	.0002	.0001	n.a.
Mixed	0	0						
% Administration								
Total	12	753	.066	.0367	.0150	.0003	.0001	n.a.
Manufacturing	10	556	.145	.0290	.0168	.0016	.0006	n.a.
Service	4	209	-.104	.0186	.0186	.0006	.0003	n.a.
Mixed	0	0						

[a]Numbers may not sum across due to rounding.

Variance Expected due to Sampling Error	Variance due to Range Difference	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structure	Residual[a] Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation: Mean	Corrected Correlation: s.d.	90 % Credibility Interval
.0224	.0029	.0011	n.a.	.0390	40.4	.197	-.265	.254	-.683 to .152
.0214	.0042	.0016	n.a.	.0339	44.6	.184	-.322	.240	-.717 to .073
.0672	.0015	.0008	n.a.	-.0587	100+	0	.225	0	.225
.0050	.0007	.0002	n.a.	.0192	23.4	.139	-.124	.179	-.419 to .171
.0109	.0007	.0003	n.a.	.0541	15.1	.232	.125	.307	-.377 to .633
(.0115)	(.0000)	(.0000)	(n.a.)	(-.0006)	(100+)	(0)	(.017)	(0)	(.017)
.0030	.0012	.0006	n.a.	-.0033	100+	0	-.200	0	-.200
.0130	.0003	.0001	n.a.	-.0134	100+	0	-.084	0	-.084
.0064	.0000	.0000	n.a.	.0044	59.4	.066	.003	.086	-.138 to .144
.0174	.0011	.0004	n.a.	-.0086	100+	0	.158	0	.158
.0045	.0000	.0000	n.a.	.0020	70.0	.044	-.029	.059	-.127 to .068
.0240	.0007	.0003	n.a.	.0036	87.3	.060	-.128	.078	-.257 to .000
.0292	.0014	.0005	n.a.	.0105	74.7	.103	-.178	.135	-.401 to .044
.0392	.0002	.0001	n.a.	.0660	37.5	.257	-.082	.342	-.646 to .481
.0150	.0003	.0001	n.a.	.0213	41.9	.146	.085	.189	-.226 to .396
.0168	.0016	.0006	n.a.	.0100	65.4	.100	.191	.132	-.026 to .408
.0186	.0006	.0003	n.a.	-.0009	100+	0	-.138	0	-.138

Table X-2. Organization Type: 95% Confidence Interval and Statistical Significance Tests

	Corrected Correlation					95%	Z-Test		
Variable	k	n	Mean	s.d.	s.e.	Confidence Interval	Manufacturing-Service	Mixed-Manufacturing	Mixed-Service
Division of Labor									
Manufacturing	9	335	.270	.000	.0805	.11 to .43			
Service	16	2195	.463	.241	.0669	.33 to .59	-1.84	.14	-.78
Mixed	3	204	.300	.297	.1981	-.09 to .69			
Functional Specialization									
Manufacturing	27	1000	.445	.141	.0494	.35 to .54			
Service	14	1004	.252	.175	.0649	.12 to .38	2.37**	-1.87	.10
Mixed	6	381	.263	.111	.0840	.10 to .43			
Standardization									
Manufacturing	7	230	.276	.000	.0968	.09 to .47			
Service	7	520	.317	.000	.0635	.19 to .44	-.35	.67	.51
Mixed	3	160	.422	.281	.1940	.04 to .80			
Overall Formalization									
Manufacturing	17	607	.314	.045	.0598	.20 to .43			
Service	20	1506	.282	.077	.0416	.20 to .36	.44	-1.18	-.99
Mixed	8	748	.160	.289	.1155	-.07 to .38			
Role Formalization									
Manufacturing	18	558	.317	.144	.0716	.18 to .46			
Service	7	273	.230	.000	.0929	.05 to .41	.74	1.66	2.14***
Mixed	3	181	.517	.000	.0970	.33 to .71			
Vertical Span									
Manufacturing	17	748	.410	.209	.0665	.28 to .54			
Service	10	1983	.342	.120	.0468	.25 to .43	.84	-1.50	-1.04
Mixed	4	241	.217	.148	.1100	.00 to .43			
Centralization									
Manufacturing	24	973	.029	.000	.0477	-.06 to .12			
Service	23	1613	.141	.254	.0646	.01 to .27	-1.39	-1.27	-2.00***
Mixed	11	845	-.139	.376	.1238	-.38 to .10			

Table X-2--continued

Variable	Corrected Correlation k	n	Mean	s.d.	s.e.	95% Confidence Interval	Z-Test Manufacturing-Service	Mixed-Manufacturing	Mixed-Service
Supervisor's Span of Control									
Manufacturing	15	719	-.071	.000	.0497	-.17 to .03			
Service	8	1807	.178	.000	.0308	.12 to .24	-4.26*	-.53	-2.70**
Mixed	1	75	-.136	n.a.	.1122	-.36 to .08			
% Direct Workers									
Manufacturing	11	458	-.322	.240	.0927	-.50 to -.14			
Service	3	47	.225	.000	.1940	-.16 to .60	-2.54***		
% Supervisors									
Manufacturing	5	380	.128	.307	.1530	-.17 to .43			
Without Harvey	(4)	(337)	(.017)	(.000)	(.0725)	(-.12 to .16)	(2.68**)	(-.79)	
Service	4	1285	-.200	.000	.0362	-.27 to -.13	2.09***	-1.14	1.05
Mixed	2	154	-.084	.000	.1045	-.29 to .12			
% Clerical Personnel									
Manufacturing	8	444	.158	.000	.0622	.04 to .28			
Service	7	1564	-.029	.059	.0405	-.11 to .03	2.52***		
% Workflow Planning and Control									
Manufacturing	4	126	-.178	.135	.1352	-.44 to .09			
Service	2	42	-.082	.342	.3206	-.71 to .55	-.28		
% Administration									
Manufacturing	10	556	.191	.132	.0692	.06 to .33			
Service	4	209	-.138	.000	.0920	-.32 to .04	2.86**		

*p < .001, two-tailed. **p < .01, two-tailed. ***p < .05, two-tailed.

Table X-3. Summary of Results for Effect of Organization Type

Structural Variable	Manufacturing Mean r	Manufacturing s.d.	Manufacturing res	Service Mean r	Service s.d.	Service res	Mixed Mean r	Mixed s.d.	Mixed res
	Corrected Correlations								
Division of Labor	.270	.000	-	.463	.241	+	.300	.297	+
Functional Specialization	.445	.141	-	.252	.175	+	.263	.111	-
Standardization	.276	.000	-	.317	.000	-	.422	.281	+
Overall Formalization	.314	.045	-	.282	.077	-	.160	.289	+
Role Formalization	.317	.144	-	.230	.000	-	.517	.000	-
Vertical Span	.410	.209	+	.342	.120	-	.217	.148	-
Centralization	.029	.000	-	.141	.254	-	-.139	.376	+
Supervisor's Span of Control	-.071	.000	-	.178	.000	-	-.136	n.a.	n.a.
% Direct Workers	-.322	.240	-	.225	.000	-			
% Supervisors	.128	.307	+	-.200	.000	-	-.084	.000	-
(without Harvey	.017	.000	-)						
% Clerical Personnel	.158	.000	-	-.029	.059	-			
% Workflow Planning and Control	-.178	.135	+	-.082	.342	+			
% Administration	.191	.132	-	-.138	.000	-			
Mean r	.151			.152			.169		
Mean Absolute Value	.239	.104		.221	.098		.249	.188	
Residual Variance: (w/o Harvey)									
Increase	3 (2)			3			4		
Decrease	10 (11)			10			4		

CHAPTER XI

MODERATOR TEST: LEVEL OF ANALYSIS

Several reviews of the technology-structure literature have concluded that level of analysis is an important contributor to the inconsistency in research findings. Ford and Slocum observed that "the influence of unit of analysis differences is perhaps most evident in research focusing on the role of technology [as a determinant of structure]. Most studies on technology at the organization level . . . have rejected the idea of a technological imperative . . .. But studies that have focused on the subunit have tended to support the technological imperative" (1977: 570).

Reimann and Inzerilli stated that "it appears that the level of analysis is the most critical factor, since those studies focusing on the lower, work group level organizational units actually have been quite consistent in their finding that technology and structure are closely related. It is at the systems level of larger, more complex organizations that most of the debate and controversy about technological determinism has taken place" (1979: 188).

Gerwin suggested that "organizational level research produces inconsistent or weak correlations which are due in part to conceptual and methodological problems. Job level studies, free of these problems, have consistent, reasonably sized associations which fit with current theory" (1979b: 78).

Fry (1982) observed that findings at the individual level of analysis ran counter to the overall population results, and when individual level studies, and those that measure operations technology, were removed, he found strong support for a technology-structure relationship. Since most of the studies that measure operations technology seem to use the organization as the unit of analysis, Fry's finding implies that studies at the subunit level of analysis tend to support a technology-structure relationship.

Reimann and Inzerilli suggest that "if we want to make sense out of the chaotic state of empirical research findings about the technology-structure connections, it seems imperative, first of all, to arrange the various studies by level(s) of organizational focus" (1979: 171).

Hypotheses

Based upon the conclusions of these reviewers of the literature it can be hypothesized that:

Hypothesis 6a: The findings of studies conducted at the subunit level of analysis will be more consistent than those for studies at the individual or organization level of analysis (i.e., variance between studies will be lower). In addition:

Hypothesis 6b: Studies conducted at the subunit level of analysis will have larger correlations than will studies using the organization level of analysis.

No hypothesis can be made about the size of the differences that should be observed in the results of studies conducted at these different levels of analysis.

Results

To test the effect of level of analysis on the outcome of technology-structure research three subgroups of studies were formed for each of 13 structural variables, and a meta-analysis was performed on each subgroup.

Table XI-1 displays the results of these analyses. It should be noted first that individual level studies could be found only for overall formalization and centralization. Second, it should be noticed that all studies addressing the relationship of technology to percentage direct workers, percentage workflow planning and control, and percentage administration were conducted at the organization level of analysis. Comparisons could therefore be made for only 10 of the 13 variables. Statistically significant differences were observed between subgroups for only 4 of those 10 variables (Table XI-2). These four are division of labor, overall formalization, supervisor's span of control, and percentage clerical personnel.

Division of Labor

Eight studies in the subunit category yield correlations ranging from r = -.25 (Study 72) to r = .391 (Study 91). See Appendix C and Table IV-1 for descriptions of Studies 13c, 20, 33, 72, 75a, 75b, 75c, and 91. The combined sample size for these eight studies is 1,787 and the mean observed correlation is $\bar{r}$ = .335. Artifacts explain all of the observed variance for studies conducted at the subunit level of analysis.

There are 18 studies of the relationship between technology and division of labor at the organization level of analysis (Studies 4h, 10, 13a, 14, 18 & 4i, 21a, 21b, 25, 30, 31, 35, 38 & 4k, 39 & 4j, 42, 50, 70, 74, and 97). The correlations included range from r = -.39 from Paulson's study of 77 retail firms (Study 70) to r = .70 for the Piernot sample of 31 California firms (Study 74). The total sample size of 939 results in a mean observed correlation of $\bar{r}$ = .207. However, artifacts account for only 24 percent of the observed variance.

Table XI-2 reveals that the corrected mean correlation for subunit studies (i.e., .485) is statistically significantly higher than the corrected correlation for organization level studies (i.e., .304). The 95 percent confidence intervals for both subgroups indicate that both corrected correlations are significantly greater than zero.

These findings for division of labor support both hypotheses being tested. First, there is much less unexplained variation among studies at the subunit level. Second, the relationship of technology and structure at the subunit level of analysis is stronger than the relationship at the organization level of analysis.

However, there is still a very large residual variance among studies conducted at the organization level of analysis (i.e., residual variance is .0633). The mean residual variance for the 8 subunit studies and the 18 organization level studies is .0205 which is only slightly lower than the residual for the total 26 studies (i.e., .0244).

A tentative interpretation of these findings is that the level of analysis does have an effect on the relationship observed between technology and the division of labor.

Overall Formalization

Two studies were conducted at the individual level of analysis. The first is the Sutton and Rousseau study involving 155 individuals in 14 northern California organizations of various types (Study 85). These researchers measured technology as the degree of interdependence for each of the 14 organizations. Formalization was measured with a questionnaire completed by each of the 155 individuals. The technology score for each individual was based upon the organization they worked in. They observed a correlation of r = -.12 between technology and formalization. The second individual level study is Hrebiniak's study of 174 workers in a single hospital (Study 40). He observed a correlation of r = .082 between formalization and task predictability/manageability. The mean correlation for these two studies is $\bar{r}$ = -.013 and sampling error explains 59 percent of the variance.

Ten studies are included in the subunit category (Studies 13b, 20, 33, 45, 51, 53, 75a, 75b, 75c, and 90). Correlations within this subgroup range from r = -.133 (Study 75b) to r = .491 (Study 45). The combined sample size of 995 yields a mean observed correlation of $\bar{r}$ = .179. Artifacts explain over 76 percent of the observed variance, and sampling error explains 55 percent by itself.

There are 31 correlations from organization level studies (Studies 3, 4c, 4d, 4e, 4h, 5, 15, 18 & 4i, 21a, 21b, 24, 30, 31, 35, 36, 38 & 4k, 39 & 4j, 41, 47, 49, 54, 59, 60, 65, 74, 81, 83, 84, 93, 95, and 97). They range from r = -.093 (Study 65) to r = .63 (Study 74). These 31 studies constitute a total sample size of 1,529, and a mean observed correlation of $\bar{r}$ = .209. Artifacts explain over 65 percent of the observed variance, and sampling error explains 51 percent by itself.

The results of the z-tests in Table XI-2 indicate that there is not a significant difference between the corrected mean correlation for subunit level studies (i.e., $\bar{r}$ = .263), and those conducted at organization level (i.e., $\bar{r}$ = .306). Even the small difference that does exist is not in the predicted direction; subunit level studies are not higher than organization level studies. The 95 percent confidence levels in Table XI-2 do place both subgroups significantly above zero.

On the other hand, the corrected mean correlations for both the subunit and the organization level subgroups are significantly higher than the corrected mean correlation for the two individual level studies. This agrees with Fry's (1982) observation that individual level studies run counter to the results in the overall population.

The residual variance for each of the three subgroups (Table XI-1) is less than the residual variance for the total 43 correlations. This indicates a higher level of homogeneity within each subgroup than for the combined studies. The combination of a reduced mean residual variance (i.e., .0083 versus .0135) and a significant difference between mean correlations supports the hypothesis that the level of analysis does contribute to the variation observed in these study results.

The results of these analyses of overall formalization do support the hypothesis that subunit level studies have more consistent findings than do studies at the organization level, but they do not support the hypothesis that the relationship of technology to structure is stronger for subunit level studies than it is for organization level studies.

Supervisor's Span of Control

Six studies at the subunit level of analysis assess the relationship between technology and supervisor's span of control (Studies 9, 13b, 13c, 19, 22, and 33). These six correlations range from $r = .04$ to $r = .47$ (Studies 19 and 9, respectively). All six studies yield positive correlations. The total sample size of 1,822 yields a mean observed correlation of $\bar{r}$ = .127 and artifacts explain all of the variance; sampling error explains 88 percent.

The 16 organization level studies have a combined sample size of 770 (Studies 3, 4c, 4d, 4e, 4h, 5, 12, 13a, 18 & 4i, 31, 38 & 4k, 39 & 4j, 41, 78, 81, and 96). These range in value from r = -.231 from Woodward's study of 78 British manufacturers (Study 96) to r = .297 for the Blau and Schoenherr study of 53 employment security agencies (Study 13a). The mean correlation is $\bar{r}$ = -.038 and sampling error explains all of the variance observed.

The statistical significance test in Table XI-2 indicates that, as predicted, the mean corrected correlation for studies at the subunit level of analysis is higher than the mean for organization level studies (i.e., .164 versus -.049, respectively). The 95 percent confidence intervals in Table XI-2 also indicate that the mean correlation for subunit level studies is significantly greater than zero, but the correlation for organization level studies is not.

The results obtained in this analysis support the hypothesis that subunit level studies yield more consistent results than organization level studies do. Notice in Table XI-1 that the observed variance for organization level studies (i.e., .0174) is four times the variance for subunit level studies (i.e., .0034). However, it should also be noticed that this difference is no more than should be expected due to sampling error and other artifacts and is therefore not indicative of greater nonartifactual variance in organization level studies than in subunit level studies.

These results also support the hypothesis that subunit level studies obtain stronger correlations between technology and supervisor's span of control than do studies at organization level. This finding, combined with reduced residual variance suggests that the level of analysis does contribute to the variance observed in correlations between technology and supervisor's span of control.

Percentage Clerical Personnel

Two studies investigate the relationship between technology and the percentage of personnel engaged in clerical jobs at the subunit level. Note in Table XI-1 that when these 2 studies are segregated from the 11 organization level studies all of the variance is explained by artifacts in the organization level subgroup. This suggests that all of the residual variance in the overall analysis of 13 correlations (i.e., .0044) can be traced to the presence of the 2 studies in the subunit category. These 2 correlations are r = -.212 from the Leatt and Schneck study of 148 subunits of a Canadian hospital (Study 55), and r = -.022 from the Blau and Schoenherr study of 1,201 local offices of employment security (Study 13c). The mean correlation for these 2 studies is $\bar{r}$ = -.043 and artifacts explain only 45 percent of the variance observed. The difference between these 2 studies is more than would be expected due to sampling error.

The 11 studies in the organization level subgroup have a combined sample size of 647 and a mean correlation of $\bar{r}$ = .097 (Studies 3, 4h, 5, 11, 12, 13a, 18 & 4i, 38 & 4k, 39 & 4j, and 81). These 11 correlations range from r = -.081 (Study 18 & 4i) to r = .415 (Study 5). Sampling error can account for all of the variance observed.

The statistical significance test in Table XI-2 indicates that the corrected mean correlation for the organization level studies (i.e., .125) is statistically different from the mean correlation for the two subunit level studies (i.e., -.055). However, the difference does not support the hypothesis that subunit level studies result in larger correlations than do organization level studies.

It is true that the range from the highest to the lowest correlation in the subunit category is much less than the range for the 11 organization level studies (i.e., .190 versus .496, respectively). However, while the observed difference between the 2 subunit studies is lower, it is more than sampling error. But, the larger range for organization level studies is no more than should be anticipated due to sampling error. Therefore, after correction for this artifact there is no support for the hypothesis that subunit level studies yield more consistent findings.

The results of these analyses indicate that, for the studies included in these analyses, the level of analysis does make a difference in the relationship observed between technology and the percentage of personnel in clerical jobs. However, the significance of the difference observed between the two subunit level studies leaves room for doubt. Clearly, the cause of that difference is also important.

Summary of Results

With the exceptions of division of labor, overall formalization, supervisor's span of control, and percentage clerical personnel no statistically significant differences were observed between levels of analysis.

Table XI-3 summarizes the results of all of the analyses performed in this chapter. For each level of analysis it indicates the corrected mean correlation and standard deviation, and also indicates whether the residual standard deviation in each subgroup was greater than (+), less than (-), or did not change (0) from the residual for all of the studies combined in the overall analysis. At the bottom of Table XI-3 are some summary indices that provide a rough approximation of the overall size of the correlation, and the extent of variation within each subgroup.

For the 10 variables for which comparisons could be made the correlation in the subunit category was greater than the correlation at the organization level in 6 cases (i.e., division of labor, functional specialization, standardization, role formalization, supervisor's span of control, and percentage supervisors) but only the differences for division of labor and supervisor's span of control were statistically significant.

There were three cases in which organization level studies resulted in higher correlations than did subunit level studies (i.e., overall formalization, vertical span, and percentage clerical personnel) but only percentage clerical personnel had a statistically significant difference.

The mean corrected correlations for studies of centralization at the subunit level and the organization level are both near zero. The mean correlation for individual level studies is higher than either the subunit level or the organization level, but the high residual variance for individual level studies reduces the confidence we can have in the mean correlation and results in a nonsignificant difference between levels of analysis.

At the bottom of Table XI-3 are the mean correlation, and the mean absolute value of the correlations for those 10 variables where comparisons could be made. The mean standard deviation is also computed. The mean r for the subunit studies is nearly identical to that for organization level studies (i.e., .21 for subunits versus .20

for organization level).

The mean absolute value of the correlations is an overall index of the strength of the correlations without regard for the direction. The mean absolute value for the subunit studies is only slightly higher than the organization level studies (i.e., .258 for subunits and .213 for organizations). This is certainly not a significant difference.

Individual level studies were included for only overall formalization, and centralization. In both cases individual level studies yield quite different results from either subunit level or organization level studies. However, as Table XI-3 shows, the corrected standard deviation for the individual level studies is quite large relative to the corrected mean correlation. This indicates the inconsistency in individual level studies of technology and structure.

Organization level studies also have a fairly large mean standard deviation relative to the mean correlation, suggesting that other factors are contributing to the inconsistency of results for organization level studies.

By contrast, the mean standard deviation for subunit level studies is quite small relative to the mean correlation. For 5 of the 10 variables analyzed at the subunit level the corrected standard deviation is zero; artifacts explain all of the variance observed. For 4 additional variables (i.e., standardization, overall formalization, vertical span, and percentage clerical personnel) the residual standard deviation is quite small. Only studies of role formalization at the subunit level have a residual standard deviation greater than .10.

The consistency in findings at the subunit level is also demonstrated by the finding that the residual variance for subunit level studies was consistently lower than the residual variance for the combined studies. At the bottom of Table XI-3 it is shown that the residual variance was lower for subunit studies in all 10 analyses. For organization level studies the residual variance increased six times and decreased four times. For individual level studies there was one increase and one decrease. This supports the conclusion of many reviewers that subunit level studies yield more consistent results (Ford & Slocum, 1977; Fry, 1982; Reimann & Inzerilli, 1979).

Conclusion

The results of analyses in this chapter support the hypothesis that studies conducted at the subunit level of analysis yield more consistent results than do studies at either the organization level or the individual level of analysis. However, there is no strong support for the hypothesis that the relationship of technology to structure is stronger at the subunit level than at organization level.

There are only four cases in which the level of analysis is associated with a statistically significant difference in study outcomes and all of those are accompanied by a reduction in residual variance. The failure to observe a consistent pattern in the direction of these differences suggests that, contrary to the conclusion of Reimann and Inzerilli, level of analysis is not "the most critical factor" (1979: 188). The tentative interpretation is that level of analysis has a moderating effect only on division of labor, overall formalization, supervisor's span of control, and percentage clerical personnel.

Table XI-1. Moderator Analyses: Level of Analysis

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Variance Expected due to Sampling Error	Variance due to Range Differ- ence	Variance due Reliability Difference: Technology	Struc
Division of Labor								
Total	26	2726	.291	.0418	.0079	.0053	.0025	.00
Individual	0	0						
Subunit	8	1787	.335	.0142	.0040	.0067	.0033	.00
Organization	18	939	.207	.0837	.0154	.0029	.0013	.00
Functional Specialization								
Total	44	2378	.239	.0372	.0156	.0035	.0016	.00
Individual	0	0						
Subunit	2	443	.265	.0038	.0043	.0045	.0020	.00
Organization	42	1935	.233	.0447	.0182	.0036	.0016	.00
Standardization								
Total	15	902	.227	.0287	.0148	.0034	.0015	.00
Individual	0	0						
Subunit	4	416	.235	.0212	.0084	.0036	.0016	.00
Organization	11	486	.220	.0351	.0203	.0032	.0014	.00
Overall Formalization								
Total	43	2853	.173	.0303	.0134	.0021	.0009	.00
Individual	2	329	-.013	.0102	.0060	.0000	.0000	.00
Subunit	10	995	.179	.0173	.0095	.0022	.0010	.00
Organization	31	1529	.209	.0344	.0176	.0030	.0013	.00
Role Formalization								
Total	25	1013	.218	.0372	.0209	.0032	.0015	.00
Individual	0	0						
Subunit	4	326	.232	.0231	.0109	.0036	.0017	.00
Organization	21	687	.211	.0437	.0256	.0030	.0014	.00
Vertical Span								
Total	29	2964	.268	.0292	.0080	.0046	.0019	n.a
Individual	0	0						
Subunit	4	1655	.261	.0099	.0020	.0044	.0018	n.a
Organization	25	1309	.276	.0535	.0157	.0049	.0020	n.a
Centralization								
Total	56	3423	.025	.0496	.0153	.0000	.0000	.00
Individual	3	666	.139	.0759	.0035	.0014	.0006	.00
Subunit	13	806	.015	.0098	.0160	.0000	.0000	.00
Organization	40	1951	-.010	.0514	.0190	.0000	.0000	.00
Supervisor's Span of Control								
Total	22	2592	.078	.0132	.0083	.0004	.0002	n.a
Individual	0	0						
Subunit	6	1522	.127	.0034	.0030	.0011	.0004	n.a
Organization	16	770	-.038	.0174	.0210	.0001	.0000	n.a

Variance Expected due to Sampling Error	Variance due to Range Difference	Variance due to Reliability Difference: Technology	Structure	Residual[a] Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation: Mean	s.d.	90 % Credibility Interval
.0079	.0053	.0025	.0016	.0244	41.6	.156	.423	.228	.049 to .798
.0040	.0067	.0033	.0022	-.0020	100+	0	.485	0	.485
.0154	.0029	.0013	.0008	.0633	24.4	.252	.304	.369	-.304 to .911
.0156	.0035	.0016	.0002	.0160	57.0	.126	.338	.179	.044 to .632
.0043	.0045	.0020	.0003	-.0073	100+	0	.374	0	.374
.0182	.0036	.0016	.0002	.0211	52.7	.145	.329	.205	-.008 to .667
.0148	.0034	.0015	.0032	.0057	80.1	.076	.332	.111	.150 to .514
.0084	.0036	.0016	.0034	.0041	80.8	.064	.343	.093	.190 to .496
.0203	.0032	.0014	.0030	.0070	80.0	.084	.322	.123	.120 to .523
.0134	.0021	.0009	.0004	.0135	55.6	.116	.254	.171	-.027 to .535
.0060	.0000	.0000	.0000	.0042	59.1	.064	-.019	.095	-.176 to .137
.0095	.0022	.0010	.0005	.0041	76.2	.064	.263	.094	.108 to .418
.0176	.0030	.0013	.0006	.0119	65.4	.109	.306	.160	.043 to .569
.0209	.0032	.0015	.0010	.0106	71.5	.103	.334	.158	.074 to .594
.0109	.0036	.0017	.0011	.0058	74.9	.076	.355	.116	.163 to .547
.0256	.0030	.0014	.0009	.0127	70.9	.113	.324	.173	.039 to .608
.0080	.0046	.0019	n.a.	.0146	49.8	.121	.342	.154	.088 to .596
.0020	.0044	.0018	n.a.	.0016	83.3	.041	.333	.052	.248 to .419
.0157	.0049	.0020	n.a.	.0310	42.1	.176	.353	.224	-.016 to .722
.0153	.0000	.0000	.0000	.0342	31.0	.185	.036	.266	-.401 to .474
.0036	.0014	.0006	.0002	.0700	7.8	.264	.199	.379	-.425 to .823
.0160	.0000	.0000	.0000	-.0062	100+	0	.026	0	.026
.0190	.0000	.0000	.0000	.0324	37.0	.180	-.015	.259	-.441 to .411
.0083	.0004	.0002	n.a.	.0043	67.7	.065	.101	.084	-.038 to .240
.0030	.0011	.0004	n.a.	-.0012	100+	0	.164	0	.164
.0210	.0001	.0000	n.a.	-.0038	100+	0	-.049	0	-.049

Table XI-1--continued

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Variance Expected due to Sampling Error	Variance due to Range Differ- ence	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structur
% Direct Workers								
Total	12	497	-.207	.0654	.0224	.0029	.0011	n.a.
Individual	0	0						
Subunit	0	0						
Organization	12	497	-.207	.0654	.0224	.0029	.0011	n.a.
% Supervisors								
Total	10	1813	-.096	.0251	.0050	.0007	.0002	n.a.
Individual	0	0						
Subunit	2	1209	-.145	.0006	.0017	.0015	.0006	n.a.
Organization	8	604	.002	.0598	.0115	.0000	.0000	n.a.
% Clerical Personnel								
Total	13	1996	.002	.0108	.0064	.0000	.0000	n.a.
Individual	0	0						
Subunit	2	1349	-.043	.0035	.0014	.0001	.0000	n.a.
Organization	11	647	.097	.0127	.0168	.0007	.0002	n.a.
% Workflow Planning and Control								
Total	4	160	-.099	.0287	.0240	.0007	.0003	n.a.
Individual	0	0						
Subunit	0	0						
Organization	4	160	-.099	.0287	.0240	.0007	.0003	n.a.
% Administration								
Total	12	753	.066	.0367	.0150	.0003	.0001	n.a.
Individual	0	0						
Subunit	0	0						
Organization	12	753	.066	.0367	.0150	.0003	.0001	n.a.

[a]Numbers may not sum across due to rounding.

riance pected e to mpling ror	Variance due to Range Differ- ence	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structure	Residual[a] Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation: Mean	Corrected Correlation: s.d.	90 % Credibility Interval
.0224	.0029	.0011	n.a.	.0390	40.4	.197	-.265	.254	-.683 to .152
.0224	.0029	.0011	n.a.	.0390	40.4	.197	-.265	.254	-.683 to .152
.0050	.0007	.0002	n.a.	.0192	23.4	.139	-.124	.179	-.419 to .171
.0017	.0015	.0006	n.a.	-.0031	100+	0	-.187	0	-.187
.0115	.0000	.0000	n.a.	.0483	19.2	.220	.002	.285	-.466 to .471
.0064	.0000	.0000	n.a.	.0044	59.4	.066	.003	.086	-.138 to .144
.0014	.0001	.0000	n.a.	.0019	45.5	.044	-.055	.057	-.149 to .038
.0168	.0007	.0002	n.a.	-.0050	100+	0	.125	0	.125
.0240	.0007	.0003	n.a.	.0036	87.3	.060	-.128	.078	-.257 to .000
.0240	.0007	.0003	n.a.	.0036	87.3	.060	-.128	.078	-.257 to .000
.0150	.0003	.0001	n.a.	.0213	41.9	.146	.085	.189	-.226 to .396
.0150	.0003	.0001	n.a.	.0213	41.9	.146	.085	.189	-.226 to .396

Table XI-2. Level of Analysis: 95% Confidence Interval and Statistical Significance Tests

Variable	Corrected Correlation k	n	Mean	s.d.	s.e.	95% Confidence Interval	Z-Test Individual-Subunit	Individual-Organization	Subunit-Organization
Division of Labor									
Subunit	8	1787	.485	.000	.0305	.42 to .54			
Organization	18	939	.304	.369	.0986	.11 to .50			1.75***
Functional Specialization									
Subunit	2	443	.374	.000	.0623	.25 to .50			
Organization	42	1935	.329	.205	.0441	.24 to .42			.59
Standardization									
Subunit	4	416	.343	.093	.0824	.18 to .50			
Organization	11	486	.322	.123	.0738	.18 to .47			.19
Overall Formalization									
Individual	2	329	-.019	.095	.1060	-.23 to .19			
Subunit	10	995	.263	.094	.0543	.16 to .37			
Organization	31	1529	.306	.160	.0462	.22 to .40	-2.37**	-2.81**	-.60
Role Formalization									
Subunit	4	326	.355	.126	.0996	.16 to .55			
Organization	21	687	.324	.173	.0682	.19 to .46			.26
Vertical Span									
Subunit	4	1655	.333	.052	.0391	.26 to .41			
Organization	25	1309	.353	.224	.0556	.24 to .46			-.29
Centralization									
Individual	3	666	.199	.379	.2256	-.24 to .64			
Subunit	13	806	.026	.000	.0511	-.07 to .13			
Organization	40	1951	-.015	.259	.0525	-.12 to .09	.75	.92	.56
Supervisor's Span of Control									
Subunit	6	1822	.164	.000	.0298	.10 to .22			
Organization	16	770	-.049	.000	.0471	-.14 to .04			3.82*

Table XI-2--continued

	Corrected Correlation					95%	Z-Test		
Variable	k	n	Mean	s.d.	s.e.	Confidence Interval	Individual-Subunit	Individual-Organization	Subunit-Organization
% Direct Workers									
Organization	12	497	-.265	.254	.0920	-.44 to -.08			
% Supervisors									
Subunit	2	1209	-.187	.000	.0363	-.26 to -.12			
Organization	8	604	.002	.285	.1138	-.22 to .22			-1.58
% Clerical Personnel									
Subunit	2	1349	-.055	.057	.0534	-.16 to .05			
Organization	11	647	.125	.000	.0508	.02 to .22			-2.44**
% Workflow Planning and Control									
Organization	4	160	-.128	.078	.1097	-.34 to .09			
% Administration									
Organization	12	753	.085	.189	.0722	-.06 to .23			

*p < .001, one-tailed. **p < .01, one-tailed. ***p < .05, one-tailed.

Table XI-3. Summary of Results for Effect of Level of Analysis

	Corrected Correlations								
	Individual			Subunit			Organization		
Structural Variable	Mean r	s.d.	res	Mean r	s.d.	res	Mean r	s.d.	res
Division of Labor				.485	.000	-	.304	.369	+
Functional Specialization				.374	.000	-	.329	.205	+
Standardization				.343	.093	-	.322	.123	+
Role Formalization				.355	.116	-	.324	.173	+
Supervisor's Span of Control				.164	.000	-	-.049	.000	-
% Supervisors				-.187	.000	-	.002	.285	+
Overall Formalization	-.019	.095	-	.263	.094	-	.306	.160	-
Vertical Span				.333	.052	-	.353	.224	+
% Clerical Personnel				-.055	.057	-	.125	.000	-
Centralization	.199	.379	+	.026	.000	-	-.015	.259	-
% Direct Workers							-.265	n.a.	0
% Workflow Planning and Control							-.128	n.a.	0
% Administration							.087	n.a.	0
Mean r	.090			.210			.200		
Mean Absolute Value	.109	.276		.258	.061		.213	.212	
Residual Variance:									
Increase		1			0			6	
Decrease		1			10			4	
No Change		0			0			3	

Note. The mean r and the mean absolute value of r do not include % direct workers, % workflow planning and control, or % administration.

CHAPTER XII

MODERATOR TEST: TYPE OF MEASURE

Two types of measures that are prevalent in organizational research are commonly referred to as institutional measures and questionnaire measures. According to Pennings "they differ in terms of whether they rely on direct measures (i.e., global assessment from records or institutional spokesmen) or whether they are based on aggregation of interview and questionnaire data from members" (1973: 687). Sathe commented that some investigators rely on "organization charts, documents, and interviews with key spokesmen of the organization in order to measure the various dimensions. This may be referred to as the institutional approach to measurement. Other investigators . . . have adopted a questionnaire approach where responses of a sample of organizational members are aggregated to obtain measures of organizational structure" (1978: 227).

Many researchers have suggested that the type of measure used can influence the results obtained (Ford, 1979; Pennings, 1973; Sathe, 1978). Sathe argued that the poor convergent validity between institutional and questionnaire measures is due to institutional measures tapping "designed" structure while questionnaire measures tap the "emergent" structure experienced by organization members (Sathe, 1978: 234). Emergent structure reflects actual behavior while designed structure reflects managerial choice regarding organizational design. Pennings (1973) suggested that the emergent situation may be more strongly influenced by technology, environmental uncertainty, and professionalization than by structural design strategies. He also commented that "the discussion on ecological correlations has suggested that aggregates of individual's responses to items do not always stand for organizational characteristics and that therefore the survey technique may be unable to grasp some group properties" (Pennings, 1973: 687-688).

In spite of the reported findings of poor convergent validity, and even significant negative correlations between alternative measures (Pennings, 1973), the effect of these two types of measures on study outcomes is not certain. Fry's extensive review of the technology-structure literature concluded that "the type of measure used in technology-structure research had no significant effect on findings" (Fry, 1982: 548).

Hypothesis

The discussion above does not cast much light on whether questionnaire measures or institutional measures will result in higher correlations. If Pennings' (1973) contention that emergent structure is more strongly influenced by technology is correct, then the correlation between technology and structure using questionnaire measures should be higher than when institutional measures are used to assess designed structure. However, since no clear prediction can be made about the direction of the differences, the null hypothesis tested in this chapter is that there is no difference. The alternative hypothesis is therefore:

Hypothesis 7: Questionnaire measures result in significantly different correlations from those obtained with institutional measures.

To test this hypothesis studies were separated into subgroups based upon the type of measure used. To be classified as a questionnaire measure there had to be an aggregation of individual scores to arrive at a score for a higher level of analysis (i.e., subunit or organization). Mail questionnaires completed by key organizational personnel such as the CEO are therefore treated as institutional measures (e.g., Khandwalla, 1977) rather than questionnaires. Likewise, studies using the individual as the unit of analysis (Studies 40, 66, and 85) do not involve an aggregation of scores. These studies are segregated into a third subgroup for "other measures". Due to the difference in level of analysis these three studies do not fit neatly into either the institutional subgroup or the questionnaire subgroup.

Results

Table XII-1 displays the results of meta-analyses performed in this chapter. An examination of this table will reveal that questionnaire measures are not frequently used in the technology-structure research. No comparison could be made for percentage direct workers, percentage supervisors, percentage workflow planning and control, or percentage administration. Likewise, only one questionnaire study could be found for functional specialization, vertical span, and percentage clerical personnel. The nature of most of these variables automatically defines them as institutional measures, because they are operationalized by counting personnel assigned to different functional areas, or counting the number of vertical and horizontal segments in the organization.

Table XII-2 displays the corrected mean correlations and standard deviations for the 13 variables analyzed. This table also includes the standard error for the corrected mean correlation, a 95 percent confidence interval around the corrected mean correlation, and statistical significance tests for those 9 variables where a comparison could be made. For 6 of those 9 variables, at least one pair-wise comparison was significant at or below the .05 level using a two-tailed test (i.e., division of labor, functional specialization, overall formalization, vertical span, centralization, and percentage clerical personnel).

Division of Labor

There were 26 correlations included in the overall analysis of division of labor. One of those (Ford, 1975) used both a questionnaire measure and an institutional measure. The analysis in this chapter separates those two correlations that were averaged for the overall analysis (Study 31).

Table XII-1 indicates that for division of labor there are 18 correlations in the institutional subgroup (Studies 4h, 13a, 13c, 14, 18 & 4i, 21a, 21b, 25, 30, 31, 38 & 4k, 39 & 4j, 42, 50, 70, 74, 91, and 97). The range of correlations in this subgroup is r = -.423 (Study 25) to r = .70 (Study 74). These studies have a total sample size of 2,327 and a mean correlation of $\bar{r}$ = .323. Artifacts explain 52 percent of the observed variance; sampling error explains only 18 percent. The 90 percent credibility interval indicates that we can expect 95 percent of the true correlations for institutional measures to be positive.

There are nine correlations in the questionnaire subgroup ranging from r = -.25 (Study 72) to r = .425 (Study 35). The total sample size for these nine studies is 474 and the mean correlation is $\bar{r}$ = .070 (Studies 10, 20, 31, 33, 35, 72, 75a, 75b, and 75c). Artifacts explain only 35.5 percent of the observed variance, and sampling error accounts for 34.5 percent. The 90 percent credibility interval includes zero, so we cannot reject the possibility of a true correlation of zero for questionnaire measures.

Table XII-2 indicates that the corrected correlation for the institutional subgroup is statistically significantly larger than zero, and also statistically significantly larger than the corrected mean correlation for the questionnaire subgroup. In addition, the mean residual variance for these two subgroups displayed in Table XII-1 is only slightly less than the residual for the combined studies (i.e., .0192 compared to .0244).

Several conclusions can be drawn from these results. First, there is less variation in the results obtained with institutional measures than with questionnaire measures. Second, there is a statistically significant difference between the correlations obtained with institutional measures and those obtained with questionnaire measures. Institutional measures tend to yield higher correlation.

However, segregating studies by the type of measure used has little effect on the mean residual variance. The large variance among questionnaire measures must be attributable to factors other than the type of measure, and we cannot rule out the possibility that the low residual variance in the institutional subgroup is due to correlation with another moderator variable. The conclusion that the type of measure used moderates the size of the observed correlation is therefore tentative.

Functional Specialization

Only 1 of the 44 correlations with functional specialization was based upon a questionnaire study. Beyer and Trice (Study 10) administered a questionnaire measure of task routineness to 640 supervisors in 71 federal organizations. Functional specialization was an institutional measure; number of divisions. The authors provided a t-statistic for the difference between 47 routine organizations and 24 nonroutine organizations. This t-statistic was converted to a point-biserial correlation using the formula provided in Hunter et al. (1982: 98).

Removing this single study has very little effect on the residual variance or upon the mean correlation of the remaining 43 studies using institutional measures. Even though the statistical significance test in Table XII-2 indicates that institutional measures have a higher correlation than questionnaire measures, it would be ill-advised to place much credence in the results of the single questionnaire study.

As can be determined from the results displayed in Table XII-1, sampling error can explain only 42 percent of the observed variance among the 44 correlations included in the analysis of functional specialization, and other correctable artifacts explain another 13 percent. Forty-three percent of the observed variance remains unexplained.

What this indicates is that these 44 correlations are much more dispersed than would be expected as a result of artifacts. It also indicates that the probability of any single correlation drawn at random from the 44 being statistically significantly different is very high; considerably higher than the conventional alpha level of .05.

This is always the case when the null hypothesis of "no difference" is, in fact, false. The large residual variance suggests that it is false.

The results of these meta-analyses indicate that the type of measure used in a study does not contribute to the variance observed between study outcomes. But, that conclusion is based on the fact that only one questionnaire study could be found, and its removal did not affect the residual variance. Future research efforts should develop and include questionnaire measures for this relationship.

Overall Formalization

There were 43 correlations included in the initial meta-analysis of overall formalization. As in the case of division of labor, the Ford study (Study 31) was split into the institutional and questionnaire subgroups.

The 33 correlations in the institutional subgroup range from r = -.095 (Study 93) to r = .63 (Study 74). The total sample size is 2,203 and the mean correlation is $\bar{r}$ = .136 (Studies 3, 4c, 4d, 4e, 4h, 5, 13b, 15, 18 & 4i, 21a, 21b, 24, 30, 31, 38 & 4k, 39 & 4j, 41, 45, 47, 49, 51, 53, 54, 59, 60, 65, 74, 81, 83, 90, 93, 95, and 97). Artifacts explain 62 percent of the variance; sampling error explains 47 percent. The 90 percent credibility interval exceeds zero, so we can be confident that most correlations using institutional measures are positive.

There are nine correlations included in the questionnaire subgroup (Studies 20, 31, 33, 35, 36, 75a, 75b, 75c, and 84) that range from r = -.133 (Study 75b) to r = .611 (Study 31). The total sample size for these nine studies is 396 and the mean correlation is $\bar{r}$ = .248. Artifacts explain approximately 61 percent of the variance, and sampling error accounts for 46 percent by itself. As was true for institutional measures, the 90 percent credibility interval does not include zero.

The two studies included in the "other measures" subgroup are the same studies described in the last chapter under the individual level of analysis subgroup for overall formalization (Studies 40 and 85). Since these two studies are conducted at the individual level of analysis they do not meet the criterion for inclusion in either the institutional subgroup or the questionnaire subgroup. The mean correlation for these two is $\bar{r} = -.013$ and artifacts explain 59 percent of the variance observed.

Table XII-2 shows that the difference between the questionnaire subgroup and the institutional subgroup is not statistically significant. It is the mean correlation for the "other measures" subgroup that is significantly lower than either of the other two subgroups. However, this is not caused entirely by the type of measure used. In the last chapter, nearly identical results were obtained when these two individual level studies were compared to subunit level studies and organization level studies. (See Tables XI-1 and XI-2 in the previous chapter.)

The results of this analysis indicate that there is no difference between the results of studies using questionnaire measures and those of studies using institutional measures.

Vertical Span

As was the case for functional specialization, the Beyer and Trice study is the only one that used a questionnaire measure of technology (Study 10). The conversion of the t-statistic for the difference between 47 routine organizations and 24 nonroutine organizations results in a point-biserial correlation of r_{pb} = .019 between task routineness and the number of hierarchical levels.

The removal of this single study has no significant effect on the mean correlation or the residual variance for the 28 correlations in the institutional subgroup which are $\bar{r}$ = .274 and residual variance = .0137. This clearly indicates that the residual variance for studies of technology and vertical span is not caused by the type of measure used in the study. However, with only one questionnaire measure no fair comparison can be made to determine whether or not questionnaire measures and institutional measures yield different results.

Centralization

Forty of the 56 correlations between technology and centralization used institutional measures (Studies 4c, 4d, 4e, 4h, 5, 7, 11, 12 & 61, 13b, 14, 15, 18 & 4i, 21a, 21b, 30, 38 & 4k, 39 & 4j, 41, 43, 45, 46, 47, 49, 51, 53, 54, 60, 65, 68, 69, 77, 80, 81, 83, 93, 95, 97, 98a, 98b, and 98c). These correlations range from r = -.52 (Study 7) to r = .484 (Study 30). The combined sample size for these 40 correlations is 1,968, and the mean correlation is $\bar{r}$ = -.042. Artifacts explain 54 percent of the observed variance and sampling error alone can account for 53.5 percent. The residual variance for the institutional subgroup (i.e., .0166) is less than half the residual variance for all studies combined (i.e., .0342). There is more consistency among studies using institutional measures than there is among the full set of 56 studies.

The questionnaire subgroup includes 13 studies (Studies 8, 20, 31, 33, 35, 36, 55, 57, 67, 75a, 75b, 75c, and 84). These correlations range from r = -.11 (Study 33) to r = .473 (Study 31). The total sample size for these 13 studies is 789, and the mean correlation is $\bar{r}$ = .099. Artifacts explain over 48 percent of the observed variance and sampling error can account for 45 percent by itself. The residual variance for the questionnaire subgroup is nearly identical to the residual variance of the institutional subgroup (i.e., .0171 and .0166, respectively) and both are about one half the size of the residual variance for combined studies.

The "other measures" subgroup includes 3 studies using the individual organization member as the unit of analysis. The correlations in this subgroup range from r = -.33 (Study 85), through r = .128 (Study 40), to r = .36 (Study 66). A total of 666 individuals were included in these 3 studies, and the mean correlation is $\bar{r}$ = .139. However, artifacts can only account for less than 8 percent of the observed variance. Clearly then, a large portion of the residual variance in the overall analysis of 56 studies can be traced to the presence of these 3 individual level studies.

Table XII-2 indicates that the 95 percent confidence interval for the corrected mean correlation in questionnaire studies just barely includes zero. The more liberal 90 percent confidence interval does not include zero (i.e., .02 to .26). Neither the institutional subgroup nor the "other measures" subgroup are significantly different from zero even with a 90 percent confidence interval.

The results of statistical significance tests in Table XII-2 indicate that the "other measures" subgroup is not statistically significantly different from either the questionnaire subgroup or the institutional subgroup. This outcome is due primarily to the large corrected residual standard deviation for the three individual level studies.

However, there is a statistically significant difference between the corrected mean correlation for the 40 studies in the institutional subgroup (i.e., -.061), and the corrected mean in the questionnaire subgroup (i.e., .142). The reduction in the residual variance for each of these two subgroups has already been pointed out. The mean residual variance for all three subgroups is .0271 which is considerably lower than the residual variance for the analysis of all 56 correlations.

These results indicate that the type of measure used does have an effect on the results obtained in studies of the relationship between technology and centralization. The difference in signs is particularly interesting because it suggests that in studies using institutional measures more routine technology leads to decentralization, but in studies using questionnaire measures it leads to greater centralization.

However, both the questionnaire subgroup and the institutional subgroup still have a significant residual standard deviation (i.e., .188 and .185, respectively). This indicates that other factors also contribute to the variance observed among correlations between technology and centralization.

It should be pointed out that for the 56 studies included in this meta-analysis of centralization the type of measure used is highly correlated with three other suspected moderators: technology concept, organization type, and level of analysis. The confounding of these moderators will be addressed in Chapter XIII. No attempt will be made to interpret the results of this meta-analysis until this confounding is clarified.

Percentage Clerical Personnel

The single questionnaire measure that was correlated with the percentage clerical personnel is the Leatt and Schneck study of 148 subunits in Canadian hospitals (Study 56). The technology measure assessed the degree of instability, uncertainty, and variability in the nursing task. The clerical ratio was measured as the number of clerical staff divided by other subunit personnel.

The results displayed in Table XII-1 show that removing this study from the 12 institutional measures does reduce the residual variance from .0044 to .0012, and increases the percentage of variance explained by sampling error from 59 percent to 83 percent. There is also a statistically significant difference between the single questionnaire study, and the mean correlation for the 12 institutional measures (Table XII-2).

A tentative interpretation of this finding is that with respect to the percentage of clerical personnel, questionnaire measures of technology yield much stronger correlations than do institutional measures of technology. Caution must be used in this interpretation, however. Placing too much reliance in any single study involves the risk of drawing the wrong inference.

In addition it should be noted that in previous chapters where other moderator tests were performed, the Leatt and Schneck study contributed to significant differences between manufacturers and service organizations (Chapter X), the difference between organization level studies and subunit level studies (Chapter XI), and now to the difference between institutional measures and questionnaires. This is clearly a problem of correlated moderators, and it may be difficult to determine which is the actual moderator.

Summary of Results

The results of meta-analyses conducted in this chapter are summarized in Table XII-3. This table displays the corrected mean correlation and standard deviation for each of the 13 structural variables based upon the type of measure used in the studies. The table also indicates whether the residual variance in each subgroup is less than (-), greater than (+), or did not change (0) from the residual variance for the combined studies. The statistical significance level of differences observed is also shown.

All four possible conditions exist for comparisons between questionnaire and institutional measures. The corrected mean correlations for questionnaire measures are larger than those for institutional measures in the analyses of overall formalization and supervisor's span of control but neither is statistically significant. It is the two individual level studies of overall formalization in the "other measures" category that result in a statistically significantly lower mean correlation than do either the questionnaire or institutional measures. The type of measure used has no affect on the results obtained for overall formalization or supervisor's span of control.

Institutional measures result in higher corrected correlations than questionnaire measures in five cases (i.e., division of labor, functional specialization, standardization, role formalization, and vertical span). Three of these differences do reach statistical significance, however, only division of labor shows a moderate reduction in the mean residual variance while neither functional specialization nor vertical span demonstrated a significant reduction in the residual variance when the single questionnaire study was removed. The type of measure used does not contribute to the inconsistency observed in the correlations between technology and functional specialization or between technology and vertical span.

The small reduction in the mean residual variance for division of labor (i.e., mean residual variance is .019 compared to .024 for the combined studies) suggests that the cause of this variance is some factor other than the type of measure used. Specifically, the large residual variance for questionnaire measures (i.e., .033) indicates that the primary source of variation is within the questionnaire subgroup rather than between questionnaire measures and institutional measures. The conclusion that the type of measure used contributes to inconsistency in the correlations observed between technology and division of labor is, therefore, extremely tentative.

Centralization appears to be negatively correlated with institutional measures and positively correlated with questionnaire measures. This difference is statistically significant and there is a marked reduction in the residual variance for these two subgroups, as well as a reduction in the mean residual variance for the three subgroups. These results suggest that the type of measure used may affect the correlation observed between technology and centralization of authority.

The percentage of personnel in clerical positions appears to be negatively correlated with questionnaire measures of technology, but not related to technology when institutional measures are used. Even though there is a statistically significant difference between these two subgroups there are always hazards involved in placing too much confidence in a single study as exists in the questionnaire subgroup.

A tentative interpretation of these results is that the type of measure used does affect the size of the correlation observed between technology and the percentage of personnel in clerical jobs.

No comparisons could be made between types of measures for percentage direct workers, percentage supervisors, percentage workflow planning and control, or percentage administration. Only institutional measures were used, so the type of measure used does not contribute to the residual variance for these four ratio variables.

On the bottom of Table XII-3 are displayed the mean correlation and the mean absolute value of those correlations for the nine variables for which comparisons could be made. In both calculations the mean for institutional measures is higher than the mean for questionnaire measures.

Institutional measures not only tend to yield larger correlations between technology and structure, but they also yield more consistent results. At the bottom of Table XII-3 it is shown that in four out of six cases questionnaire measures resulted in a higher residual variance than the residual for the total set of studies. In eight out of nine cases for institutional measures the residual variance was lower. This finding indicates that most of the residual variance in the technology-structure literature is within the questionnaire studies subgroup.

Conclusion

Centralization is the only variable for which there is strong support for the hypothesis that the type of measure used makes a difference in the results obtained. The support for this hypothesis in the case of division of labor and percentage clerical personnel is less compelling due to the very small reduction in mean residual variance. For all other variables tested, the evidence is far too weak to conclude that type of measure makes any difference at all.

It should be pointed out that many of these conclusions are based upon a total absence of questionnaire studies. While it can be said that the type of measure does not contribute to the residual variance observed in the omnibus test reported in Chapter VI, no general statement can be made about whether or not the two types of measures yield different results. More questionnaire studies are needed before an adequate meta-analytic test will be possible.

It should also be noted that for most of the studies included in the questionnaire subgroup, only the independent variable was measured by questionnaire. With the exceptions of formalization and centralization the dependent measures are institutional (e.g., percentage clerks, vertical span, functional specialization). The absence of "pure" questionnaire studies may have influenced the results obtained. However, this is the state of the research literature, and does not detract from the conclusion that the type of measure used has little effect on the results observed in that literature.

The results obtained in these meta-analyses do not support the arguments of Ford (1979), Pennings (1973), or Sathe (1978). The conclusion reached here echoes that of Fry (1982). "The type of measure used in technology-structure research had no significant effect on findings" (Fry, 1982: 548).

Table XII-1. Moderator Analyses: Type of Technology Measure

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Variance Expected due to Sampling Error	Variance due to Range Differ- ence	Variance due Reliability Difference: Technology	Struc
Division of Labor								
Total	26	2726	.291	.0418	.0079	.0053	.0025	.00
Institutional	18	2327	.323	.0338	.0061	.0063	.0031	.00
Questionnaire	9	474	.070	.0515	.0178	.0004	.0001	.00
Functional Specialization								
Total	44	2378	.239	.0372	.0156	.0038	.0016	.00
Institutional	43	2307	.246	.0369	.0156	.0040	.0017	.00
Questionnaire	1	71	.023					
Standardization								
Total	15	902	.227	.0287	.0148	.0034	.0015	.00
Institutional	13	812	.242	.0225	.0144	.0038	.0017	.00
Questionnaire	2	90	.090	.0644	.0182	.0006	.0002	.00
Overall Formalization								
Total	43	2853	.173	.0303	.0134	.0021	.0009	.00
Institutional	33	2203	.196	.0281	.0131	.0026	.0012	.00
Questionnaire	9	391	.248	.0449	.0206	.0040	.0018	.00
Other Measures	2	329	-.013	.0102	.0060	.0000	.0000	.00
Role Formalization								
Total	25	1013	.218	.0372	.0209	.0032	.0015	.00
Institutional	23	837	.233	.0418	.0232	.0036	.0017	.00
Questionnaire	2	176	.143	.0085	.0101	.0014	.0006	.00
Vertical Span								
Total	29	2964	.268	.0292	.0080	.0046	.0019	n.a
Institutional	28	2893	.274	.0283	.0079	.0048	.0020	n.a
Questionnaire	1	71	.019					
Centralization								
Total	56	3423	.025	.0496	.0153	.0000	.0000	.00
Institutional	40	1968	-.042	.0361	.0193	.0001	.0000	.00
Questionnaire	13	789	.099	.0332	.0150	.0007	.0003	.00
Other Measures	3	666	.139	.0759	.0036	.0014	.0006	.00
Supervisor's Span of Control								
Total	22	2592	.078	.0132	.0083	.0004	.0002	n.a
Institutional	20	2494	.070	.0126	.0080	.0004	.0001	n.a
Questionnaire	3	173	.116	.0318	.0151	.0010	.0004	n.a

logy Measure

Variance Expected due to Sampling Error	Variance due to Range Difference	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structure	Residual[a] Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation: Mean	Corrected Correlation: s.d.	90 % Credibility Interval
.0079	.0053	.0025	.0016	.0244	41.6	.156	.423	.228	.049 to .798
.0061	.0063	.0031	.0020	.0163	51.8	.128	.468	.185	.164 to .773
.0178	.0004	.0001	.0001	.0332	35.5	.182	.103	.269	-.340 to .547
.0156	.0038	.0016	.0002	.0160	57.0	.126	.338	.179	.044 to .632
.0156	.0040	.0017	.0002	.0153	58.4	.124	.347	.175	.059 to .634
							.032	n.a.	
.0148	.0034	.0015	.0032	.0057	80.1	.076	.332	.111	.150 to .514
.0144	.0038	.0017	.0036	-.0012	100+	0	.353	0	.353
.0182	.0006	.0002	.0005	.0448	30.4	.212	.133	.312	-.380 to .647
.0134	.0021	.0009	.0004	.0135	55.6	.116	.254	.171	-.027 to .535
.0131	.0026	.0012	.0006	.0107	62.0	.103	.287	.152	.037 to .537
.0206	.0040	.0018	.0009	.0176	60.8	.133	.362	.194	.043 to .681
.0060	.0000	.0000	.0000	.0042	59.1	.064	-.019	.095	-.176 to .137
.0209	.0032	.0015	.0010	.0106	71.5	.103	.334	.158	.074 to .594
.0232	.0036	.0017	.0011	.0122	70.9	.110	.357	.169	.080 to .635
.0101	.0014	.0006	.0004	-.0041	100+	0	.221	0	.221
.0080	.0046	.0019	n.a.	.0146	49.8	.121	.342	.154	.088 to .596
.0079	.0048	.0020	n.a.	.0137	51.7	.117	.349	.149	.104 to .595
							.024	n.a.	
.0153	.0000	.0000	.0000	.0342	31.0	.185	.036	.266	-.401 to .474
.0193	.0001	.0000	.0000	.0166	54.0	.129	-.061	.185	-.366 to .244
.0150	.0007	.0003	.0001	.0171	48.5	.131	.142	.188	-.167 to .451
.0038	.0014	.0006	.0002	.0700	7.8	.265	.199	.379	-.425 to .823
.0083	.0004	.0002	n.a.	.0043	67.7	.065	.101	.084	-.038 to .240
.0080	.0004	.0001	n.a.	.0041	67.4	.064	.091	.083	-.046 to .227
.0151	.0010	.0004	n.a.	.0154	51.6	.124	.149	.160	-.114 to .413

Table XII-1--continued

Variable	Number of Corre-lations	Total Sample	Mean r Observed	Observed Variance	Variance Expected due to Sampling Error	Variance due to Range Differ-ence	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structu
% Direct Workers								
Total	12	497	-.207	.0654	.0224	.0029	.0011	n.a.
Institutional	12	497	-.207	.0654	.0224	.0029	.0011	n.a.
Questionnaire	0	0						
% Supervisors								
Total	10	1813	-.096	.0251	.0050	.0007	.0002	n.a.
Institutional	10	1813	-.096	.0251	.0050	.0007	.0002	n.a.
Questionnaire	0	0						
% Clerical Personnel								
Total	13	1996	.002	.0108	.0064	.0000	.0000	n.a.
Institutional	12	1848	.020	.0077	.0064	.0000	.0000	n.a.
Questionnaire	1	148	-.212					
% Workflow Planning and Control								
Total	4	160	-.099	.0287	.0240	.0007	.0003	n.a.
Institutional	4	160	-.099	.0287	.0240	.0007	.0003	n.a.
Questionnaire	0	0						
% Administration								
Total	12	753	.066	.0367	.0150	.0003	.0001	n.a.
Institutional	12	753	.066	.0367	.0150	.0003	.0001	n.a.
Questionnaire	0	0						

[a]Numbers may not sum across due to rounding.

Variance Expected due to Sampling Error	Variance due to Range Difference	Variance due to Reliability Difference: Technology	Variance due to Reliability Difference: Structure	Residual[a] Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation: Mean	Corrected Correlation: s.d.	90 % Credibility Interval
.0224	.0029	.0011	n.a.	.0390	40.4	.197	-.265	.254	-.683 to .152
.0224	.0029	.0011	n.a.	.0390	40.4	.197	-.265	.254	-.683 to .152
.0050	.0007	.0002	n.a.	.0192	23.4	.139	-.124	.179	-.419 to .171
.0050	.0007	.0002	n.a.	.0192	23.4	.139	-.124	.179	-.419 to .171
.0064	.0000	.0000	n.a.	.0044	59.4	.066	.003	.086	-.138 to .144
.0064	.0000	.0000	n.a.	.0012	84.2	.035	.025	.045	-.049 to .100
							-.297	n.a.	
.0240	.0007	.0003	n.a.	.0036	87.3	.060	-.128	.078	-.257 to .000
.0240	.0007	.0003	n.a.	.0036	87.3	.060	-.128	.078	-.257 to .000
.0150	.0003	.0001	n.a.	.0213	41.9	.146	.085	.189	-.226 to .396
.0150	.0003	.0001	n.a.	.0213	41.9	.146	.085	.189	-.226 to .396

Table XII-2. Type of Measure: 95% Confidence Interval and Statistical Significance Tests

	Corrected Correlation					95%	Z-Test		
Variable	k	n	Mean	s.d.	s.e.	Confidence Interval	Questionnaire-Institutional	Questionnaire-Other	Institutional Other
Division of Labor									
Questionnaire	9	474	.103	.269	.1128	-.12 to .32			
Institutional	18	2327	.468	.185	.0513	.37 to .57	-2.94**		
Functional Specialization									
Questionnaire	1	71	.032	n.a.	.1184	-.20 to .26			
Institutional	43	2307	.347	.175	.0386	.27 to .42	-2.53***		
Standardization									
Questionnaire	2	90	.133	.312	.2702	-.40 to .66			
Institutional	13	812	.353	.000	.0486	.26 to .45	-.80		
Overall Formalization									
Questionnaire	9	391	.362	.194	.0950	.18 to .55			
Institutional	33	2203	.287	.152	.0402	.21 to .36			
Other Measures	2	329	-.019	.095	.1060	-.23 to .19	.73	2.68**	2.70**
Role Formalization									
Questionnaire	2	176	.221	.000	.1145	-.00 to .44			
Institutional	23	837	.357	.167	.0618	.24 to .48	-1.04		
Vertical Span									
Questionnaire	1	71	.024	n.a.	.1184	-.21 to .26			
Institutional	28	2893	.349	.149	.0358	.28 to .42	-2.63**		
Centralization									
Questionnaire	13	789	.142	.188	.0729	-.00 to .28			
Institutional	40	1968	-.061	.185	.0439	-.15 to .02			
Other Measures	3	666	.199	.379	.2256	-.24 to .64	2.38***	-.24	-1.13
Supervisor's Span of Control									
Questionnaire	3	173	.149	.160	.1346	-.11 to .41			
Institutional	20	2494	.091	.083	.0318	.03 to .15	.42		

Table XII-2--continued

	Corrected Correlation					95%	Z-Test		
Variable	k	n	Mean	s.d.	s.e.	Confidence Interval	Questionnaire-Institutional	Questionnaire-Other	Institutional Other
% Direct Workers									
Institutional	12	497	-.265	.254	.0920	-.44 to -.08			
% Supervisors									
Institutional	10	1813	-.124	.179	.0642	-.25 to .00			
% Clerical Personnel									
Questionnaire	1	148	-.297	n.a.	.0747	-.44 to -.15			
Institutional	12	1848	.025	.045	.0329	-.04 to .09	-3.94*		
% Workflow Planning and Control									
Institutional	4	160	-.128	.078	.1097	-.34 to .09			
% Administration									
Institutional	12	753	.085	.189	.0722	-.06 to .23			

*p < .001, two-tailed. **p < .01, two-tailed. ***p < .05, two-tailed.

Table XII-3. Summary of Results for Effect of Type of Measure

Structural Variable	Questionnaire Mean r	Questionnaire s.d.	Questionnaire res	Institutional Mean r	Institutional s.d.	Institutional res	Other[a] Mean r	Other[a] s.d.	Other[a] res	Significance
Questionnaire > Institutional:										
Overall Formalization	.362	.194	+	.287	.152	-	-.019	.095	-	p < .01
Supervisor's Span of Control	.149	.160	+	.091	.083	-				n.s.
Institutional > Questionnaire:										
Division of Labor	.103	.269	+	.468	.185	-				p < .01
Functional Specialization	.032	n.a.	n.a.	.347	.175	-				p < .05
Standardization	.133	.312	+	.353	.000	-				n.s.
Role Formalization	.221	.000	-	.357	.169	+				n.s.
Vertical Span	.024	n.a.	n.a.	.349	.149	-				p < .01
Questionnaire (positive) & Institutional (negative):										
Centralization	.142	.188	-	-.061	.185	-	.199	.379	+	p < .05
Institutional (positive) & Questionnaire (negative):										
% Clerical Personnel	-.297	n.a.	n.a.	.025	.045	-				p < .001
No comparison possible:										
% Direct Workers				-.265	.254	0				
% Supervisors				-.124	.179	0				
% Workflow Planning and Control				-.128	.078	0				
% Administration				.085	.189	0				
Mean r	.096			.246			.090			
Mean Absolute Value	.162	.125		.260	.127		.109	.237		
Residual Variance:										
Increase		4			1			1		
Decrease		2			8			1		
No Change		0			4			0		
n.a.		3								

[a]Other measures are questionnaires using the individual as the unit of analysis.

CHAPTER XIII

RECONCILIATION OF MULTIPLE MODERATORS

In the previous five chapters meta-analyses were used to test the effect of study attributes that have been proposed as moderators of the technology-structure relationship. Table XIII-1 summarizes the results of each of those analyses indicating whether the observed difference between moderator subgroups was statistically significant (S) or nonsignificant (N), and whether the mean residual variance for those subgroups decreased (D), increased (I), or did not change (U) from the residual variance for the combined studies.

The strongest evidence in support of a moderator effect is the combination of both a statistically significant difference and a reduction in the residual variance. This condition occurs most frequently in the moderator tests for organization type performed in Chapter X. Eight of those 13 analyses resulted in statistically significant differences, and 4 others showed a reduction in the mean residual variance.

The least important moderator appears to be organization size. Only two of the moderator tests resulted in a significant difference between subgroups. There were eight additional cases in which the mean residual variance did decline even though no statistically significant difference was observed between large and small subgroups.

The technology concept used in a study also appears to result in statistically significant differences in the correlations observed. Since there were four technology subcategories used to classify studies in Chapter VIII, there were six possible pair-wise comparisons (i.e., N (N - 1) / 2 = 4 (3) / 2). The corrected mean correlation for each of the four technology concepts was compared with the corrected mean correlation for all other technology concepts. For division of labor, functional specialization, overall formalization, centralization, and percentage workflow planning and control, at least one of the six possible comparisons was statistically significant when the Bonferroni inequalities method was used to establish the overall alpha level for the multiple comparisons. When a more liberal statistical significance level is applied to each pair-wise comparison, significant differences were also detected for standardization, role formalization, supervisor's span of control, and percentage direct workers.

The mean residual variance for the four technology concepts declined only five times; for division of labor, centralization, percentage direct workers, percentage supervisors, and for percentage administration. However, no significant difference was observed for percentage supervisors or percentage administration. The failure to observe a reduction in the residual variance more frequently may be due to the use of average correlations in the omnibus test of the situation specificity hypothesis conducted in Chapter VI. Calculation of mean correlations tends to mitigate the impact of extreme correlations within the individual studies. The variance observed between these composite correlations could be less than the variance of their component correlations. To recognize this possibility, any statistically significant difference is tentatively treated as evidence of a moderator effect.

Multiple Moderators

Several of the variables in Table XIII-1 display evidence that more than one moderator may contribute to the inconsistency in study outcomes. That is, several of the moderator tests resulted in statistically significant differences. Functional specialization, for example, had a significant difference for all of the moderator tests except level of analysis.

In this chapter an effort will be made to reconcile these multiple moderators in recognition of the fact that these five moderator variables are frequently correlated. To evaluate this condition the correlations between these five proposed moderator variables were calculated for each of the 13 structural variables included in these analyses. The correlation matrices in Appendix G clearly show that the moderator variables are frequently correlated with one another among the studies included in these meta-analyses. For example, for functional specialization there is a correlation of r = .46 between the subunit level of analysis and service organizations, and a correlation of r = .28 between the organization level of analysis and manufacturing organizations. There is also a significant negative correlation between service organization studies and both workflow continuity and workflow integration (i.e., r = -.35 and r = -.33, respectively). These correlations indicate that the studies that report relationships between functional specialization and workflow continuity or workflow integration tend to have mixed samples or manufacturing samples. Also, studies of manufacturers tend to be performed at the organization level of analysis while studies of service organizations are at subunit level. The lack of independence demonstrated between these various moderators makes it necessary to attempt a determination of the dominant variable.

It should be noted that the correlations in Appendix G are unique to the set of studies included in these meta-analyses. It should also be remembered that the correlations in Appendix G were calculated by coding each study for its characteristics, while the mean correlations computed in the meta-analyses were weighted by the total sample size of those studies. Thus, it is possible for two or more moderators to have independent effects on the relationship between technology and structure, yet be highly correlated within a given set of studies.

The goal of this chapter is to determine the nature of the relationship that exists between the various moderator variables. More specifically, the goal is to determine whether any of the moderator effects are spurious due to confounding of variables. This will involve a series of two-way analyses pitting one suspected moderator against another. Each of these analyses will involve three two-dimensional tables. Each of these three tables assesses the degree to which the observed pattern of correlations fits a hypothesized pattern of correlations. The procedure used is very similar to the chi square test for independence described by Hays (1981).

Each of these two-way analyses places primary emphasis on the size of the main effects for each variable, and then moves inside the tables. The comparisons made within the tables are intended to determine whether the competing variables are independent moderators, not the strength of the moderator effect within subcategories. The main concern is the degree of dependence or independence of the moderator effects.

The first two tables in each set test the hypothesis that one of the moderators is spurious when compared to the other. For example, assume that the main effects of variables A and B both indicate that they are moderators. If the moderator effect of variable A is spurious, the expected correlations within the two-dimensional table will not change as the main effect of A suggests; there is no change on the A-dimension. However, within each subgroup formed on the bases of variable A there will be changes along the B-dimension that correspond to the main effect of variable B. Likewise, if the moderator effect of variable B is spurious there will be no effect of variable B within the subcategories formed on the bases of A, but the main effect of variable A will persist within the subcategories of variable B. If the pattern of corrected mean correlations obtained in meta-analyses tends to fit the pattern of correlations expected in one of these cases, then there is evidence that one moderator (i.e., A or B) is spurious when compared to the other.

If neither variable A nor B is spurious they could be orthogonal and their individual main effects additive. If so, the main effects of both variables will also exist within the two-dimensional table. The third table in each of the two-way analyses addresses this condition. To the extent that the pattern of corrected mean correlations fits this expectation it may be concluded that the moderator effects of variables A and B are independent.

These three hypothesized conditions are mutually exclusive, but not exhaustive. If one is true the other two are, by definition, false. By comparing the fit between the observed correlations and those correlations expected in each of the three cases one of the cases may be identified as more representative of the observed pattern, and the other two can be rejected. The task then becomes one of determining whether the fit in the best fitting case is close enough to warrant the conclusion that it does represent the relationship between two competing moderators.

It is possible that the observed correlations do not fit any of these three extreme cases. In that situation there may be a random relationship between the two variables (i.e., no relationship), or the two variables may interact with one another. That is, there may be too much random variation among these studies to make a determination of what the relationship is between the two moderators. This is the meaning implied in this chapter when a relationship is described as being random.

These two-way analyses will also address the possibility of an interaction between the two potential moderator variables. Hays states "when interaction effects are absent, differences among the means representing different column-treatment populations have the same size and sign" (1981: 363). For example, if manufacturing organizations yield larger correlations than service organizations when the organizations are small, but just the reverse is true in large organizations, then there is evidence of an interaction effect. But, if the relative size of the correlations for manufacturing firms and service firms is the same for both large and small organizations no interaction is indicated.

The tables presented in this chapter include only summary data from the meta-analyses performed, but more detailed tables are included in Appendix H. The summary tables provide the number of correlations included (k), the combined sample size for the k correlations (N), the corrected mean correlation ($\bar{r}c$), the correlation that would be expected if the hypothesized case were true ($\bar{r}e$), and the difference between $\bar{r}c$ and $\bar{r}e$ (d). The row and column labeled "Total" reflect the results of moderator tests conducted in earlier chapters, and the lower right hand cell in each table reflects the results obtained for the omnibus test performed in Chapter VI. In each of the tables the marginal row and column are arranged so that the mean corrected correlations for each subcategory are in ascending order from top to bottom, and left to right.

The interpretations presented in this chapter must be considered to be tentative. However, the approach used is believed to be the most appropriate of those available. Ideally, determination of the degree of independence among competing moderators would be based upon a hierarchical analysis. For example, if three moderators are suspected, the studies would be subdivided into groups; each group representing a subset of the next-higher-level moderator. However, since the number of studies available for these meta-analyses is small, the number of studies in the cells of each successive level of the hierarchy would become prohibitively small. Thus statistical power to detect a moderator would be greatly reduced. Statistical significance tests are avoided in these analyses for the same reason (i.e., low statistical power due to the reduction of the number of studies).

Division of Labor

Moderator tests for division of labor indicated statistically significant differences for technology concept, level of analysis, and type of measure used. Two-way analyses will be performed on these variables.

Table XIII-2 through Table XIII-4 all compare the type of measure used with the level of analysis for the study. Appendix G indicates that among the 26 studies included in these analyses the type of measure used has a correlation of r = .49 with the level of analysis. The difference between mean correlations for questionnaire measures and institutional measures is .37 (i.e., $\bar{r}c$ = .47 minus $\bar{r}c$ = .10). This is more than twice the difference between the mean correlations for subunit level studies and organization level studies (i.e., $\bar{r}c$ = .48 minus $\bar{r}c$ = .30 equals .18). This suggests that level of analysis may be spurious when compared to the type of measure used.

In Table XIII-2 the expected correlation is based upon the hypothesis that level of analysis has no effect when type of measure is controlled. If this were the case then level of analysis is totally spurious and there would be no differences between the correlations obtained at different levels of analysis. The expected correlations (i.e., $\bar{r}e$) are computed by selecting a reference correlation (in this case $\bar{r}c$ = -.05) and adjusting it for the main effect of type of measure (i.e., .37) within each column. However, there is no adjustment made for the main effect of level of analysis. Note that $\bar{r}e$ is the same for both levels of analysis within each type of measure. The observed correlations, especially at subunit level, are quite different from what would be expected.

In Table XIII-3 the hypothesis is that the type of measure has no effect. The expected correlations in this table are computed using the same reference correlation as in Table XIII-2 (i.e., $\bar{r}c$ = -.05). However, it is the main effect of level of analysis that is used to adjust within each type of measure (i.e., .18), while no adjustment is made within levels of analysis for the main effect of type of measure. Once again, the observed correlations are quite different from that expectation. Thus, neither the type of measure nor the level of analysis is spurious when compared to the other.

Table XIII-4 gives the correlations that would be expected if level of analysis and type of measure were orthogonal moderators and the main effects of each are additive. These expected correlations (i.e., $\bar{r}e$) are computed by selecting the same reference correlation as in the previous two tables (i.e., $\bar{r}c = -.05$) and adjusting it for the main effects of the two moderator variables. For example, the expected correlation for questionnaire studies at subunit level is computed as the correlation for questionnaire studies at organization level (i.e., $\bar{r}c = -.05$) plus the main effect for level of analysis (i.e., .18) which results in an expected correlation of $\bar{r}e = .13$. The expected correlation for organization level studies is similarly computed by adding the main effect of type of measure (i.e., .37) to the expected correlations for questionnaire measures. The differences (i.e., d's) in Table XIII-4 support the hypothesis that level of analysis and the type of measure used are orthogonal, and their effects are additive with respect to the relationship between technology and division of labor.

In summary, the results suggest that the difference between correlations obtained with questionnaires at organization level ($\bar{r}c = -.05$) and those for institutional measures at subunit level ($\bar{r}c = .54$) is caused by the independent effects of type of measure (i.e., .37) and level of analysis (i.e., .18).

The next step is to determine how each is related to the technology concept. Appendix G indicates that measurement type has a correlation of approximately .40 with the concepts of workflow continuity, information processing, and task routineness. Likewise, workflow continuity has a correlation of approximately .40 with level of analysis.

The main effect of the technology concept is .37 (i.e., $\bar{r}c$ = .46 minus $\bar{r}c$ = .09), and the main effect of level of analysis is again .18. Note also that the main effect for technology concept is the same as the main effect for the type of measure (i.e., .37) which suggests that one may be spuriously driven by the other. Table XIII-5 presents the expected correlations if the effect of technology concept is spurious when compared to level of analysis. The differences from the expected correlations are large so the hypothesis is rejected. The main effect for technology concept is not spurious when compared to level of analysis. Table XIII-6 leads to the conclusion that the moderator effect of level of analysis is not spurious either. Thus neither technology concept nor level of analysis is spurious when compared to the other.

Table XIII-7 includes the correlations that would be expected if technology concept and level of analysis were independent. The differences between the expected correlations and the observed correlations are too large to retain that hypothesis. Technology concept and level of analysis are not independent moderators.

These results suggest that both the technology concept and the level of analysis have a moderating effect. They are neither independent nor spurious when compared to each other. This relationship may be interactive, or even random. The nature of the relationship cannot be determined from these data.

Both the technology concept and the type of measure used have a main effect of .37 suggesting that one may be spurious when compared to the other.

Table XIII-8 presents the correlations expected if the moderator effect of the technology concept is spurious when compared with the type of measure used. The consistently large differences between the observed and expected correlation indicate that the moderator effect of the technology concept is not spurious.

Table XIII-9 addresses the question of whether the moderator effect of the type of measure is spurious relative to the technology concept. The largest difference in Table XIII-9 occurs in the cell for questionnaire measures of workflow integration. With the exception of that cell with only two studies in it other differences are not large. These results suggest that the moderating effect of the type of measure used may be spurious due to confounding with the technology concept.

Table XIII-10 examines whether the type of measure used and the technology concept employed are orthogonal moderators. This table shows a large difference between the observed correlation and the expected correlation for task routineness for questionnaire measures, but other comparisons result in smaller differences. Nevertheless, the data do not support the hypothesis that technology concept and type of measure are orthogonal.

<u>Summary of Findings</u>

Five potential moderators were tested in the relationship between technology and division of labor, but only two of those have been shown to have an effect. Those are the technology concept, and the level of analysis of the study.

Table XIII-4 illustrated that the type of measure used and the level of analysis were independent of one another. The moderating effect of the technology concept was found not to be independent of either the level of analysis or the type of measure used (Tables XIII-7 and XIII-10). However, the moderating effect of type of measure may be spurious due to confounding with the technology concept (Table XIII-9).

The technology concept appears to be the strongest moderator (i.e., .37), and level of analysis contributes an additional effect of approximately .18. Studies at the subunit level of analysis yield higher correlations between technology and division of labor. Workflow continuity measures have the lowest correlations with division of labor (i.e., $\bar{r}c$ = .09), followed by task routineness ($\bar{r}c$ = .15), workflow integration ($\bar{r}c$ = .34), and finally information technology ($\bar{r}c$ = .46). Table XIII-5 suggests that technology concept and level of analysis may not be totally independent moderators of the relationship between technology and division of labor.

Functional Specialization

Table XIII-1 indicates that four moderator tests resulted in statistically significant differences: technology concept, organization size, organization type, and type of measure. However, the statistically significant difference for the type of measure is related to a single study that used a questionnaire measure. Removal of this single study had a trivial effect on the residual variance. The two-way analyses of functional specialization will address only the technology concept, the size of the organization, and the type of organization.

Table XIII-11 through Table XIII-13 display the comparison of organization type with organization size. The correlation matrix in Appendix G indicates that the correlations of organization size with manufacturing, mixed, and service are quite small (i.e., r = .01, r = .08, and r = -.10, respectively). Nothing can be said about the size of the organizations studied in the "Unknown Size" subcategory, so the mean correlation for that subcategory is not used for determining the main effect of organization size. Instead, the difference between the mean correlation for small organizations ($\bar{r}c$ = .32) and that for large organizations ($\bar{r}c$ = .45) is used. In addition, care was taken not to select a mean correlation in the unknown size subcategory as the reference point for calculating the expected correlations (i.e., $\bar{r}e$) in these tables.

The main effect of the technology concept is .41 (i.e., a low correlation of $\bar{r}c$ = .06 for task routineness to $\bar{r}c$ = .47 for information technology). The corrected mean correlation for large organizations is .13 greater than the corrected mean for small organizations, and the difference between the corrected mean correlations for service and manufacturing organizations is .19. These main effect sizes suggest that organization size may be spurious when compared to both organization type and technology concept, and that organization type may be spurious when compared to technology concept.

Table XIII-11 tests the hypothesis that the moderator effect of organization size is spurious when compared to organization type. There is only one relatively large deviation from the expected correlation and that is in the cell for the large mixed sample. That cell has only one sample of 31 organizations, so confidence in that corrected correlation is low. Organization size may be spurious when compared to organization type.

The data in Table XIII-12 do not indicate that organization type is spurious when compared to organization size. The relative differences between the expected and the observed correlations is greater for Table XIII-12 than it is for Table XIII-11. This indicates that the pattern of corrected mean correlations better fits the case in which organization size is spurious when compared to organization type.

The data in Table XIII-13 do not clearly reject the hypothesis that organization type and organization size are orthogonal. Only one of the differences in the rows for large and small organizations is large relative to the expected correlation, and that is for the lone study of a mixed sample of large organizations. The differences observed in the other cells for which the organization size is known are relatively small when compared to the expected correlation. The low correlation between these two variables also suggests that they may be independent. Organization type and organization size may be orthogonal moderators.

The results of the analyses in Tables XIII-11 through XIII-13 are inconclusive. Organization size is either orthogonal to organization type, or it is spurious when compared to organization type. In the latter case its effect is zero, but in the former it is .13.

Table XIII-14 through Table XIII-16 analyze the relationship between the technology concept and organization size. These two moderators are not highly correlated. Appendix G indicates that workflow integration has a correlation of r = .19 with large organizations and workflow continuity a correlation of r = .18 with small organizations, but neither is statistically significant.

The relative differences in Table XIII-16 are much smaller than the differences in either Table XIII-14 or Table XIII-15. These results suggest that neither the technology concept nor organization size are spurious when compared to one another, and each has an independent effect on the relationship between technology and functional specialization. The best fit between the observed correlations ($\bar{r}c$) and the correlations expected is observed in Table XIII-16 where the expected correlations are computed using the assumption of independence. However, the difference observed in Table XIII-16 for measures of workflow integration in large organizations (i.e., d = .21) is large enough to cause some doubt in that interpretation. The relationship between organization size and the technology concept measured cannot be determined from these data.

Table XIII-17 gives the correlations that would be expected if technology concept were spurious when compared to the type of organization, and Table XIII-18 treats organization type as the spurious variable. Neither hypothesized case is supported.

Table XIII-19 treats both technology concept and organization type as independent moderators. The largest differences from the expected correlation appear in the row for workflow continuity. Two of these differences involve single studies so little confidence can be placed in them. In spite of these differences the fit between the observed correlations and the correlations expected in Table XIII-19 is much better than the fit in either Table XIII-17 or Table XIII-18. This indicates that neither the effect of technology concept nor organization type is spurious when compared to the other and both have an independent effect on the relationship of technology and functional specialization.

<u>Summary of Findings</u>

The two-way analyses conducted in this section suggest that technology concept, and organization type moderate the relationship between technology and functional specialization. The largest effect is due to the different technology concepts employed. There is a difference of .41 between the low mean correlation for task routineness and the high mean correlation for information technology. This effect appears to be relatively independent of the difference between large and small organizations (i.e., .13), as well as the difference due to organization type (i.e., .19).

The role of organization size as a moderator is less clear. The two extreme possibilities are that it is either orthogonal to both technology concept and organization type and results in a difference of .13 between large and small firms, or it is confounded by organization type and has no unique effect.

Overall Formalization

The moderator tests of overall formalization resulted in statistically significant differences for the technology concept measured, the level of analysis for the study, and the type of measure used. However, the statistically significant difference for the type of measure used was actually due to the studies that used the individual organization member as the unit of analysis. These studies were classified as "other measures". The type of measure was not the real moderator; level of analysis was. The two-way analyses of overall formalization will compare only the technology concept and the level of analysis. Appendix G indicates that studies of workflow continuity tend to be conducted at the organization level of analysis (i.e., $r = .51$), but measures of task routineness tend to be used at subunit level (i.e., $r = .31$).

The main effect for level of analysis was .33 between the individual level of analysis (i.e., $\bar{r}c$ = -.02) to the organization level of analysis (i.e., $\bar{r}c$ = .31). The main effect for the technology concept is .25 for the difference between workflow integration and information technology. These main effect sizes suggest that the technology concept may be spurious when compared to the level of analysis. Tables XIII-20 through XIII-22 compare the technology concept to the level of analysis.

The difference between the mean correlation for workflow integration and that for information technology is .25, but almost all of that difference (i.e., .19) is between task routineness and information technology. There is little difference between workflow integration, workflow continuity, and task routineness. There is also a very small difference between subunit level studies and organization level studies (i.e., .05), but the mean correlation for individual level studies is much smaller than that for organization level studies (i.e., .33).

The data in Table XIII-20 and Table XIII-21, respectively, reject the hypotheses that the moderator effects of technology concept and level of analysis are spurious when compared to one another.

The differences between the corrected mean correlations in Table XIII-22 and the expected correlations are too great to support the hypothesis that technology concept and level of analysis are orthogonal.

Summary of Findings

The analyses in this section suggest that the moderator effects of the technology concept employed and the level of analysis are neither spurious nor orthogonal. The relationship may be random, or there is an interaction between the two.

Evidence for an interaction can be found in Table XIII-20 by the comparison of the mean corrected correlations for task routineness and workflow integration. For workflow integration, organization level studies have the higher correlations, but it is subunit level studies that have the higher correlation for task routineness.

Role Formalization

Two moderator tests resulted in statistically significant differences for role formalization. Those were the technology concept employed in the study, and the type of organization included in the sample. Appendix G indicates that measures of task routineness tend to be used in manufacturing organizations (i.e., r = .34). This is not a large correlation, but it is the largest observed between the four technology concepts, and the three levels of analysis.

The main effect for the technology concept is .25 which is the difference between $\bar{r}c$ = .16 for task routineness to $\bar{r}c$ = .41 for information technology. The difference between the corrected mean correlation for service organizations and that for mixed samples is .32. The relative size of these two main effects suggests that it is the technology concept that may be spurious when compared to the organization type. Tables XIII-23 through XIII-25 compare these two moderators.

Table XIII-23 compares the corrected correlations to those expected if the technology concept is spurious when compared to organization type and the observed moderator effect is driven by its confounding with organization type. Table XIII-24 treats organization type as the spurious variable. Table XIII-25 compares the corrected mean correlations to the correlation that would be expected if technology concept and organization type were orthogonal variables and their effects were additive.

The smallest relative differences between the corrected correlations and the expected correlations are in Table XIII-25. These results indicate that neither the technology concept nor the organization type is spurious when compared to the other. Each of these variables has a moderating effect, but the effects are not completely independent. The differences in Table XIII-25 are still too large to support that hypothesis.

The relationship between the technology concept and the type of organization may be interactive. Notice in Table XIII-25 that for task routineness the corrected mean correlation for manufacturing organizations is larger than the mean for service organizations. However, for workflow integration it is the service organizations with the larger corrected mean correlation.

<u>Summary of Findings</u>

The results of analyses in this section suggest that either the technology concept employed in the study, and the type of organization studied are orthogonal moderators of the relationship between technology and role formalization, or these two moderators interact with each other. The relative differences in Table XIII-25 are large enough to cause some doubt about the independence of these two moderators. There is a possibility that the relationship between the technology concept and the type of organization is interactive in nature.

The lowest correlations are obtained in service organizations and the largest in mixed samples. Lower correlations are obtained with measures of task routineness, but higher correlations are obtained with measures of information technology.

Centralization

Table XIII-1 indicates that the relationship between technology and centralization may be moderated by the technology concept, the organization type, and the type of measure used. The main effect for the technology concept is .38, that for organization type is .28, and finally the difference between institutional and questionnaire measures is .20. The relative size of these effects suggests that the type of measure may be spurious when compared to the type of organization, and/or the technology concept. The type of organization may also be spurious when compared to the technology concept employed. Tables XIII-26 through XIII-34 address the relationships between these three moderators.

The data in Tables XIII-26 through XIII-28 compare organization type with the type of measure used. Appendix G indicates that for the 56 studies included in these analyses questionnaire measures tend to be used more in service organizations (i.e., r = .49). The differences observed between the corrected mean correlations and the expected correlations in these three tables indicate that these two variables are not spurious when compared to one another (Tables XIII-26 and XIII-27), nor are they orthogonal (Table XIII-28). Visual inspection of the corrected mean correlations in these tables does not reveal any interaction pattern, so the relationship between the type of organization studied and the type of measure used appears to be random (i.e., no relationship can be determined).

Table XIII-29 through Table XIII-31 present the comparisons of the technology concept with the type of organization studied.

Appendix G indicates that workflow continuity measures are used most in manufacturing organizations (i.e., r = .50), while measures of task routineness are used in service organizations (i.e., r = .48). The large differences observed in Tables XIII-29 through XIII-31 suggest that these two moderators are neither spurious when compared to one another nor orthogonal.

The pattern of corrected mean correlations in these tables suggests an interaction between the technology concept and the type of organization studied. Measures of information technology and workflow integration result in negative correlations with centralization, but measures of workflow continuity and task routineness have positive correlations. With the exception of workflow integration, service organizations have stronger correlations than manufacturers regardless of whether the correlation is positive or negative. The correlations for mixed samples are very inconsistent, except that they tend to be negative in sign.

The data in Tables XIII-32 through XIII-34 compare the technology concept to the type of measure used. Recall from Chapter XII that the subcategory dubbed "other measures" includes studies that used the individual organization member as the unit of analysis. Differences between these studies and those included in the "institutional" or "questionnaire" subcategories cannot be attributed to measurement differences; they are level of analysis differences. Appendix G indicates that studies of workflow integration and workflow continuity tend to use institutional measures (i.e., r = .38 and .45, respectively), but studies of task routineness use questionnaire measures (i.e., r = .55).

The small relative differences observed in Table XIII-33 between the corrected mean correlations and the expected correlations suggests that the moderator effect of type of measure is spurious when compared to the technology concepts. Note that for both workflow integration and task routineness there is virtually no difference between the corrected mean correlations for institutional and questionnaire measures, and only institutional measures were found for information technology and workflow continuity.

Summary of Findings

The relationship between technology and centralization is moderated by both the technology concept employed in the study and the type of organization studied. However, these two moderators are not independent. Correlations between task routineness and centralization came primarily from samples of service organizations, but those for workflow integration and workflow continuity are computed on manufacturing samples.

Measures of information technology and workflow integration are negatively correlated with centralization, but measures of workflow continuity and task routineness are positively correlated with centralization. The size of the correlation appears to be stronger in service organizations than in manufacturing organizations regardless of the sign of the correlation. However, the pattern of correlations for mixed samples appears to be random.

The type of measure used in the study is not a moderator of the relationship between technology and centralization. The moderator effect detected in Chapter XII is spurious; confounded by the relationship of the type of measure used to the technology concept.

Supervisor's Span of Control

Table XIII-1 indicates that three moderators were found for the relationship between technology and the supervisor's span of control. They were organization type with a main effect of .32, level of analysis with a main effect of .21, and technology concept with a main effect of .18. The relative sizes of these main effects suggest that the technology concept may be spurious when compared to both organization type and the level of analysis. Level of analysis may also be spurious when compared to organization type. Tables XIII-35 through XIII-43 contain the two-way analyses for these three variables.

Tables XIII-35 through XIII-37 compare the level of analysis to the type of organization studied. Appendix G indicates that subunit level studies tend to be conducted in service organizations (i.e., r = .54). The differences between the observed and the expected correlations presented in these tables suggest that organization type, and level of analysis are not spurious when compared to one another (Tables XIII-35 and XIII-36), nor are they orthogonal (Table XIII-37). The relationship between these two variables is not clear. The main effects for both are confounded by the fact that most of the organization level studies have samples of manufacturing firms (i.e., k = 13 and N = 604), but samples of service organizations dominate the subunit level studies (i.e., k = 4 and N = 1707). Because of the disproportionately large sample sizes in these two cells they have a strong impact on both main effects.

Note in Table XIII-35 that the difference between the corrected mean correlation for the 13 studies of manufacturers at the organization level of analysis (i.e., $\bar{r}c$ = -.10), and the corrected mean correlation for the four subunit level studies of service organizations (i.e., $\bar{r}c$ = .17) is .27. This difference is very nearly the same as the main effect for level of analysis (i.e., .21) as well as the difference between manufacturing and service (i.e., .25).

This suggests that one of these two moderators is spurious when compared to the other. The spurious variable is probably the level of analysis since its main effect is less than the difference between manufacturers and service organizations. The tentative interpretation of these analyses is that level of analysis is spurious when compared to organization type.

Table XIII-38 through XIII-40 compare the level of analysis to the technology concept. Appendix G indicates that studies of workflow integration and workflow continuity tend to be performed at organization level (i.e., r = .68 and r = .60, respectively). The differences (i.e., d's) observed in Tables XIII-38 and XIII-39 are too large relative to the expected correlation to support the hypothesis that either the technology concept or the level of analysis is spurious when compared to the other. Based upon the data in Table XIII-40 these two variables do not appear to be orthogonal either.

The relationship between the technology concept and the level of analysis may be interactive. Examination of the corrected mean correlations (i.e., $\bar{r}c$) in Table XIII-38 reveals that the correlations for the four technology concepts are very similar at the organization level with a range from $\bar{r}c$ = -.09 for workflow continuity to $\bar{r}c$ = -.02 for information technology.

The larger differences between correlations for the four technology concepts occur at the subunit level of analysis. However, it should be noted that the two extreme values at the subunit level of analysis are each from single small-sample studies of workflow continuity, and workflow integration; $\bar{r}c$ = .31 and $\bar{r}c$ = -.18, respectively. Little confidence can be placed in these small sample sizes.

This pattern of correlations suggests that the technology concept may be spurious when compared to the level of analysis. The main effect observed for technology concept is caused by the disproportional distribution of studies between the organization level and the subunit level. Note in Table XIII-38 that the two technology concepts that obtained negative correlations are dominated by samples of organization level studies (i.e., 477 out of 497 for workflow continuity, and 627 out of 688 for workflow integration), but the positive correlation for information technology is based primarily on subunit level samples (i.e., 1,616 out of 2,028).

Tables XIII-41 through XIII-43 address the relationship between the technology concept and the type of organization studied. The results obtained are very similar to those for technology concept and level of analysis. This is not surprising given the confounded relationship between level of analysis and organization type. Tables XIII-41 through XIII-43 reveal that the corrected mean correlation for manufacturing organizations is negative for all four technology concepts. These range from $\bar{r}c$ = -.10 for workflow integration to $\bar{r}c$ = -.03 for task routineness. Service organizations have positive correlations for three of the technology concepts; only workflow integration is negative (i.e., $\bar{r}c$ = -.01).

The main effect for the technology concept is primarily due to the disproportional size of manufacturing and service samples. Note in Table XIII-41 that the negative correlations for workflow continuity and workflow integration are driven by the disproportionately large number of manufacturers (i.e., 491 out of 497, and 496 out of 688, respectively). The positive correlation for information technology is due to the large representation of service organizations (i.e., 1,694 out of 2,028).

This pattern of correlations suggests that the technology concept may be spurious when compared to the type of organization studied.

Summary of Findings

These analyses suggest that the moderator effect of the technology concept may be spurious when compared to both level of analysis, and organization type. Technology concept is not a significant moderator of the relationship between technology and supervisor's span of control.

Tables XIII-35 through XIII-37 indicate that level of analysis and organization type are confounded moderators, but organization type has the larger main effect. Therefore, it appears that level of analysis is spurious when compared to organization type.

Thus, only one moderator of the relationship between technology and supervisor's span of control is found. That moderator is organization type. There is a negative correlation in manufacturing firms, but a positive correlation in service organizations. None of the other four moderators tested have an unique effect on the correlation between technology and supervisor's span of control.

Percentage Direct Workers

Table XIII-1 shows that only three moderator tests could be conducted on the relationship between technology and the percentage of organization personnel engaged in direct labor. Those three were the technology concept, organization size, and organization type. All three tests indicated a moderator effect. The main effects of these three moderators are .54 for organization type, and .29 for both the technology concept and organization size. These effect sizes suggest that technology concept and organization size may be spurious when compared to one another, and both may be spurious when compared to organization type.

Tables XIII-44 through XIII-52 compare the three suspected moderators of the relationship between technology and percentage direct workers. Note the small sample sizes in these tables, and that most of the studies are conducted in small manufacturing firms (i.e., 367 out of 497). This condition provides additional reason to believe that organization size may be spurious when compared to organization type.

Table XIII-44 gives the correlations that would be expected if organization type is spurious when compared to organization size. Note that all of the differences between the expected correlations and the observed correlations are at least as large as the expected correlation. These relatively large differences indicate that organization type is not spurious when compared to organization size.

Table XIII-45 presents the correlations that would be expected if organization size is spurious when compared to organization type. The size of the differences (i.e., d's) are relatively small when compared to the expected correlations. The only exception is the single study of six small service organizations. These results suggest that organization size is spurious when compared to organization type.

The data presented in Table XIII-46 reject the hypothesis that organization size and organization type are orthogonal. The relative differences between the observed correlations and the expected correlations are much larger than those observed in Table XIII-45.

The analyses in Tables XIII-44 through XIII-46 suggest that organization type is not spurious when compared to organization size, and that these two variables are not orthogonal. However, organization size may be spurious when compared to organization type.

Table XIII-47 through Table XIII-49 compare the technology concept to organization size. Both of these variables have a main effect of .29 which suggests that one may be totally spurious when compared to the other. The differences observed in Table XIII-47 indicate that the technology concept is not spurious when compared to organization size. Table XIII-48 does not support the hypothesis that organization size is spurious with the technology concept. Finally, the data in Table XIII-49 argue against an orthogonal relationship between technology concept and organization size.

Examination of the corrected mean correlations in Tables XIII-47 through XIII-49 does not reveal any particular pattern of interaction between these two moderators. The relationship between technology concept and organization size appears to be random (i.e., no relationship can be determined).

Tables XIII-50 through XIII-52 present the comparisons between technology concept and organization type. The main effect for the technology concept is again .29, and that for organization type is .54 which indicates that technology concept could be spurious when compared to organization type.

Table XIII-50 gives the correlations that would be expected if the technology concept is spurious when compared to organization type. The differences (i.e., d's) in this table are relatively small when compared to the expected correlations. The only exception is the cell with a single study of six service organizations. Note that this is the same study that was the exception in Table XIII-45 where it was concluded that organization size may be spurious when compared to organization type. The data presented in Table XIII-50 tend to support the hypothesis that technology concept is spurious when compared to organization type, but there is still room for doubt.

Table XIII-51 does not support the hypothesis that organization type is spurious when compared to the technology concept. The deviation from the correlations that would be expected if this were true is quite large.

The data in Table XIII-52 do not support the hypothesis that the technology concept and organization type are independent moderators of the relationship between technology and percentage direct workers. The relative deviation from the expected pattern of correlations is greater than the deviation observed in Table XIII-50.

The pattern of correlations in Tables XIII-50 through XIII-52 is revealing. Note that for each of the four technology concepts the mean corrected correlations (i.e., $\bar{r}c$) for manufacturing organizations are negative, and those for service organizations are positive. This is consistent with the main effect for organization type.

There is also evidence that technology concept has a moderator effect within the manufacturing column of Tables XIII-50 through XIII-52. The corrected mean correlations in this column range from $\bar{r}c$ = -.28 for workflow continuity to $\bar{r}c$ = -.10 for task routineness. The relative ranking of these mean corrected correlations is the same as the ranking for the mean correlations in the "Total" column. However, the difference between the high and the low correlations for manufacturers is only .18 rather than the .29 for the main effect.

The small sample sizes for the service organizations in Tables XIII-50 through XIII-52 reduce the confidence we can have in these mean correlations, and the absence of any clear pattern among the four corrected mean correlations is not surprising.

These analyses suggest that both organization type and technology concept are moderators of the relationship between technology and percentage direct workers, but they are not additive effects. The larger effect is due to organization type (i.e., .54), but the effect of technology concept is smaller than the .29 obtained for a main effect (e.g., the .18 effect size observed among manufacturers).

Summary of Findings

The analyses conducted in this section suggest that organization type, and the technology concept are both moderators of the relationship between technology and percentage direct workers. The larger moderator effect is approximately .54 for organization type, and the smaller is approximately .29 for the technology concept. However, these moderators are not orthogonal, so the effects are not additive.

The main effect observed for organization size appears to be spurious due to confounding with organization type.

The correlation between technology and percentage direct labor tends to be negative in manufacturing organizations but positive in service organizations. The largest correlations are obtained in studies of workflow continuity, followed by information technology, workflow integration, and finally task routineness.

Percentage Clerical Personnel

Table XIII-1 indicates that three of the moderator analyses resulted in statistically significant differences. Organization type, level of analysis, and type of measure are all suspected to be moderators of the relationship between technology and percentage clerical personnel. The main effects for these three are .32 for the type of measure, .19 for organization type, and .18 for level of analysis. Tables XIII-53 through XIII-61 compare these three variables.

Tables XIII-53 through XIII-55 contain the two-way analyses of organization type and level of analysis. Note the disproportionate distribution of sample sizes in these tables. All subunit level studies were performed in service organizations, and nearly 70 percent of the total sample size for organization level studies used manufacturing samples. These two cells dominate the main effects observed for both organization type and level of analysis. It is not surprising that the main effects for these two variables are nearly identical (i.e., .19 for organization type and .18 for level of analysis). The slightly larger main effect for organization type suggests that level of analysis may be spurious when compared to organization type, but the .01 difference could be due to rounding in which case either could be spurious when compared to the other.

Table XIII-53 gives the correlations expected if the moderator effect of level of analysis is spurious when compared to organization type. The deviation from this expectation is fairly large so it must be concluded that level of analysis is not spurious when compared to organization type.

The data in Table XIII-54 support the hypothesis that the moderator effect of organization type is spurious when compared to the level of analysis. The mean corrected correlations within this table are very similar to those that would be expected if organization type had no effect. The moderator effect of organization type may be spurious due to confounding with the level of analysis.

Table XIII-55 gives the correlations that would be expected if the moderator effects of organization type and level of analysis were additive (i.e., orthogonal). The large deviation from these expected correlations leads to a rejection of that case.

Thus, it appears that the moderator effect of organization type is spurious when compared to the level of analysis.

Tables XIII-56 through XIII-58 compare the type of measure used to organization type. The main effect for type of measure is .32 which is much larger than the .19 for organization type. However, note that the main effect for type of measure is based upon only one questionnaire study of 148 service organizations (Study 56). Nevertheless, the larger main effect for type of measure suggests that the main effect of organization type may be spurious.

The data in Table XIII-56 indicate that the moderator effect of organization type is not spurious when compared to type of measure. Likewise, Table XIII-57 indicates that the type of measure is not spurious when compared to organization type. Thus, neither the type of measure nor the type of organization is a spurious moderator relative to each other.

Table XIII-58 gives the correlations that would be expected if the type of measure used and the organization type were independent moderators and the effect were additive. The observed correlations deviate very little from this expectation suggesting that these two moderators are orthogonal.

The level of analysis is compared with the types of measure in Tables XIII-59 through XIII-61. As before, the main effect for type of measure is .32 and that for level of analysis is .18, thus suggesting that level of analysis may be the spurious moderator.

The data in Tables XIII-59 and XIII-60, respectively, reject the hypotheses that either level of analysis or type of measure is spurious when compared to the other. However, the data in Table XIII-61 indicate that level of analysis may be orthogonal to the type of measure.

The results of the analyses in Tables XIII-59 through XIII-61 are nearly identical to the conclusions reached with Tables XIII-56 through XIII-58. Type of measure appeared to be orthogonal to both organization type and to level of analysis. However, Table XIII-54 revealed that organization type is spurious when compared to level of analysis, so organization type is not a moderator.

This leaves the case portrayed in Table XIII-61; level of analysis and type of measure are orthogonal moderators of the relationship between technology and percentage clerical personnel. Level of analysis has a main effect of .18, and the type of measure has an additional effect of .32. However, as stated before, there is only one questionnaire study so confidence in the main effect of type of measure is not high.

Summary of Findings

The analyses in this section indicate that only two of the five moderators tested have an effect. Those two are the level of analysis, and the type of measure used. Confidence in the moderating effect of the type of measure is reduced because there is only one questionnaire study. By the same token, the larger sample sizes for the two levels of analysis increases the confidence we have in that main effect.

The moderator effect detected for the type of organization studied appears to be spurious due to confounding with the level of analysis.

The results suggest that there is a small negative correlation between technology and percentage clerical personnel at subunit level, but a small positive correlation at organization level. They also suggest that questionnaire measures may yield larger correlations, but this is based upon a single subunit level study.

Conclusion

The analyses in this chapter suggest that there are fewer moderators of the relationship between technology and structure than were indicated by the results of the individual moderator tests. Organization size, and the type of measure used in the study do not appear to be moderators, and level of analysis has a very limited effect. The two major moderators are the type of organization included in the sample, and the technology concept measured.

Organization size appeared as a moderator for only percentage direct workers, and functional specialization. In the case of percentage direct workers this moderator effect was found to be spurious when compared to organization type. For the relationship between technology and functional specialization the moderator effect of organization size was also suspected of being spurious when compared to organization type, but it could also be orthogonal. However, given the finding that organization size is not a moderator in 12 of the 13 relationships tested, and the finding that the moderator effect observed for functional specialization could be spurious when compared to organization type, the conclusion to be drawn in this analysis is that organization size does not moderate the relationship between technology and functional specialization. It may therefore be stated that when organization size is dichotomized into small and large subcategories, where small organizations are those with less than 1,000 members, no moderator effect is detected in the relationship between technology and organization structure.

The type of measure used appeared to have a significant main effect in the relationship between technology and three structural variables: division of labor, centralization, and percentage clerical personnel. This moderator effect was found to be spurious for both division of labor and centralization when compared to the technology concept. In the case of percentage clerical personnel there is only one questionnaire study. Therefore, a moderator effect is found for the type of measure used in only one of the nine relationships where a test could be performed, and that effect is based upon a single questionnaire study. The combined evidence from all of these analyses suggests that type of measure is not a moderator, and the results obtained for percentage clerical personnel should be viewed with skepticism.

The level of analysis appeared as a moderator of the relationship between technology and structure in four cases: supervisor's span of control, division of labor, overall formalization, and percentage clerical personnel. In the case of supervisor's span of control this moderator effect was found to be spurious when compared to organization type. For the other three relationships the relative size of the correlations for the different levels of analysis was not in the predicted direction (i.e., subunit correlations should be larger than organization level correlations). Only division of labor had a main effect that met this criterion, but there appears to be an interaction with the four technology concepts (Table XIII-5 through Table XIII-7). For overall formalization the moderator effect is not between subunit level studies and organization level studies, but between these two and individual level studies.

The inconsistency in the relative size of the correlations for different levels of analysis, and the failure to observe a moderator effect more frequently for level of analysis not only reduces the importance of level of analysis as a theoretical moderator of the relationship between technology and structure, but it also gives reason to doubt the validity of the three cases where it was retained as a moderator.

Technology concept is retained as a moderator of 8 of 13 relationships tested. These are functional specialization, role formalization, centralization, percentage direct workers, division of labor, overall formalization, standardization, and percentage workflow planning and control.

Organization type is a moderator in 7 of 13 relationships. Four of these 7 are also moderated by the technology concept: functional specialization, role formalization, centralization, and percentage direct workers. The other 3 are supervisor's span of control, percentage supervisors, and percentage administration.

The next chapter will contain a summary of the conclusions reached as a result of the analyses in Chapter VI through Chapter XIII.

Table XIII-1. Summary of Moderator Tests

Structural Variable	Chp. VIII Technology Concept		Chp. IX Organization Size		Chp. X Organization Type		Chp. XI Level of Analysis		Chp. XII Type of Measure	
Division of Labor	S[a]	D	N	U	N	D	S	D	S	D
Functional Specialization	S[a]	I	S	D	S	D	N	U	S	U
Overall Formalization	S[a]	I	N	D	N	D	S	D	S[b]	D
Role formalization	S	I	N	U	S	D	N	D	N	D
Centralization	S[a]	D	N	D	S	D	N	D	S	D
Supervisor's Span of Control	S	I	N	D	S	D	S	D	N	U
% Direct Workers	S	D	S	D	S	D	n.a.		n.a.	
% Clerical Personnel	N	I	N	D	S	D	S	D	S	D
Standardization	S	I	N	D	N	D	N	U	N	D
% Workflow Planning and Control	S[a]	I	N	I	N	I	n.a.		n.a.	
% Supervisors	N	D	N	D	S	D	N	D	n.a.	
% Administration	N	D	N	D	S	D	n.a.		n.a.	
Vertical Span	N	I	N	D	N	D	N	U	S	U

Note. S = Statistically significant difference observed;
N = No statistically significant difference observed;
D = Mean residual variance decreased;
I = Mean residual variance increased;
U = Mean residual variance unchanged.

[a]Statistically significant when the Bonferroni inequalities method is applied to multiple comparisons.

[b]Significant difference is due to individual level studies.

Table XIII-2. Division of Labor: Type of Measure with Level of Analysis -- Level of Analysis Spurious

	Organization	Subunit	Total
Questionnaire	k = 3	k = 6	k = 9
	N = 183	N = 291	N = 474
	$\bar{r}c$ = -.05	$\bar{r}c$ = .20	$\bar{r}c$ = .10
	$\bar{r}e$ = -.05	$\bar{r}e$ = -.05	
	d =	d = .25	
Institutional	k = 16	k = 2	k = 18
	N = 831	N = 1496	N = 2327
	$\bar{r}c$ = .34	$\bar{r}c$ = .54	$\bar{r}c$ = .47
	$\bar{r}e$ = .32	$\bar{r}e$ = .32	
	d = .02	d = .22	
Total	k = 18	k = 8	k = 26
	N = 939	N = 1787	N = 2726
	$\bar{r}c$ = .30	$\bar{r}c$ = .48	$\bar{r}c$ = .42

Table XIII-3. Division of Labor: Type of Measure with Level of Analysis -- Type of Measure Spurious

	Organization	Subunit	Total
Questionnaire	k = 3	k = 6	k = 9
	N = 183	N = 291	N = 474
	$\bar{r}c$ = -.05	$\bar{r}c$ = .20	$\bar{r}c$ = .10
	$\bar{r}e$ = -.05	$\bar{r}e$ = .13	
	d =	d = .07	
Institutional	k = 16	k = 2	k = 18
	N = 831	N = 1496	N = 2327
	$\bar{r}c$ = .34	$\bar{r}c$ = .54	$\bar{r}c$ = .47
	$\bar{r}e$ = -.05	$\bar{r}e$ = .13	
	d = .39	d = .41	
Total	k = 18	k = 8	k = 26
	N = 939	N = 1787	N = 2726
	$\bar{r}c$ = .30	$\bar{r}c$ = .48	$\bar{r}c$ = .42

Table XIII-4. Division of Labor: Type of Measure with Level of Analysis -- Both Independent

	Organization	Subunit	Total
Questionnaire	k = 3 N = 183 $\bar{r}c$ = -.05 $\bar{r}e$ = -.05 d =	k = 6 N = 291 $\bar{r}c$ = .20 $\bar{r}e$ = .13 d = .07	k = 9 N = 474 $\bar{r}c$ = .10
Institutional	k = 16 N = 831 $\bar{r}c$ = .34 $\bar{r}e$ = .32 d = .02	k = 2 N = 1496 $\bar{r}c$ = .54 $\bar{r}e$ = .50 d = .04	k = 18 N = 2327 $\bar{r}c$ = .47
Total	k = 18 N = 939 $\bar{r}c$ = .30	k = 8 N = 1787 $\bar{r}c$ = .48	k = 26 N = 2726 $\bar{r}c$ = .42

Table XIII-5. Division of Labor: Level of Analysis with Technology Concept -- Technology Concept Spurious

	Organization	Subunit	Total
Workflow Continuity	k = 5 N = 122 $\bar{r}c$ = .09 $\bar{r}e$ = .09 d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 5 N = 122 $\bar{r}c$ = .09
Task Routineness	k = 11 N = 582 $\bar{r}c$ = .10 $\bar{r}e$ = .09 d = .01	k = 5 N = 251 $\bar{r}c$ = .26 $\bar{r}e$ = .27 d = -.01	k = 16 N = 833 $\bar{r}c$ = .15
Workflow Integration	k = 9 N = 501 $\bar{r}c$ = .42 $\bar{r}e$ = .09 d = .33	k = 2 N = 101 $\bar{r}c$ = -.04 $\bar{r}e$ = .27 d = -.31	k = 11 N = 602 $\bar{r}c$ = .34
Information Technology	k = 4 N = 263 $\bar{r}c$ = .54 $\bar{r}e$ = .09 d = .45	k = 2 N = 1496 $\bar{r}c$ = .45 $\bar{r}e$ = .27 d = .18	k = 6 N = 1759 $\bar{r}c$ = .46
Total	k = 18 N = 939 $\bar{r}c$ = .30	k = 8 N = 1787 $\bar{r}c$ = .48	k = 26 N = 2726 $\bar{r}c$ = .42

Table XIII-6. Division of Labor: Level of Analysis with Technology Concept -- Level of Analysis Spurious

	Organization	Subunit	Total
Workflow Continuity	k = 5	k =	k = 5
	N = 122	N = NONE	N = 122
	$\bar{r}$c = .09	$\bar{r}$c =	$\bar{r}$c = .09
	$\bar{r}$e = .09	$\bar{r}$e =	
	d =	d =	
Task Routineness	k = 11	k = 5	k = 16
	N = 582	N = 251	N = 833
	$\bar{r}$c = .10	$\bar{r}$c = .26	$\bar{r}$c = .15
	$\bar{r}$e = .15	$\bar{r}$e = .15	
	d = -.05	d = .11	
Workflow Integration	k = 9	k = 2	k = 11
	N = 501	N = 101	N = 602
	$\bar{r}$c = .42	$\bar{r}$c = -.04	$\bar{r}$c = .34
	$\bar{r}$e = .24	$\bar{r}$e = .24	
	d = .18	d = -.28	
Information Technology	k = 4	k = 2	k = 6
	N = 263	N = 1496	N = 1759
	$\bar{r}$c = .54	$\bar{r}$c = .45	$\bar{r}$c = .46
	$\bar{r}$e = .36	$\bar{r}$e = .36	
	d = .18	d = .09	
Total	k = 18	k = 8	k = 26
	N = 939	N = 1787	N = 2726
	$\bar{r}$c = .30	$\bar{r}$c = .48	$\bar{r}$c = .42

Table XIII-7. Division of Labor: Level of Analysis with Technology Concept -- Both Independent

	Organization	Subunit	Total
Workflow Continuity	k = 5	k =	k = 5
	N = 122	N = NONE	N = 122
	$\bar{r}c$ = .09	$\bar{r}c$ =	$\bar{r}c$ = .09
	$\bar{r}e$ = .09	$\bar{r}e$ =	
	d = 0	d =	
Task Routineness	k = 11	k = 5	k = 16
	N = 582	N = 251	N = 833
	$\bar{r}c$ = .10	$\bar{r}c$ = .26	$\bar{r}c$ = .15
	$\bar{r}e$ = .15	$\bar{r}e$ = .33	
	d = -.05	d = -.07	
Workflow Integration	k = 9	k = 2	k = 11
	N = 501	N = 101	N = 602
	$\bar{r}c$ = .42	$\bar{r}c$ = -.04	$\bar{r}c$ = .34
	$\bar{r}e$ = .34	$\bar{r}e$ = .52	
	d = .08	d = -.56	
Information Technology	k = 4	k = 2	k = 6
	N = 263	N = 1496	N = 1759
	$\bar{r}c$ = .54	$\bar{r}c$ = .45	$\bar{r}c$ = .46
	$\bar{r}e$ = .46	$\bar{r}e$ = .64	
	d = .08	d = -.19	
Total	k = 18	k = 8	k = 26
	N = 939	N = 1787	N = 2726
	$\bar{r}c$ = .30	$\bar{r}c$ = .48	$\bar{r}c$ = .42

Table XIII-8. Division of Labor: Type of Measure with Technology Concept -- Technology Concept Spurious

	Questionnaire	Institutional	Total
Workflow Continuity	k =	k = 5	k = 5
	N = NONE	N = 122	N = 122
	$\bar{r}c$ =	$\bar{r}c$ = .09	$\bar{r}c$ = .09
	$\bar{r}e$ =	$\bar{r}e$ = .09	
	d =	d =	
Task Routineness	k = 8	k = 8	k = 16
	N = 434	N = 399	N = 833
	$\bar{r}c$ = .13	$\bar{r}c$ = .16	$\bar{r}c$ = .15
	$\bar{r}e$ = -.28	$\bar{r}e$ = .09	
	d = .41	d = .07	
Workflow Integration	k = 2	k = 9	k = 11
	N = 101	N = 501	N = 602
	$\bar{r}c$ = -.04	$\bar{r}c$ = .42	$\bar{r}c$ = .34
	$\bar{r}e$ = -.28	$\bar{r}e$ = .09	
	d = .24	d = .33	
Information Technology	k =	k = 6	k = 6
	N = NONE	N = 1759	N = 1759
	$\bar{r}c$ =	$\bar{r}c$ = .46	$\bar{r}c$ = .46
	$\bar{r}e$ =	$\bar{r}e$ = .09	
	d =	d = .37	
Total	k = 9	k = 18	k = 26
	N = 474	N = 2327	N = 2726
	$\bar{r}c$ = .10	$\bar{r}c$ = .47	$\bar{r}c$ = .42

Table XIII-9. Division of Labor: Type of Measure with Technology Concept -- Type of Measure Spurious

	Questionnaire	Institutional	Total
Workflow Continuity	k =	k = 5	k = 5
	N = NONE	N = 122	N = 122
	$\bar{r}c$ =	$\bar{r}c$ = .09	$\bar{r}c$ = .09
	$\bar{r}e$ =	$\bar{r}e$ = .09	
	d =	d =	
Task Routineness	k = 8	k = 8	k = 16
	N = 434	N = 399	N = 833
	$\bar{r}c$ = .13	$\bar{r}c$ = .16	$\bar{r}c$ = .15
	$\bar{r}e$ = .15	$\bar{r}e$ = .15	
	d = -.02	d = .01	
Workflow Integration	k = 2	k = 9	k = 11
	N = 101	N = 501	N = 602
	$\bar{r}c$ = -.04	$\bar{r}c$ = .42	$\bar{r}c$ = .34
	$\bar{r}e$ = .34	$\bar{r}e$ = .34	
	d = -.38	d = .08	
Information Technology	k =	k = 6	k = 6
	N = NONE	N = 1759	N = 1759
	$\bar{r}c$ =	$\bar{r}c$ = .46	$\bar{r}c$ = .46
	$\bar{r}e$ =	$\bar{r}e$ = .34	
	d =	d = .12	
Total	k = 9	k = 18	k = 26
	N = 474	N = 2327	N = 2726
	$\bar{r}c$ = .10	$\bar{r}c$ = .47	$\bar{r}c$ = .42

Table XIII-10. Division of Labor: Type of Measure with Technology Concept -- Both Independent

	Questionnaire	Institutional	Total
Workflow Continuity	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 5 N = 122 $\bar{r}c$ = .09 $\bar{r}e$ = .09 d =	k = 5 N = 122 $\bar{r}c$ = .09
Task Routineness	k = 8 N = 434 $\bar{r}c$ = .13 $\bar{r}e$ = -.22 d = .35	k = 8 N = 399 $\bar{r}c$ = .16 $\bar{r}e$ = .15 d = .01	k = 16 N = 833 $\bar{r}c$ = .15
Workflow Integration	k = 2 N = 101 $\bar{r}c$ = -.04 $\bar{r}e$ = -.03 d = -.01	k = 9 N = 501 $\bar{r}c$ = .42 $\bar{r}e$ = .34 d = .08	k = 11 N = 602 $\bar{r}c$ = .34
Information Technology	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 6 N = 1759 $\bar{r}c$ = .46 $\bar{r}e$ = .46 d =	k = 6 N = 1759 $\bar{r}c$ = .46
Total	k = 9 N = 474 $\bar{r}c$ = .10	k = 18 N = 2327 $\bar{r}c$ = .47	k = 26 N = 2726 $\bar{r}c$ = .42

Table XIII-11. Functional Specialization: Organization Size with Organization Type -- Organization Size Spurious

	Service	Mixed	Manufacturing	Total
Unknown Size	k = 2 N = 143 $\bar{r}c$ = .17 $\bar{r}e$ = .31 d = -.14	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 2 N = 143 $\bar{r}c$ = .17
Small	k = 7 N = 713 $\bar{r}c$ = .28 $\bar{r}e$ = .31 d = -.03	k = 5 N = 350 $\bar{r}c$ = .23 $\bar{r}e$ = .32 d = -.09	k = 15 N = 670 $\bar{r}c$ = .42 $\bar{r}e$ = .50 d = -.08	k = 27 N = 1733 $\bar{r}c$ = .32
Large	k = 5 N = 148 $\bar{r}c$ = .19 $\bar{r}e$ = .31 d = -.12	k = 1 N = 31 $\bar{r}c$ = .72 $\bar{r}e$ = .32 d = .40	k = 12 N = 330 $\bar{r}c$ = .50 $\bar{r}e$ = .50 d =	k = 15 N = 502 $\bar{r}c$ = .45
Total	k = 14 N = 1004 $\bar{r}c$ = .25	k = 6 N = 381 $\bar{r}c$ = .26	k = 27 N = 1000 $\bar{r}c$ = .44	k = 44 N = 2378 $\bar{r}c$ = .34

Table XIII-12. Functional Specialization: Organization Size with Organization Type -- Organization Type Spurious

	Service	Mixed	Manufacturing	Total
Unknown Size	k = 2 N = 143 $\bar{r}c$ = .17 $\bar{r}e$ = .22 d = -.05	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 2 N = 143 $\bar{r}c$ = .17
Small	k = 7 N = 713 $\bar{r}c$ = .28 $\bar{r}e$ = .37 d = -.09	k = 5 N = 350 $\bar{r}c$ = .23 $\bar{r}e$ = .37 d = -.14	k = 15 N = 670 $\bar{r}c$ = .42 $\bar{r}e$ = .37 d = .05	k = 27 N = 1733 $\bar{r}c$ = .32
Large	k = 5 N = 148 $\bar{r}c$ = .19 $\bar{r}e$ = .50 d = -.31	k = 1 N = 31 $\bar{r}c$ = .72 $\bar{r}e$ = .50 d = .22	k = 12 N = 330 $\bar{r}c$ = .50 $\bar{r}e$ = .50 d =	k = 15 N = 502 $\bar{r}c$ = .45
Total	k = 14 N = 1004 $\bar{r}c$ = .25	k = 6 N = 381 $\bar{r}c$ = .26	k = 27 N = 1000 $\bar{r}c$ = .44	k = 44 N = 2378 $\bar{r}c$ = .34

Table XIII-13. Functional Specialization: Organization Size with Organization Type -- Both Independent

	Service	Mixed	Manufacturing	Total
Unknown Size	k = 2 N = 143 $\bar{r}c$ = .17 $\bar{r}e$ = .04 d = .13	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 2 N = 143 $\bar{r}c$ = .17
Small	k = 7 N = 713 $\bar{r}c$ = .28 $\bar{r}e$ = .19 d = .09	k = 5 N = 350 $\bar{r}c$ = .23 $\bar{r}e$ = .20 d = .03	k = 15 N = 670 $\bar{r}c$ = .42 $\bar{r}e$ = .38 d = .04	k = 27 N = 1733 $\bar{r}c$ = .32
Large	k = 5 N = 148 $\bar{r}c$ = .19 $\bar{r}e$ = .31 d = -.12	k = 1 N = 31 $\bar{r}c$ = .72 $\bar{r}e$ = .32 d = .40	k = 12 N = 330 $\bar{r}c$ = .50 $\bar{r}e$ = .50 d =	k = 15 N = 502 $\bar{r}c$ = .45
Total	k = 14 N = 1004 $\bar{r}c$ = .25	k = 6 N = 381 $\bar{r}c$ = .26	k = 27 N = 1000 $\bar{r}c$ = .44	k = 44 N = 2378 $\bar{r}c$ = .34

Table XIII-14. Functional Specialization: Technology Concept with Organization Size -- Technology Concept Spurious

	Unknown Size	Small	Large	Total
Task Routineness	k = 2 N = 143 $\bar{r}c$ = .15 $\bar{r}e$ = .23 d = -.08	k = 8 N = 295 $\bar{r}c$ = -.05 $\bar{r}e$ = .38 d = -.43	k = 8 N = 251 $\bar{r}c$ = .14 $\bar{r}e$ = .51 d = -.37	k = 18 N = 689 $\bar{r}c$ = .06
Workflow Continuity	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 11 N = 424 $\bar{r}c$ = .19 $\bar{r}e$ = .38 d = -.19	k = 5 N = 135 $\bar{r}c$ = .15 $\bar{r}e$ = .51 d = -.36	k = 16 N = 559 $\bar{r}c$ = .18
Workflow Integration	k = 1 N = 27 $\bar{r}c$ = .01 $\bar{r}e$ = .23 d = -.22	k = 18 N = 949 $\bar{r}c$ = .22 $\bar{r}e$ = .38 d = -.16	k = 13 N = 425 $\bar{r}c$ = .57 $\bar{r}e$ = .51 d = .06	k = 32 N = 1401 $\bar{r}c$ = .32
Information Technology	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 10 N = 1086 $\bar{r}c$ = .46 $\bar{r}e$ = .38 d = .08	k = 5 N = 250 $\bar{r}c$ = .51 $\bar{r}e$ = .51 d =	k = 15 N = 1336 $\bar{r}c$ = .47
Total	k = 2 N = 143 $\bar{r}c$ = .17	k = 27 N = 1733 $\bar{r}c$ = .32	k = 15 N = 502 $\bar{r}c$ = .45	k = 44 N = 2378 $\bar{r}c$ = .34

Table XIII-15. Functional Specialization: Technology Concept with Organization Size -- Organization Size Spurious

	Unknown Size	Small	Large	Total
Task Routineness	k = 2 N = 143 $\bar{r}c$ = .15 $\bar{r}e$ = .10 d = .05	k = 8 N = 295 $\bar{r}c$ = -.05 $\bar{r}e$ = .10 d = -.15	k = 8 N = 251 $\bar{r}c$ = .14 $\bar{r}e$ = .10 d = .04	k = 18 N = 689 $\bar{r}c$ = .06
Workflow Continuity	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 11 N = 424 $\bar{r}c$ = .19 $\bar{r}e$ = .22 d = -.03	k = 5 N = 135 $\bar{r}c$ = .15 $\bar{r}e$ = .22 d = -.07	k = 16 N = 559 $\bar{r}c$ = .18
Workflow Integration	k = 1 N = 27 $\bar{r}c$ = .01 $\bar{r}e$ = .36 d = -.35	k = 18 N = 949 $\bar{r}c$ = .22 $\bar{r}e$ = .36 d = -.14	k = 13 N = 425 $\bar{r}c$ = .57 $\bar{r}e$ = .36 d = .21	k = 32 N = 1401 $\bar{r}c$ = .32
Information Technology	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 10 N = 1086 $\bar{r}c$ = .46 $\bar{r}e$ = .51 d = -.05	k = 5 N = 250 $\bar{r}c$ = .51 $\bar{r}e$ = .51 d =	k = 15 N = 1336 $\bar{r}c$ = .47
Total	k = 2 N = 143 $\bar{r}c$ = .17	k = 27 N = 1733 $\bar{r}c$ = .32	k = 15 N = 502 $\bar{r}c$ = .45	k = 44 N = 2378 $\bar{r}c$ = .34

Table XIII-16. Functional Specialization: Technology Concept with Organization Size -- Both Independent

	Unknown Size	Small	Large	Total
Task Routineness	k = 2	k = 8	k = 8	k = 18
	N = 143	N = 295	N = 251	N = 689
	r̄c = .15	r̄c = -.05	r̄c = .14	r̄c = .06
	r̄e = -.17	r̄e = -.02	r̄e = .10	
	d = .32	d = .03	d = .04	
Workflow Continuity	k =	k = 11	k = 5	k = 16
	N = NONE	N = 424	N = 135	N = 559
	r̄c =	r̄c = .19	r̄c = .15	r̄c = .18
	r̄e =	r̄e = .10	r̄e = .22	
	d =	d = .09	d = -.07	
Workflow Integration	k = 1	k = 18	k = 13	k = 32
	N = 27	N = 949	N = 425	N = 1401
	r̄c = .01	r̄c = .22	r̄c = .57	r̄c = .32
	r̄e = .09	r̄e = .24	r̄e = .36	
	d = -.08	d = -.02	d = .21	
Information Technology	k =	k = 10	k = 5	k = 15
	N = NONE	N = 1086	N = 250	N = 1336
	r̄c =	r̄c = .46	r̄c = .51	r̄c = .47
	r̄e =	r̄e = .39	r̄e = .51	
	d =	d = .07	d =	
Total	k = 2	k = 27	k = 15	k = 44
	N = 143	N = 1733	N = 502	N = 2378
	r̄c = .17	r̄c = .32	r̄c = .45	r̄c = .34

Table XIII-17. Functional Specialization: Technology Concept with Organization Type -- Technology Concept Spurious

	Service	Mixed	Manufacturing	Total
Task Routineness	k = 9 N = 375 $\bar{r}c$ = -.02 $\bar{r}e$ = -.02 d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 12 N = 314 $\bar{r}c$ = .15 $\bar{r}e$ = .17 d = -.02	k = 18 N = 689 $\bar{r}c$ = .06
Workflow Continuity	k = 1 N = 6 $\bar{r}c$ = .21 $\bar{r}e$ = -.02 d = .23	k = 1 N = 93 $\bar{r}c$ = .23 $\bar{r}e$ = -.01 d = .24	k = 14 N = 460 $\bar{r}c$ = .17 $\bar{r}e$ = .17 d =	k = 16 N = 559 $\bar{r}c$ = .18
Workflow Integration	k = 8 N = 255 $\bar{r}c$ = .21 $\bar{r}e$ = -.02 d = .23	k = 5 N = 288 $\bar{r}c$ = .17 $\bar{r}e$ = -.01 d = .18	k = 22 N = 842 $\bar{r}c$ = .36 $\bar{r}e$ = .17 d = .19	k = 32 N = 1401 $\bar{r}c$ = .32
Information Technology	k = 4 N = 611 $\bar{r}c$ = .38 $\bar{r}e$ = -.02 d = .40	k = 3 N = 189 $\bar{r}c$ = .37 $\bar{r}e$ = -.01 d = .38	k = 9 N = 536 $\bar{r}c$ = .63 $\bar{r}e$ = .17 d = .46	k = 15 N = 1336 $\bar{r}c$ = .47
Total	k = 14 N = 1004 $\bar{r}c$ = .25	k = 6 N = 381 $\bar{r}c$ = .26	k = 27 N = 1000 $\bar{r}c$ = .44	k = 44 N = 2378 $\bar{r}c$ = .34

Table XIII-18. Functional Specialization: Technology Concept with Organization Type -- Organization Type Spurious

	Service	Mixed	Manufacturing	Total
Task Routineness	k = 9 N = 375 $\bar{r}$c = -.02 $\bar{r}$e = -.02 d =	k = N = NONE $\bar{r}$c = $\bar{r}$e = d =	k = 12 N = 314 $\bar{r}$c = .15 $\bar{r}$e = -.02 d = .17	k = 18 N = 689 $\bar{r}$c = .06
Workflow Continuity	k = 1 N = 6 $\bar{r}$c = .21 $\bar{r}$e = .10 d = .11	k = 1 N = 93 $\bar{r}$c = .23 $\bar{r}$e = .10 d = .13	k = 14 N = 460 $\bar{r}$c = .17 $\bar{r}$e = .10 d = .07	k = 16 N = 559 $\bar{r}$c = .18
Workflow Integration	k = 8 N = 255 $\bar{r}$c = .21 $\bar{r}$e = .24 d = -.03	k = 5 N = 288 $\bar{r}$c = .17 $\bar{r}$e = .24 d = -.07	k = 22 N = 842 $\bar{r}$c = .36 $\bar{r}$e = .24 d = .12	k = 32 N = 1401 $\bar{r}$c = .32
Information Technology	k = 4 N = 611 $\bar{r}$c = .38 $\bar{r}$e = .39 d = -.01	k = 3 N = 189 $\bar{r}$c = .37 $\bar{r}$e = .39 d = -.02	k = 9 N = 536 $\bar{r}$c = .63 $\bar{r}$e = .39 d = .24	k = 15 N = 1336 $\bar{r}$c = .47
Total	k = 14 N = 1004 $\bar{r}$c = .25	k = 6 N = 381 $\bar{r}$c = .26	k = 27 N = 1000 $\bar{r}$c = .44	k = 44 N = 2378 $\bar{r}$c = .34

Table XIII-19. Functional Specialization: Technology Concept with Organization Type -- Both Independent

	Service	Mixed	Manufacturing	Total
Task Routineness	k = 9 N = 375 $\bar{r}c$ = -.02 $\bar{r}e$ = -.02 d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 12 N = 314 $\bar{r}c$ = .15 $\bar{r}e$ = .17 d = -.02	k = 18 N = 689 $\bar{r}c$ = .06
Workflow Continuity	k = 1 N = 6 $\bar{r}c$ = .21 $\bar{r}e$ = .10 d = .11	k = 1 N = 93 $\bar{r}c$ = .23 $\bar{r}e$ = .11 d = .12	k = 14 N = 460 $\bar{r}c$ = .17 $\bar{r}e$ = .29 d = -.12	k = 16 N = 559 $\bar{r}c$ = .18
Workflow Integration	k = 8 N = 255 $\bar{r}c$ = .21 $\bar{r}e$ = .24 d = -.03	k = 5 N = 288 $\bar{r}c$ = .17 $\bar{r}e$ = .25 d = -.08	k = 22 N = 842 $\bar{r}c$ = .36 $\bar{r}e$ = .43 d = -.07	k = 32 N = 1401 $\bar{r}c$ = .32
Information Technology	k = 4 N = 611 $\bar{r}c$ = .38 $\bar{r}e$ = .39 d = -.01	k = 3 N = 189 $\bar{r}c$ = .37 $\bar{r}e$ = .40 d = -.03	k = 9 N = 536 $\bar{r}c$ = .63 $\bar{r}e$ = .58 d = .05	k = 15 N = 1336 $\bar{r}c$ = .47
Total	k = 14 N = 1004 $\bar{r}c$ = .25	k = 6 N = 381 $\bar{r}c$ = .26	k = 27 N = 1000 $\bar{r}c$ = .44	k = 44 N = 2378 $\bar{r}c$ = .34

Table XIII-20. Overall Formalization: Technology Concept with Level of Analysis -- Technology Concept Spurious

	Individual	Subunit	Organization	Total
Workflow Integration	k = 2 N = 329 $\bar{r}c$ = .03 $\bar{r}e$ = .11 d = -.08	k = 5 N = 539 $\bar{r}c$ = -.05 $\bar{r}e$ = .39 d = -.44	k = 18 N = 936 $\bar{r}c$ = .34 $\bar{r}e$ = .44 d = -.10	k = 25 N = 1804 $\bar{r}c$ = .17
Workflow Continuity	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 16 N = 628 $\bar{r}c$ = .21 $\bar{r}e$ = .44 d = -.23	k = 16 N = 628 $\bar{r}c$ = .21
Task Routineness	k = 1 N = 174 $\bar{r}c$ = .03 $\bar{r}e$ = .11 d = -.08	k = 7 N = 341 $\bar{r}c$ = .40 $\bar{r}e$ = .39 d = .01	k = 15 N = 715 $\bar{r}c$ = .18 $\bar{r}e$ = .44 d = -.26	k = 23 N = 1233 $\bar{r}c$ = .22
Information Technology	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 1 N = 400 $\bar{r}c$ = .36 $\bar{r}e$ = .39 d = -.03	k = 8 N = 538 $\bar{r}c$ = .44 $\bar{r}e$ = .44 d =	k = 9 N = 938 $\bar{r}c$ = .41
Total	k = 2 N = 329 $\bar{r}c$ = -.02	k = 10 N = 995 $\bar{r}c$ = .26	k = 31 N = 1529 $\bar{r}c$ = .31	k = 43 N = 2853 $\bar{r}c$ = .25

Table XIII-21. Overall Formalization: Technology Concept with Level of Analysis -- Level of Analysis Spurious

	Individual	Subunit	Organization	Total
Workflow Integration	k = 2 N = 329 $\bar{r}c$ = .03 $\bar{r}e$ = .20 d = -.17	k = 5 N = 539 $\bar{r}c$ = -.05 $\bar{r}e$ = .20 d = -.25	k = 18 N = 936 $\bar{r}c$ = .34 $\bar{r}e$ = .20 d = .14	k = 25 N = 1804 $\bar{r}c$ = .17
Workflow Continuity	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 16 N = 628 $\bar{r}c$ = .21 $\bar{r}e$ = .24 d = -.03	k = 16 N = 628 $\bar{r}c$ = .21
Task Routineness	k = 1 N = 174 $\bar{r}c$ = .03 $\bar{r}e$ = .25 d = -.22	k = 7 N = 341 $\bar{r}c$ = .40 $\bar{r}e$ = .25 d = .15	k = 15 N = 715 $\bar{r}c$ = .18 $\bar{r}e$ = .25 d = -.07	k = 23 N = 1233 $\bar{r}c$ = .22
Information Technology	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 1 N = 400 $\bar{r}c$ = .36 $\bar{r}e$ = .44 d = -.08	k = 8 N = 538 $\bar{r}c$ = .44 $\bar{r}e$ = .44 d =	k = 9 N = 938 $\bar{r}c$ = .41
Total	k = 2 N = 329 $\bar{r}c$ = -.02	k = 10 N = 995 $\bar{r}c$ = .26	k = 31 N = 1529 $\bar{r}c$ = .31	k = 43 N = 2853 $\bar{r}c$ = .25

Table XIII-22. Overall Formalization: Technology Concept with Level of Analysis -- Both Independent

	Individual	Subunit	Organization	Total
Workflow Integration	k = 2 N = 329 $\bar{r}c$ = .03 $\bar{r}e$ = -.13 d = .16	k = 5 N = 539 $\bar{r}c$ = -.05 $\bar{r}e$ = .15 d = -.20	k = 18 N = 936 $\bar{r}c$ = .34 $\bar{r}e$ = .20 d = .14	k = 25 N = 1804 $\bar{r}c$ = .17
Workflow Continuity	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 16 N = 628 $\bar{r}c$ = .21 $\bar{r}e$ = .24 d = -.03	k = 16 N = 628 $\bar{r}c$ = .21
Task Routineness	k = 1 N = 174 $\bar{r}c$ = .03 $\bar{r}e$ = -.08 d = .11	k = 7 N = 341 $\bar{r}c$ = .40 $\bar{r}e$ = .20 d = .20	k = 15 N = 715 $\bar{r}c$ = .18 $\bar{r}e$ = .25 d = -.07	k = 23 N = 1233 $\bar{r}c$ = .22
Information Technology	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 1 N = 400 $\bar{r}c$ = .36 $\bar{r}e$ = .39 d = -.03	k = 8 N = 538 $\bar{r}c$ = .44 $\bar{r}e$ = .44 d =	k = 9 N = 938 $\bar{r}c$ = .41
Total	k = 2 N = 329 $\bar{r}c$ = -.02	k = 10 N = 995 $\bar{r}c$ = .26	k = 31 N = 1529 $\bar{r}c$ = .31	k = 43 N = 2853 $\bar{r}c$ = .25

Table XIII-23. Role Formalization: Technology Concept with Organization Type -- Technology Concept Spurious

	Service	Manufacturing	Mixed	Total
Task Routineness	k = 5	k = 14	k =	k = 16
	N = 216	N = 385	N = NONE	N = 601
	$\bar{r}c$ = .05	$\bar{r}c$ = .21	$\bar{r}c$ =	$\bar{r}c$ = .16
	$\bar{r}e$ = .05	$\bar{r}e$ = .14	$\bar{r}e$ =	
	d =	d = .07	d =	
Workflow Continuity	k =	k = 3	k =	k = 3
	N = NONE	N = 52	N = NONE	N = 52
	$\bar{r}c$ =	$\bar{r}c$ = .25	$\bar{r}c$ =	$\bar{r}c$ = .25
	$\bar{r}e$ =	$\bar{r}e$ = .14	$\bar{r}e$ =	
	d =	d = .11	d =	
Workflow Integration	k = 5	k = 15	k = 3	k = 20
	N = 74	N = 463	N = 181	N = 719
	$\bar{r}c$ = .44	$\bar{r}c$ = .31	$\bar{r}c$ = .55	$\bar{r}c$ = .40
	$\bar{r}e$ = .05	$\bar{r}e$ = .14	$\bar{r}e$ = .37	
	d = .39	d = .17	d = .18	
Information Technology	k = 1	k = 1	k =	k = 2
	N = 51	N = 20	N = NONE	N = 71
	$\bar{r}c$ = .48	$\bar{r}c$ = .47	$\bar{r}c$ =	$\bar{r}c$ = .41
	$\bar{r}e$ = .05	$\bar{r}e$ = .14	$\bar{r}e$ =	
	d = .43	d = .33	d =	
Total	k = 7	k = 18	k = 3	k = 25
	N = 273	N = 558	N = 181	N = 1013
	$\bar{r}c$ = .23	$\bar{r}c$ = .32	$\bar{r}c$ = .55	$\bar{r}c$ = .33

Table XIII-24. Role Formalization: Technology Concept with Organization Type -- Organization Type Spurious

	Service	Manufacturing	Mixed	Total
Task Routineness	k = 5 N = 216 $\bar{r}c$ = .05 $\bar{r}e$ = .05 d =	k = 14 N = 385 $\bar{r}c$ = .21 $\bar{r}e$ = .05 d = .16	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 16 N = 601 $\bar{r}c$ = .16
Workflow Continuity	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 3 N = 52 $\bar{r}c$ = .25 $\bar{r}e$ = .14 d = .11	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 3 N = 52 $\bar{r}c$ = .25
Workflow Integration	k = 5 N = 74 $\bar{r}c$ = .44 $\bar{r}e$ = .29 d = .15	k = 15 N = 463 $\bar{r}c$ = .31 $\bar{r}e$ = .29 d = .02	k = 3 N = 181 $\bar{r}c$ = .55 $\bar{r}e$ = .29 d = .26	k = 20 N = 719 $\bar{r}c$ = .40
Information Technology	k = 1 N = 51 $\bar{r}c$ = .48 $\bar{r}e$ = .30 d = .18	k = 1 N = 20 $\bar{r}c$ = .47 $\bar{r}e$ = .30 d = .17	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 2 N = 71 $\bar{r}c$ = .41
Total	k = 7 N = 273 $\bar{r}c$ = .23	k = 18 N = 558 $\bar{r}c$ = .32	k = 3 N = 181 $\bar{r}c$ = .55	k = 25 N = 1013 $\bar{r}c$ = .33

Table XIII-25. Role Formalization: Technology Concept with Organization Type -- Both Independent

	Service	Manufacturing	Mixed	Total
Task Routineness	k = 5 N = 216 $\bar{r}c$ = .05 $\bar{r}e$ = .05 d =	k = 14 N = 385 $\bar{r}c$ = .21 $\bar{r}e$ = .14 d = .07	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 16 N = 601 $\bar{r}c$ = .16
Workflow Continuity	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 3 N = 52 $\bar{r}c$ = .25 $\bar{r}e$ = .23 d = .02	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 3 N = 52 $\bar{r}c$ = .25
Workflow Integration	k = 5 N = 74 $\bar{r}c$ = .44 $\bar{r}e$ = .29 d = .15	k = 15 N = 463 $\bar{r}c$ = .31 $\bar{r}e$ = .38 d = -.07	k = 3 N = 181 $\bar{r}c$ = .55 $\bar{r}e$ = .61 d = -.06	k = 20 N = 719 $\bar{r}c$ = .40
Information Technology	k = 1 N = 51 $\bar{r}c$ = .48 $\bar{r}e$ = .30 d = .18	k = 1 N = 20 $\bar{r}c$ = .47 $\bar{r}e$ = .39 d = .08	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 2 N = 71 $\bar{r}c$ = .41
Total	k = 7 N = 273 $\bar{r}c$ = .23	k = 18 N = 558 $\bar{r}c$ = .32	k = 3 N = 181 $\bar{r}c$ = .55	k = 25 N = 1013 $\bar{r}c$ = .33

Table XIII-26. Centralization: Organization Type with Type of Measure -- Type of Measure Spurious

	Mixed	Manufacturing	Service	Total
Institutional	k = 9 N = 608 $\bar{r}c$ = -.16 $\bar{r}e$ = -.35 d = .19	k = 21 N = 925 $\bar{r}c$ = .02 $\bar{r}e$ = -.18 d = .20	k = 12 N = 443 $\bar{r}c$ = -.07 $\bar{r}e$ = -.07 d =	k = 40 N = 1968 $\bar{r}c$ = -.06
Questionnaire	k = 1 N = 82 $\bar{r}c$ = .68 $\bar{r}e$ = -.35 d = 1.03	k = 3 N = 48 $\bar{r}c$ = .29 $\bar{r}e$ = -.18 d = .47	k = 9 N = 659 $\bar{r}c$ = .07 $\bar{r}e$ = -.07 d = .14	k = 13 N = 789 $\bar{r}c$ = .14
Other Measures	k = 1 N = 155 $\bar{r}c$ = -.47 $\bar{r}e$ = -.35 d = -.12	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 2 N = 511 $\bar{r}c$ = .41 $\bar{r}e$ = -.07 d = .48	k = 3 N = 666 $\bar{r}c$ = .20
Total	k = 11 N = 845 $\bar{r}c$ = -.14	k = 24 N = 973 $\bar{r}c$ = .03	k = 23 N = 1613 $\bar{r}c$ = .14	k = 56 N = 3423 $\bar{r}c$ = .04

Table XIII-27. Centralization: Organization Type with Type of Measure -- Organization Type Spurious

	Mixed	Manufacturing	Service	Total
Institutional	k = 9 N = 608 $\bar{r}c$ = -.16 $\bar{r}e$ = -.07 d = -.09	k = 21 N = 925 $\bar{r}c$ = .02 $\bar{r}e$ = -.07 d = .09	k = 12 N = 443 $\bar{r}c$ = -.07 $\bar{r}e$ = -.07 d =	k = 40 N = 1968 $\bar{r}c$ = -.06
Questionnaire	k = 1 N = 82 $\bar{r}c$ = .68 $\bar{r}e$ = .13 d = .55	k = 3 N = 48 $\bar{r}c$ = .29 $\bar{r}e$ = .13 d = .16	k = 9 N = 659 $\bar{r}c$ = .07 $\bar{r}e$ = .13 d = -.06	k = 13 N = 789 $\bar{r}c$ = .14
Other Measures	k = 1 N = 155 $\bar{r}c$ = -.47 $\bar{r}e$ = .19 d = -.66	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 2 N = 511 $\bar{r}c$ = .41 $\bar{r}e$ = .19 d = .22	k = 3 N = 666 $\bar{r}c$ = .20
Total	k = 11 N = 845 $\bar{r}c$ = -.14	k = 24 N = 973 $\bar{r}c$ = .03	k = 23 N = 1613 $\bar{r}c$ = .14	k = 56 N = 3423 $\bar{r}c$ = .04

Table XIII-28. Centralization: Organization Type with Type of Measure -- Both Independent

	Mixed	Manufacturing	Service	Total
Institutional	k = 9 N = 608 r̄c = -.16 r̄e = -.35 d = .19	k = 21 N = 925 r̄c = .02 r̄e = -.18 d = .20	k = 12 N = 443 r̄c = -.07 r̄e = -.07 d =	k = 40 N = 1968 r̄c = -.06
Questionnaire	k = 1 N = 82 r̄c = .68 r̄e = -.15 d = .83	k = 3 N = 48 r̄c = .29 r̄e = .02 d = .27	k = 9 N = 659 r̄c = .07 r̄e = .13 d = -.06	k = 13 N = 789 r̄c = .14
Other Measures	k = 1 N = 155 r̄c = -.47 r̄e = -.09 d = -.38	k = N = NONE r̄c = r̄e = d =	k = 2 N = 511 r̄c = .41 r̄e = .19 d = .22	k = 3 N = 666 r̄c = .20
Total	k = 11 N = 845 r̄c = -.14	k = 24 N = 973 r̄c = .03	k = 23 N = 1613 r̄c = .14	k = 56 N = 3423 r̄c = .04

Table XIII-29. Centralization: Technology Concept with Organization Type -- Technology Concept Spurious

	Mixed	Manufacturing	Service	Total
Information Technology	k = 4	k = 6	k = 3	k = 12
	N = 294	N = 353	N = 195	N = 842
	$\bar{r}$c = -.17	$\bar{r}$c = -.10	$\bar{r}$c = -.29	$\bar{r}$c = -.18
	$\bar{r}$e = -.57	$\bar{r}$e = -.40	$\bar{r}$e = -.29	
	d = .40	d = .30	d =	
Workflow Integration	k = 9	k = 15	k = 11	k = 33
	N = 670	N = 701	N = 836	N = 2222
	$\bar{r}$c = -.26	$\bar{r}$c = -.02	$\bar{r}$c = -.02	$\bar{r}$c = -.09
	$\bar{r}$e = -.57	$\bar{r}$e = -.40	$\bar{r}$e = -.29	
	d = .31	d = .38	d = .27	
Workflow Continuity	k = 2	k = 16	k = 1	k = 19
	N = 196	N = 583	N = 6	N = 785
	$\bar{r}$c = -.14	$\bar{r}$c = .12	$\bar{r}$c = .24	$\bar{r}$c = .06
	$\bar{r}$e = -.57	$\bar{r}$e = -.40	$\bar{r}$e = -.29	
	d = .43	d = .52	d = .53	
Task Routineness	k = 1	k = 9	k = 19	k = 27
	N = 82	N = 226	N = 1397	N = 1705
	$\bar{r}$c = .68	$\bar{r}$c = .09	$\bar{r}$c = .22	$\bar{r}$c = .20
	$\bar{r}$e = -.57	$\bar{r}$e = -.40	$\bar{r}$e = -.29	
	d = 1.15	d = .49	d = .51	
Total	k = 11	k = 24	k = 23	k = 56
	N = 845	N = 973	N = 1613	N = 3423
	$\bar{r}$c = -.14	$\bar{r}$c = .03	$\bar{r}$c = .14	$\bar{r}$c = .036

Table XIII-30. Centralization: Technology Concept with Organization Type -- Organization Type Spurious

	Mixed	Manufacturing	Service	Total
Information Technology	k = 4	k = 6	k = 3	k = 12
	N = 294	N = 353	N = 195	N = 842
	$\bar{r}c$ = -.17	$\bar{r}c$ = -.10	$\bar{r}c$ = -.29	$\bar{r}c$ = -.18
	$\bar{r}e$ = -.29	$\bar{r}e$ = -.29	$\bar{r}e$ = -.29	
	d = .08	d = .19	d =	
Workflow Integration	k = 9	k = 15	k = 11	k = 33
	N = 670	N = 701	N = 836	N = 2222
	$\bar{r}c$ = -.26	$\bar{r}c$ = -.02	$\bar{r}c$ = -.02	$\bar{r}c$ = -.09
	$\bar{r}e$ = -.20	$\bar{r}e$ = -.20	$\bar{r}e$ = -.20	
	d = -.06	d = .18	d = .18	
Workflow Continuity	k = 2	k = 16	k = 1	k = 19
	N = 196	N = 583	N = 6	N = 785
	$\bar{r}c$ = -.14	$\bar{r}c$ = .12	$\bar{r}c$ = .24	$\bar{r}c$ = .06
	$\bar{r}e$ = -.05	$\bar{r}e$ = -.05	$\bar{r}e$ = -.05	
	d = -.09	d = .17	d = .29	
Task Routineness	k = 1	k = 9	k = 19	k = 27
	N = 82	N = 226	N = 1397	N = 1705
	$\bar{r}c$ = .68	$\bar{r}c$ = .09	$\bar{r}c$ = .22	$\bar{r}c$ = .20
	$\bar{r}e$ = .09	$\bar{r}e$ = .09	$\bar{r}e$ = .09	
	d = .59	d =	d = .13	
Total	k = 11	k = 24	k = 23	k = 56
	N = 845	N = 973	N = 1613	N = 3423
	$\bar{r}c$ = -.14	$\bar{r}c$ = .03	$\bar{r}c$ = .14	$\bar{r}c$ = .036

Table XIII-31. Centralization: Technology Concept with Organization Type -- Both Independent

	Mixed	Manufacturing	Service	Total
Information Technology	k = 4 N = 294 r̄c = -.17 r̄e = -.57 d = .40	k = 6 N = 353 r̄c = -.10 r̄e = -.40 d = .30	k = 3 N = 195 r̄c = -.29 r̄e = -.29 d =	k = 12 N = 842 r̄c = -.18
Workflow Integration	k = 9 N = 670 r̄c = -.26 r̄e = -.20 d = -.06	k = 15 N = 701 r̄c = -.02 r̄e = -.03 d = .01	k = 11 N = 836 r̄c = -.02 r̄e = -.20 d = .18	k = 33 N = 2222 r̄c = -.09
Workflow Continuity	k = 2 N = 196 r̄c = -.14 r̄e = -.05 d = -.09	k = 16 N = 583 r̄c = .12 r̄e = .12 d =	k = 1 N = 6 r̄c = .24 r̄e = -.05 d = .29	k = 19 N = 785 r̄c = .06
Task Routineness	k = 1 N = 82 r̄c = .68 r̄e = -.19 d = .87	k = 9 N = 226 r̄c = .09 r̄e = -.02 d = .11	k = 19 N = 1397 r̄c = .22 r̄e = .09 d = .13	k = 27 N = 1705 r̄c = .20
Total	k = 11 N = 845 r̄c = -.14	k = 24 N = 973 r̄c = .03	k = 23 N = 1613 r̄c = .14	k = 56 N = 3423 r̄c = .036

Table XIII-32. Centralization: Technology Concept with Type of Measure -- Technology Concept Spurious

	Institutional	Questionnaire	Other	Total
Information Technology	k = 12 N = 842 $\bar{r}c$ = -.18 $\bar{r}e$ = -.18 d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 12 N = 842 $\bar{r}c$ = -.18
Workflow Integration	k = 28 N = 1546 $\bar{r}c$ = -.08 $\bar{r}e$ = -.18 d = .10	k = 3 N = 347 $\bar{r}c$ = -.07 $\bar{r}e$ = .02 d = -.09	k = 2 N = 329 $\bar{r}c$ = -.17 $\bar{r}e$ = .08 d = -.25	k = 33 N = 2222 $\bar{r}c$ = -.09
Workflow Continuity	k = 19 N = 785 $\bar{r}c$ = .06 $\bar{r}e$ = -.18 d = .24	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 19 N = 785 $\bar{r}c$ = .06
Task Routineness	k = 12 N = 405 $\bar{r}c$ = .14 $\bar{r}e$ = -.18 d = .32	k = 13 N = 789 $\bar{r}c$ = .13 $\bar{r}e$ = .02 d = .11	k = 2 N = 511 $\bar{r}c$ = .36 $\bar{r}e$ = .08 d = .28	k = 27 N = 1705 $\bar{r}c$ = .20
Total	k = 40 N = 1968 $\bar{r}c$ = -.06	k = 13 N = 789 $\bar{r}c$ = .14	k = 3 N = 666 $\bar{r}c$ = .20	k = 56 N = 3423 $\bar{r}c$ = .036

Table XIII-33. Centralization: Technology Concept with Type of Measure -- Type of Measure Spurious

	Institutional	Questionnaire	Other	Total
Information Technology	k = 12 N = 842 $\bar{r}c$ = -.18 $\bar{r}e$ = -.18 d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 12 N = 842 $\bar{r}c$ = -.18
Workflow Integration	k = 28 N = 1546 $\bar{r}c$ = -.08 $\bar{r}e$ = -.09 d = .01	k = 3 N = 347 $\bar{r}c$ = -.07 $\bar{r}e$ = -.09 d = .02	k = 2 N = 329 $\bar{r}c$ = -.17 $\bar{r}e$ = -.09 d = -.12	k = 33 N = 2222 $\bar{r}c$ = -.09
Workflow Continuity	k = 19 N = 785 $\bar{r}c$ = .06 $\bar{r}e$ = .06 d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 19 N = 785 $\bar{r}c$ = .06
Task Routineness	k = 12 N = 405 $\bar{r}c$ = .14 $\bar{r}e$ = .20 d = -.06	k = 13 N = 789 $\bar{r}c$ = .13 $\bar{r}e$ = .20 d = -.07	k = 2 N = 511 $\bar{r}c$ = .36 $\bar{r}e$ = .20 d = .16	k = 27 N = 1705 $\bar{r}c$ = .20
Total	k = 40 N = 1968 $\bar{r}c$ = -.06	k = 13 N = 789 $\bar{r}c$ = .14	k = 3 N = 666 $\bar{r}c$ = .20	k = 56 N = 3423 $\bar{r}c$ = .036

Table XIII-34. Centralization: Technology Concept with Type of Measure -- Both Independent

	Institutional	Questionnaire	Other	Total
Information Technology	k = 12 N = 842 $\bar{r}c$ = -.18 $\bar{r}e$ = -.18 d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 12 N = 842 $\bar{r}c$ = -.18
Workflow Integration	k = 28 N = 1546 $\bar{r}c$ = -.08 $\bar{r}e$ = -.09 d = .01	k = 3 N = 347 $\bar{r}c$ = -.07 $\bar{r}e$ = .11 d = -.18	k = 2 N = 329 $\bar{r}c$ = -.17 $\bar{r}e$ = .17 d = -.34	k = 33 N = 2222 $\bar{r}c$ = -.09
Workflow Continuity	k = 19 N = 785 $\bar{r}c$ = .06 $\bar{r}e$ = .06 d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 19 N = 785 $\bar{r}$[illegible] = .06
Task Routineness	k = 12 N = 405 $\bar{r}c$ = .14 $\bar{r}e$ = .20 d = -.06	k = 13 N = 789 $\bar{r}c$ = .13 $\bar{r}e$ = .40 d = -.27	k = 2 N = 511 $\bar{r}c$ = .36 $\bar{r}e$ = .46 d = -.10	k = 27 N = 1705 $\bar{r}c$ = .20
Total	k = 40 N = 1968 $\bar{r}c$ = -.06	k = 13 N = 789 $\bar{r}c$ = .14	k = 3 N = 666 $\bar{r}c$ = .20	k = 56 N = 3423 $\bar{r}c$ = .036

Table XIII-35. Supervisor's Span of Control: Level of Analysis with Organization Type -- Level of Analysis Spurious

	Mixed	Manufacturing	Service	Total
Organization	k = 1 N = 75 $\bar{r}c$ = -.14 $\bar{r}e$ = -.05 d = -.09	k = 13 N = 604 $\bar{r}c$ = -.10 $\bar{r}e$ = .02 d = -.12	k = 4 N = 100 $\bar{r}c$ = .27 $\bar{r}e$ = .27 d =	k = 16 N = 770 $\bar{r}c$ = -.05
Subunit	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 2 N = 115 $\bar{r}c$ = .11 $\bar{r}e$ = .02 d = .09	k = 4 N = 1707 $\bar{r}c$ = .17 $\bar{r}e$ = .27 d = -.10	k = 6 N = 1822 $\bar{r}c$ = .16
Total	k = 1 N = 75 $\bar{r}c$ = -.14	k = 15 N = 719 $\bar{r}c$ = -.07	k = 8 N = 1807 $\bar{r}c$ = .18	k = 22 N = 2592 $\bar{r}c$ = .10

Table XIII-36. Supervisor's Span of Control: Level of Analysis with Organization Type -- Organization Type Spurious

	Mixed	Manufacturing	Service	Total
Organization	k = 1 N = 75 $\bar{r}c$ = -.14 $\bar{r}e$ = .27 d = -.41	k = 13 N = 604 $\bar{r}c$ = -.10 $\bar{r}e$ = .27 d = -.37	k = 4 N = 100 $\bar{r}c$ = .27 $\bar{r}e$ = .27 d =	k = 16 N = 770 $\bar{r}c$ = -.05
Subunit	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 2 N = 115 $\bar{r}c$ = .11 $\bar{r}e$ = .48 d = -.37	k = 4 N = 1707 $\bar{r}c$ = .17 $\bar{r}e$ = .48 d = -.31	k = 6 N = 1822 $\bar{r}c$ = .16
Total	k = 1 N = 75 $\bar{r}c$ = -.14	k = 15 N = 719 $\bar{r}c$ = -.07	k = 8 N = 1807 $\bar{r}c$ = .18	k = 22 N = 2592 $\bar{r}c$ = .10

Table XIII-37. Supervisor's Span of Control: Level of Analysis with Organization Type -- Both Independent

	Mixed	Manufacturing	Service	Total
Organization	k = 1 N = 75 $\bar{r}c$ = -.14 $\bar{r}e$ = -.05 d = -.09	k = 13 N = 604 $\bar{r}c$ = -.10 $\bar{r}e$ = .02 d = -.12	k = 4 N = 100 $\bar{r}c$ = .27 $\bar{r}e$ = .27 d =	k = 16 N = 770 $\bar{r}c$ = -.05
Subunit	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 2 N = 115 $\bar{r}c$ = .11 $\bar{r}e$ = .23 d = -.12	k = 4 N = 1707 $\bar{r}c$ = .17 $\bar{r}e$ = .48 d = -.31	k = 6 N = 1822 $\bar{r}c$ = .16
Total	k = 1 N = 75 $\bar{r}c$ = -.14	k = 15 N = 719 $\bar{r}c$ = -.07	k = 8 N = 1807 $\bar{r}c$ = .18	k = 22 N = 2592 $\bar{r}c$ = .10

Table XIII-38. Supervisor's Span of Control: Technology Concept with Level of Analysis -- Technology Concept Spurious

	Organization	Subunit	Total
Workflow Continuity	k = 13 N = 477 $\bar{r}c$ = -.09 $\bar{r}e$ = -.09 d =	k = 1 N = 20 $\bar{r}c$ = .31 $\bar{r}e$ = .12 d = .19	k = 14 N = 497 $\bar{r}c$ = -.08
Workflow Integration	k = 13 N = 627 $\bar{r}c$ = -.03 $\bar{r}e$ = -.09 d = .06	k = 1 N = 61 $\bar{r}c$ = -.18 $\bar{r}e$ = .12 d = -.30	k = 14 N = 688 $\bar{r}c$ = -.04
Task Routineness	k = 7 N = 297 $\bar{r}c$ = -.03 $\bar{r}e$ = -.09 d = .06	k = 3 N = 186 $\bar{r}c$ = .25 $\bar{r}e$ = .12 d = .13	k = 10 N = 483 $\bar{r}c$ = .08
Information Technology	k = 6 N = 412 $\bar{r}c$ = -.02 $\bar{r}e$ = -.09 d = .07	k = 2 N = 1616 $\bar{r}c$ = .13 $\bar{r}e$ = .12 d = .01	k = 8 N = 2028 $\bar{r}c$ = .10
Total	k = 16 N = 770 $\bar{r}c$ = -.05	k = 6 N = 1822 $\bar{r}c$ = .16	k = 22 N = 2592 $\bar{r}c$ = .10

Table XIII-39. Supervisor's Span of Control: Technology Concept with Level of Analysis -- Level of Analysis Spurious

	Organization	Subunit	Total
Workflow Continuity	k = 13 N = 477 $\bar{r}c$ = -.09 $\bar{r}e$ = -.09 d =	k = 1 N = 20 $\bar{r}c$ = .31 $\bar{r}e$ = -.09 d = .40	k = 14 N = 497 $\bar{r}c$ = -.08
Workflow Integration	k = 13 N = 627 $\bar{r}c$ = -.03 $\bar{r}e$ = -.05 d = .02	k = 1 N = 61 $\bar{r}c$ = -.18 $\bar{r}e$ = -.05 d = -.13	k = 14 N = 688 $\bar{r}c$ = -.04
Task Routineness	k = 7 N = 297 $\bar{r}c$ = -.03 $\bar{r}e$ = .07 d = -.10	k = 3 N = 186 $\bar{r}c$ = .25 $\bar{r}e$ = .07 d = .18	k = 10 N = 483 $\bar{r}c$ = .08
Information Technology	k = 6 N = 412 $\bar{r}c$ = -.02 $\bar{r}e$ = .09 d = -.11	k = 2 N = 1616 $\bar{r}c$ = .13 $\bar{r}e$ = .09 d = .04	k = 8 N = 2028 $\bar{r}c$ = .10
Total	k = 16 N = 770 $\bar{r}c$ = -.05	k = 6 N = 1822 $\bar{r}c$ = .16	k = 22 N = 2592 $\bar{r}c$ = .10

Table XIII-40. Supervisor's Span of Control: Technology Concept with Level of Analysis -- Both Independent

	Organization	Subunit	Total
Workflow Continuity	k = 13 N = 477 $\bar{r}c$ = -.09 $\bar{r}e$ = -.09 d =	k = 1 N = 20 $\bar{r}c$ = .31 $\bar{r}e$ = .12 d = .19	k = 14 N = 497 $\bar{r}c$ = -.08
Workflow Integration	k = 13 N = 627 $\bar{r}c$ = -.03 $\bar{r}e$ = -.05 d = .02	k = 1 N = 61 $\bar{r}c$ = -.18 $\bar{r}e$ = .16 d = -.34	k = 14 N = 688 $\bar{r}c$ = -.04
Task Routineness	k = 7 N = 297 $\bar{r}c$ = -.03 $\bar{r}e$ = .07 d = -.10	k = 3 N = 186 $\bar{r}c$ = .25 $\bar{r}e$ = .28 d = -.03	k = 10 N = 483 $\bar{r}c$ = .08
Information Technology	k = 6 N = 412 $\bar{r}c$ = -.02 $\bar{r}e$ = .09 d = -.11	k = 2 N = 1616 $\bar{r}c$ = .13 $\bar{r}e$ = .30 d = -.17	k = 8 N = 2028 $\bar{r}c$ = .10
Total	k = 16 N = 770 $\bar{r}c$ = -.05	k = 6 N = 1822 $\bar{r}c$ = .16	k = 22 N = 2592 $\bar{r}c$ = .10

Table XIII-41. Supervisor's Span of Control: Technology Concept with Organization Type -- Technology Concept Spurious

	Mixed	Manufacturing	Service	Total
Workflow Continuity	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 13 N = 491 $\bar{r}c$ = -.08 $\bar{r}e$ = -.08 d =	k = 1 N = 6 $\bar{r}c$ = .39 $\bar{r}e$ = .17 d = .22	k = 14 N = 497 $\bar{r}c$ = -.08
Workflow Integration	k = 1 N = 68 $\bar{r}c$ = -.26 $\bar{r}e$ = -.15 d = -.11	k = 11 N = 496 $\bar{r}c$ = -.10 $\bar{r}e$ = -.08 d = -.02	k = 4 N = 109 $\bar{r}c$ = -.01 $\bar{r}e$ = .17 d = -.18	k = 14 N = 688 $\bar{r}c$ = -.04
Task Routineness	k = 1 N = 82 $\bar{r}c$ = -.04 $\bar{r}e$ = -.15 d = .11	k = 7 N = 268 $\bar{r}c$ = -.03 $\bar{r}e$ = -.08 d = .05	k = 4 N = 133 $\bar{r}c$ = .37 $\bar{r}e$ = .17 d = .20	k = 10 N = 483 $\bar{r}c$ = .08
Information Technology	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 5 N = 334 $\bar{r}c$ = -.06 $\bar{r}e$ = -.08 d = .02	k = 4 N = 1694 $\bar{r}c$ = .14 $\bar{r}e$ = .17 d = -.03	k = 8 N = 2028 $\bar{r}c$ = .10
Total	k = 1 N = 75 $\bar{r}c$ = -.14	k = 15 N = 719 $\bar{r}c$ = -.07	k = 8 N = 1807 $\bar{r}c$ = .18	k = 22 N = 2592 $\bar{r}c$ = .10

Table XIII-42. Supervisor's Span of Control: Technology Concept with Organization Type -- Organization Type Spurious

	Mixed	Manufacturing	Service	Total
Workflow Continuity	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 13 N = 491 $\bar{r}c$ = -.08 $\bar{r}e$ = -.08 d =	k = 1 N = 6 $\bar{r}c$ = .39 $\bar{r}e$ = -.08 d = .47	k = 14 N = 497 $\bar{r}c$ = -.08
Workflow Integration	k = 1 N = 68 $\bar{r}c$ = -.26 $\bar{r}e$ = -.04 d = -.22	k = 11 N = 496 $\bar{r}c$ = -.10 $\bar{r}e$ = -.04 d = .06	k = 4 N = 109 $\bar{r}c$ = -.01 $\bar{r}e$ = -.04 d = .03	k = 14 N = 688 $\bar{r}c$ = -.04
Task Routineness	k = 1 N = 82 $\bar{r}c$ = -.04 $\bar{r}e$ = .08 d = -.12	k = 7 N = 268 $\bar{r}c$ = -.03 $\bar{r}e$ = .08 d = -.11	k = 4 N = 133 $\bar{r}c$ = .37 $\bar{r}e$ = .08 d = .29	k = 10 N = 483 $\bar{r}c$ = .08
Information Technology	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 5 N = 334 $\bar{r}c$ = -.06 $\bar{r}e$ = .10 d = -.16	k = 4 N = 1694 $\bar{r}c$ = .14 $\bar{r}e$ = .10 d = .04	k = 8 N = 2028 $\bar{r}c$ = .10
Total	k = 1 N = 75 $\bar{r}c$ = -.14	k = 15 N = 719 $\bar{r}c$ = -.07	k = 8 N = 1807 $\bar{r}c$ = .18	k = 22 N = 2592 $\bar{r}c$ = .10

Table XIII-43. Supervisor's Span of Control: Technology Concept with Organization Type -- Both Independent

	Mixed	Manufacturing	Service	Total
Workflow Continuity	k = N = NONE $\bar{r}$c = $\bar{r}$e = d =	k = 13 N = 491 $\bar{r}$c = -.08 $\bar{r}$e = -.08 d =	k = 1 N = 6 $\bar{r}$c = .39 $\bar{r}$e = .17 d = .22	k = 14 N = 497 $\bar{r}$c = -.08
Workflow Integration	k = 1 N = 68 $\bar{r}$c = -.26 $\bar{r}$e = -.11 d = -.15	k = 11 N = 496 $\bar{r}$c = -.10 $\bar{r}$e = -.04 d = -.06	k = 4 N = 109 $\bar{r}$c = -.01 $\bar{r}$e = .21 d = -.22	k = 14 N = 688 $\bar{r}$c = -.04
Task Routineness	k = 1 N = 82 $\bar{r}$c = -.04 $\bar{r}$e = .01 d = -.05	k = 7 N = 268 $\bar{r}$c = -.03 $\bar{r}$e = .08 d = -.11	k = 4 N = 133 $\bar{r}$c = .37 $\bar{r}$e = .33 d = .04	k = 10 N = 483 $\bar{r}$c = .08
Information Technology	k = N = NONE $\bar{r}$c = $\bar{r}$e = d =	k = 5 N = 334 $\bar{r}$c = -.06 $\bar{r}$e = .10 d = -.16	k = 4 N = 1694 $\bar{r}$c = .14 $\bar{r}$e = .35 d = -.21	k = 8 N = 2028 $\bar{r}$c = .10
Total	k = 1 N = 75 $\bar{r}$c = -.14	k = 15 N = 719 $\bar{r}$c = -.07	k = 8 N = 1807 $\bar{r}$c = .18	k = 22 N = 2592 $\bar{r}$c = .10

Table XIII-44. Percentage Direct Workers: Organization Type with Organization Size -- Organization Type Spurious

	Small	Large	Total
Manufacturing	k = 8 N = 367 $\bar{r}c$ = -.35 $\bar{r}e$ = -.35 d =	k = 3 N = 91 $\bar{r}c$ = -.22 $\bar{r}e$ = -.06 d = -.16	k = 11 N = 458 $\bar{r}c$ = -.32
Service	k = 1 N = 6 $\bar{r}c$ = .00 $\bar{r}e$ = -.35 d = .35	k = 2 N = 41 $\bar{r}c$ = .26 $\bar{r}e$ = -.06 d = .32	k = 3 N = 47 $\bar{r}c$ = .22
Total	k = 9 N = 373 $\bar{r}c$ = -.34	k = 3 N = 124 $\bar{r}c$ = -.05	k = 12 N = 497 $\bar{r}c$ = -.26

Table XIII-45. Percentage Direct Workers: Organization Type with Organization Size -- Organization Size Spurious

	Small	Large	Total
Manufacturing	k = 8 N = 367 $\bar{r}c$ = -.35 $\bar{r}e$ = -.35 d =	k = 3 N = 91 $\bar{r}c$ = -.22 $\bar{r}e$ = -.35 d = .13	k = 11 N = 458 $\bar{r}c$ = -.32
Service	k = 1 N = 6 $\bar{r}c$ = .00 $\bar{r}e$ = .19 d = -.19	k = 2 N = 41 $\bar{r}c$ = .26 $\bar{r}e$ = .19 d = .07	k = 3 N = 47 $\bar{r}c$ = .22
Total	k = 9 N = 373 $\bar{r}c$ = -.34	k = 3 N = 124 $\bar{r}c$ = -.05	k = 12 N = 497 $\bar{r}c$ = -.26

Table XIII-46. Percentage Direct Workers: Organization Type with Organization Size -- Both Independent

	Small	Large	Total
Manufacturing	k = 8 N = 367 $\bar{r}c$ = -.35 $\bar{r}e$ = -.35 d =	k = 3 N = 91 $\bar{r}c$ = -.22 $\bar{r}e$ = -.06 d = -.16	k = 11 N = 458 $\bar{r}c$ = -.32
Service	k = 1 N = 6 $\bar{r}c$ = .00 $\bar{r}e$ = .19 d = -.19	k = 2 N = 41 $\bar{r}c$ = .26 $\bar{r}e$ = .48 d = -.22	k = 3 N = 47 $\bar{r}c$ = .22
Total	k = 9 N = 373 $\bar{r}c$ = -.34	k = 3 N = 124 $\bar{r}c$ = -.05	k = 12 N = 497 $\bar{r}c$ = -.26

Table XIII-47. Percentage Direct Workers: Technology Concept with Organization Size -- Technology Concept Spurious

	Small	Large	Total
Workflow Continuity	k = 9 N = 372 $\bar{r}c$ = -.32 $\bar{r}e$ = -.32 d =	k = 3 N = 81 $\bar{r}c$ = -.00 $\bar{r}e$ = -.03 d = .03	k = 12 N = 453 $\bar{r}c$ = -.27
Information Technology	k = 2 N = 137 $\bar{r}c$ = -.12 $\bar{r}e$ = -.32 d = .20	k = 1 N = 81 $\bar{r}c$ = -.27 $\bar{r}e$ = -.03 d = -.24	k = 3 N = 218 $\bar{r}c$ = -.17
Workflow Integration	k = 8 N = 298 $\bar{r}c$ = -.15 $\bar{r}e$ = -.32 d = .17	k = 3 N = 138 $\bar{r}c$ = .09 $\bar{r}e$ = -.03 d = .12	k = 11 N = 436 $\bar{r}c$ = -.06
Task Routineness	k = 3 N = 71 $\bar{r}c$ = .10 $\bar{r}e$ = -.32 d = .42	k = 3 N = 143 $\bar{r}c$ = -.03 $\bar{r}e$ = -.03 d =	k = 6 N = 214 $\bar{r}c$ = .02
Total	k = 9 N = 373 $\bar{r}c$ = -.34	k = 3 N = 124 $\bar{r}c$ = -.05	k = 12 N = 497 $\bar{r}c$ = -.26

Table XIII-48. Percentage Direct Workers: Technology Concept with Organization Size -- Organization Size Spurious

	Small	Large	Total
Workflow Continuity	k = 9 N = 372 $\bar{r}c$ = -.32 $\bar{r}e$ = -.32 d =	k = 3 N = 81 $\bar{r}c$ = -.00 $\bar{r}e$ = -.32 d = .32	k = 12 N = 453 $\bar{r}c$ = -.27
Information Technology	k = 2 N = 137 $\bar{r}c$ = -.12 $\bar{r}e$ = -.22 d = .10	k = 1 N = 81 $\bar{r}c$ = -.27 $\bar{r}e$ = -.22 d = -.05	k = 3 N = 218 $\bar{r}c$ = -.17
Workflow Integration	k = 8 N = 298 $\bar{r}c$ = -.15 $\bar{r}e$ = -.11 d = -.04	k = 3 N = 138 $\bar{r}c$ = .09 $\bar{r}e$ = -.11 d = .20	k = 11 N = 436 $\bar{r}c$ = -.06
Task Routineness	k = 3 N = 71 $\bar{r}c$ = .10 $\bar{r}e$ = -.03 d = .13	k = 3 N = 143 $\bar{r}c$ = -.03 $\bar{r}e$ = -.03 d =	k = 6 N = 214 $\bar{r}c$ = .02
Total	k = 9 N = 373 $\bar{r}c$ = -.34	k = 3 N = 124 $\bar{r}c$ = -.05	k = 12 N = 497 $\bar{r}c$ = -.26

Table XIII-49. Percentage Direct Workers: Technology Concept with Organization Size -- Both Independent

	Small	Large	Total
Workflow Continuity	k = 9 N = 372 r̄c = -.32 r̄e = -.32 d =	k = 3 N = 81 r̄c = -.00 r̄e = -.03 d = .03	k = 12 N = 453 r̄c = -.27
Information Technology	k = 2 N = 137 r̄c = -.12 r̄e = -.22 d = .10	k = 1 N = 81 r̄c = -.27 r̄e = .07 d = -.34	k = 3 N = 218 r̄c = -.17
Workflow Integration	k = 8 N = 298 r̄c = -.15 r̄e = -.11 d = -.04	k = 3 N = 138 r̄c = .09 r̄e = .18 d = -.09	k = 11 N = 436 r̄c = -.06
Task Routineness	k = 3 N = 71 r̄c = .10 r̄e = -.03 d = .13	k = 3 N = 143 r̄c = -.03 r̄e = .26 d = -.29	k = 6 N = 214 r̄c = .02
Total	k = 9 N = 373 r̄c = -.34	k = 3 N = 124 r̄c = -.05	k = 12 N = 497 r̄c = -.26

Table XIII-50. Percentage Direct Workers: Technology Concept with Organization Type -- Technology Concept Spurious

	Manufacturing	Service	Total
Workflow Continuity	k = 11 N = 447 $\bar{r}c$ = -.28 $\bar{r}e$ = -.28 d =	k = 1 N = 6 $\bar{r}c$ = .88 $\bar{r}e$ = .26 d = .62	k = 12 N = 453 $\bar{r}c$ = -.27
Information Technology	k = 3 N = 192 $\bar{r}c$ = -.18 $\bar{r}e$ = -.28 d = .10	k = 1 N = 26 $\bar{r}c$ = .12 $\bar{r}e$ = .26 d = -.14	k = 3 N = 218 $\bar{r}c$ = -.17
Workflow Integration	k = 10 N = 373 $\bar{r}c$ = -.16 $\bar{r}e$ = -.28 d = .12	k = 3 N = 47 $\bar{r}c$ = .23 $\bar{r}e$ = .26 d = -.03	k = 11 N = 436 $\bar{r}c$ = -.06
Task Routineness	k = 6 N = 173 $\bar{r}c$ = -.10 $\bar{r}e$ = -.28 d = .18	k = 2 N = 41 $\bar{r}c$ = .23 $\bar{r}e$ = .26 d = -.03	k = 6 N = 214 $\bar{r}c$ = .02
Total	k = 11 N = 458 $\bar{r}c$ = -.32	k = 3 N = 47 $\bar{r}c$ = .22	k = 12 N = 497 $\bar{r}c$ = -.26

Table XIII-51. Percentage Direct Workers: Technology Concept with Organization Type -- Organization Type Spurious

		Manufacturing	Service	Total
Workflow Continuity	k	11	1	12
	N	447	6	453
	$\bar{r}c$	-.28	.88	-.27
	$\bar{r}e$	-.28	-.28	
	d		1.16	
Information Technology	k	3	1	3
	N	192	26	218
	$\bar{r}c$	-.18	.12	-.17
	$\bar{r}e$	-.18	-.18	
	d		.30	
Workflow Integration	k	10	3	11
	N	373	47	436
	$\bar{r}c$	-.16	.23	-.06
	$\bar{r}e$	-.09	-.09	
	d	-.07	.32	
Task Routineness	k	6	2	6
	N	173	41	214
	$\bar{r}c$	-.10	.23	.02
	$\bar{r}e$	-.01	-.01	
	d	-.09	.24	
Total	k	11	3	12
	N	458	47	497
	$\bar{r}c$	-.32	.22	-.26

Table XIII-52. Percentage Direct Workers: Technology Concept with Organization Type -- Both Independent

	Manufacturing	Service	Total
Workflow Continuity	k = 11 N = 447 $\bar{r}c$ = -.28 $\bar{r}e$ = -.28 d =	k = 1 N = 6 $\bar{r}c$ = .88 $\bar{r}e$ = .26 d = .62	k = 12 N = 453 $\bar{r}c$ = -.27
Information Technology	k = 3 N = 192 $\bar{r}c$ = -.18 $\bar{r}e$ = -.18 d =	k = 1 N = 26 $\bar{r}c$ = .12 $\bar{r}e$ = .36 d = -.24	k = 3 N = 218 $\bar{r}c$ = -.17
Workflow Integration	k = 10 N = 373 $\bar{r}c$ = -.16 $\bar{r}e$ = -.09 d = -.07	k = 3 N = 47 $\bar{r}c$ = .23 $\bar{r}e$ = .45 d = -.22	k = 11 N = 436 $\bar{r}c$ = -.06
Task Routineness	k = 6 N = 173 $\bar{r}c$ = -.10 $\bar{r}e$ = -.01 d = -.09	k = 2 N = 41 $\bar{r}c$ = .23 $\bar{r}e$ = .53 d = -.30	k = 6 N = 214 $\bar{r}c$ = .02
Total	k = 11 N = 458 $\bar{r}c$ = -.32	k = 3 N = 47 $\bar{r}c$ = .22	k = 12 N = 497 $\bar{r}c$ = -.26

Table XIII-53. Percentage Clerical Personnel: Organization Type with Level of Analysis -- Level of Analysis Spurious

	Service	Manufacturing	Total
Subunit	k = 2	k =	k = 2
	N = 1349	N = NONE	N = 1349
	$\bar{r}c$ = -.06	$\bar{r}c$ =	$\bar{r}c$ = -.06
	$\bar{r}e$ = -.03	$\bar{r}e$ =	
	d = -.03	d =	
Organization	k = 5	k = 8	k = 11
	N = 215	N = 444	N = 647
	$\bar{r}c$ = .14	$\bar{r}c$ = .16	$\bar{r}c$ = .12
	$\bar{r}e$ = -.03	$\bar{r}e$ = .16	
	d = .17	d =	
Total	k = 7	k = 8	k = 13
	N = 1564	N = 444	N = 1996
	$\bar{r}c$ = -.03	$\bar{r}c$ = .16	$\bar{r}c$ = .00

Table XIII-54. Percentage Clerical Personnel: Organization Type with Level of Analysis -- Organization Type Spurious

	Service	Manufacturing	Total
Subunit	k = 2	k =	k = 2
	N = 1349	N = NONE	N = 1349
	$\bar{r}c$ = -.06	$\bar{r}c$ =	$\bar{r}c$ = -.06
	$\bar{r}e$ = -.02	$\bar{r}e$ =	
	d = -.04	d =	
Organization	k = 5	k = 8	k = 11
	N = 215	N = 444	N = 647
	$\bar{r}c$ = .14	$\bar{r}c$ = .16	$\bar{r}c$ = .12
	$\bar{r}e$ = .16	$\bar{r}e$ = .16	
	d = -.02	d =	
Total	k = 7	k = 8	k = 13
	N = 1564	N = 444	N = 1996
	$\bar{r}c$ = -.03	$\bar{r}c$ = .16	$\bar{r}c$ = .00

Table XIII-55. Percentage Clerical Personnel: Organization Type with Level of Analysis -- Both Independent

	Service	Manufacturing	Total
Subunit	k = 2 N = 1349 $\bar{r}c$ = -.06 $\bar{r}e$ = -.21 d = .15	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 2 N = 1349 $\bar{r}c$ = -.06
Organization	k = 5 N = 215 $\bar{r}c$ = .14 $\bar{r}e$ = -.03 d = .17	k = 8 N = 444 $\bar{r}c$ = .16 $\bar{r}e$ = .16 d =	k = 11 N = 647 $\bar{r}c$ = .12
Total	k = 7 N = 1564 $\bar{r}c$ = -.03	k = 8 N = 444 $\bar{r}c$ = .16	k = 13 N = 1996 $\bar{r}c$ = .00

Table XIII-56. Percentage Clerical Personnel: Organization Type with Type of Measure -- Organization Type Spurious

	Questionnaire	Institutional	Total
Service	k = 1 N = 148 $\bar{r}c$ = -.30 $\bar{r}e$ = -.32 d = .02	k = 6 N = 1416 $\bar{r}c$ = -.00 $\bar{r}e$ = -.00 d =	k = 7 N = 1564 $\bar{r}c$ = -.03
Manufacturing	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 8 N = 444 $\bar{r}c$ = .16 $\bar{r}e$ = -.00 d = .16	k = 8 N = 444 $\bar{r}c$ = .16
Total	k = 1 N = 148 $\bar{r}c$ = -.30	k = 12 N = 1848 $\bar{r}c$ = .02	k = 13 N = 1996 $\bar{r}c$ = .00

Table XIII-57. Percentage Clerical Personnel: Organization Type with Type of Measure -- Type of Measure Spurious

	Questionnaire	Institutional	Total
Service	k = 1	k = 6	k = 7
	N = 148	N = 1416	N = 1564
	$\bar{r}c$ = -.30	$\bar{r}c$ = -.00	$\bar{r}c$ = -.03
	$\bar{r}e$ = -.00	$\bar{r}e$ = -.00	
	d = -.30	d =	
Manufacturing	k =	k = 8	k = 8
	N = NONE	N = 444	N = 444
	$\bar{r}c$ =	$\bar{r}c$ = .16	$\bar{r}c$ = .16
	$\bar{r}e$ =	$\bar{r}e$ = .19	
	d =	d = -.03	
Total	k = 1	k = 12	k = 13
	N = 148	N = 1848	N = 1996
	$\bar{r}c$ = -.30	$\bar{r}c$ = .02	$\bar{r}c$ = .00

Table XIII-58. Percentage Clerical Personnel: Organization Type with Type of Measure -- Both Independent

	Questionnaire	Institutional	Total
Service	k = 1	k = 6	k = 7
	N = 148	N = 1416	N = 1564
	$\bar{r}c$ = -.30	$\bar{r}c$ = -.00	$\bar{r}c$ = -.03
	$\bar{r}e$ = -.32	$\bar{r}e$ = -.00	
	d = .02	d =	
Manufacturing	k =	k = 8	k = 8
	N = NONE	N = 444	N = 444
	$\bar{r}c$ =	$\bar{r}c$ = .16	$\bar{r}c$ = .16
	$\bar{r}e$ =	$\bar{r}e$ = .19	
	d =	d = -.03	
Total	k = 1	k = 12	k = 13
	N = 148	N = 1848	N = 1996
	$\bar{r}c$ = -.30	$\bar{r}c$ = .02	$\bar{r}c$ = .00

Table XIII-59. Percentage Clerical Personnel: Level of Analysis with Type of Measure -- Level of Analysis Spurious

	Questionnaire	Institutional	Total
Subunit	k = 1 N = 148 $\bar{r}c$ = -.30 $\bar{r}e$ = -.20 d = -.10	k = 1 N = 1201 $\bar{r}c$ = -.03 $\bar{r}e$ = .12 d = -.15	k = 2 N = 1349 $\bar{r}c$ = -.06
Organization	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 11 N = 647 $\bar{r}c$ = .12 $\bar{r}e$ = .12 d =	k = 11 N = 647 $\bar{r}c$ = .12
Total	k = 1 N = 148 $\bar{r}c$ = -.30	k = 12 N = 1848 $\bar{r}c$ = .02	k = 13 N = 1996 $\bar{r}c$ = .00

Table XIII-60. Percentage Clerical Personnel: Level of Analysis with Type of Measure -- Type of Measure Spurious

	Questionnaire	Institutional	Total
Subunit	k = 1 N = 148 $\bar{r}c$ = -.30 $\bar{r}e$ = -.06 d = -.24	k = 1 N = 1201 $\bar{r}c$ = -.03 $\bar{r}e$ = -.06 d = .03	k = 2 N = 1349 $\bar{r}c$ = -.06
Organization	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 11 N = 647 $\bar{r}c$ = .12 $\bar{r}e$ = .12 d =	k = 11 N = 647 $\bar{r}c$ = .12
Total	k = 1 N = 148 $\bar{r}c$ = -.30	k = 12 N = 1848 $\bar{r}c$ = .02	k = 13 N = 1996 $\bar{r}c$ = .00

Table XIII-61. Percentage Clerical Personnel: Level of Analysis with Type of Measure -- Both Independent

	Questionnaire	Institutional	Total
Subunit	k = 1 N = 148 $\bar{r}c$ = -.30 $\bar{r}e$ = -.38 d = .08	k = 1 N = 1201 $\bar{r}c$ = -.03 $\bar{r}e$ = -.06 d = .03	k = 2 N = 1349 $\bar{r}c$ = -.06
Organization	k = N = NONE $\bar{r}c$ = $\bar{r}e$ = d =	k = 11 N = 647 $\bar{r}c$ = .12 $\bar{r}e$ = .12 d =	k = 11 N = 647 $\bar{r}c$ = .12
Total	k = 1 N = 148 $\bar{r}c$ = -.30	k = 12 N = 1848 $\bar{r}c$ = .02	k = 13 N = 1996 $\bar{r}c$ = .00

CHAPTER XIV

SUMMARY OF RESULTS

In this study we have sought to explore the causes of inconsistencies in empirical studies of the technology-structure relationship. Several potential moderators of the relationship between technology and organization structure have been identified in earlier literature reviews. These suspected moderators were tested (i.e., technology concept, organization size, level of analysis, type of organization, and type of measure). The objective of this study was to determine whether or not there is a consistent relationship between technology and organization structure.

In Chapter VI it was shown that the single most significant reason for variation in study correlations is sampling error. On average, that artifact alone explains nearly 70 percent of the observed variance. Other correctable artifacts, such as variation in measurement reliability and differences between studies in the degree of range restriction, explained an average of 17 percent of the variance. These initial findings suggested that if moderators do exist, they probably do not make a significant contribution to the residual variances.

The meta-analyses performed in Chapters VIII through XIII tested several hypotheses regarding the impact of proposed moderators of the relationship between technology and organization structure. As a result of these analyses three of the five suspected moderators were rejected as significant contributors to the inconsistency observed in the results of technology-structure research. Those three were the size of the organization, the level of analysis for the study, and the type of measure used in the study. The most potent moderators of the relationship between technology and structure appear to be the type of organization studied and the technology concept measured.

Table XIV-1 displays summary results of analyses based upon the conclusions reached regarding the existence of moderators in the relationships of technology and structure. First are those relationships for which no significant moderator was detected. Then come those correlations for which only one significant moderator was detected, and finally those with two moderators. Within this latter group the moderator with the larger main effect comes first, then the moderator with the second largest main effect is listed below it. For example, division of labor appears to be moderated by both the technology concept, and level of analysis, with the technology concept having the larger main effect. Table XIV-1 therefore lists the four technology concepts in order of the size of the mean corrected correlation, and within each of those four subcategories the results for levels of analysis are shown.

No Significant Moderator Detected

The correlation between technology and vertical span does not appear to be moderated by any of the five proposed moderators. Even though artifacts explained only 50 percent of the observed variance, Table XIV-1 indicates that the 90 percent credibility interval does not include zero. Based upon this interval we can expect 90 percent of the corrected correlations to fall within an interval from .09 to .60. Thus, the relationship is consistently positive. The narrow range of the 95 percent confidence interval (i.e., .27 to .41) allows us a high degree of certainty in the results of this meta-analysis.

In Chapter VI artifacts explained all of the variance for 17 of the 30 correlations analyzed. Therefore, there are no actual inconsistencies across research studies for these 17 variables. These are the 17 variables following vertical span in Table XIV-1. All of these are ratio variables, and all except CEO span of control indicate the relative representation of different specialisms in an organization. Also note that for all except CEO span of control the total sample size (i.e., N) is quite small. As a result, several of the 95 percent confidence intervals include zero. In fact, only 5 of 16 intervals do not include zero: percentage nonworkflow personnel, percentage transportation, percentage welfare and security, percentage facility maintenance, and percentage legal and insurance.

This highlights the variables that need to be included in future primary research. As more studies are added to future meta-analyses, confidence in results should increase; the confidence interval will become narrower.

<u>Relationships with Only One Moderator</u>

The results of these meta-analyses indicate that the technology concept is the only significant moderator of the relationship of technology to standardization, and percentage workflow planning and control. In both cases information technology and workflow continuity result in the two most extreme correlations. In fact, the rank ordering of the correlations for the four technology concepts is exactly the same for both standardization and percentage workflow planning and control. However, information technology is the only one that has a positive correlation with both structural variables.

The type of organization studied was the only moderator found for supervisor's span of control, percentage supervisors, and percentage administration. The correlation between technology and supervisor's span of control is negative in manufacturing firms but positive in service organizations. The case is just the reverse for both percentage supervisors and percentage administration. As the supervisor's span of control increases we would expect a decline in the percentage of organization personnel who are supervisors if all other things are equal. The signs of the correlations displayed in Table XIV-1 support that relationship.

Relationships with More than One Moderator

More than one moderator was found for the correlation between technology and seven structural variables. Those variables are division of labor, overall formalization, functional specialization, formalization of roles, centralization, percentage direct workers, and percentage clerical personnel.

Technology Concept and Level of Analysis

The relationships of technology to division of labor, and overall formalization are both affected by the technology concept and the level of analysis. Technology concept has the larger main effect for division of labor, but for overall formalization the larger main effect is associated with the level of analysis.

Table XIV-1 reveals that the moderating effect of level of analysis on division of labor is not very significant once the technology concept is controlled. The most significant difference between subunit level studies and organization level studies occurs with measures of workflow integration. In that case the correlation for organization level studies is stronger than that for subunit level studies.

For overall formalization the technology concept continues to have a moderator effect within the subunit level and organization level studies.

Measures of workflow integration and information technology tend to yield larger correlations with division of labor and overall formalization than do measures of task routineness or workflow continuity.

Technology Concept and Organization Type

The technology concept and the type of organization studied both moderate the relationship of technology with functional specialization, formalization of roles, centralization, and percentage direct workers. Functional specialization had a larger main effect for the technology concept, but organization type had the larger effect on the other three.

Functional Specialization

Table XIV-1 indicates that the relationship between technology and functional specialization is stronger in manufacturing firms than service organizations. The results also suggest that measures of operations technology (i.e., workflow continuity and workflow integration) and information technology have larger correlations than measures of task routineness do.

Formalization of Roles

Table XIV-1 reveals that mixed samples resulted in larger correlations between technology and formalization of roles. There is not a significant difference between the correlations for service organizations and those for manufacturers. The results displayed in Table XIV-1 also indicate that measures of workflow integration and information technology result in larger correlations than measures of task routineness for both manufacturers and service organizations. Note that this also seemed to be the case for functional specialization. The moderator effect of the technology concept appears to be more significant among the studies of service organizations.

Centralization

The results obtained for the meta-analyses of centralization are particularly interesting. Table XIV-1 indicates that service organizations have higher correlations than manufacturers do. This is true for all four technology concepts. Note that the ranking of the four technology concepts is the same for both manufacturing and service studies, and it is approximately the same for mixed samples.

A more interesting finding is that for both manufacturing firms and service organizations increasing workflow continuity and task routineness are associated with increased centralization of decision making, but increased use of automated information processing technology is related to decentralization. Automation of the production process (i.e., workflow integration) results in the same trivial correlation in both manufacturing and service organizations (i.e., $\bar{r} = -.02$).

These results suggest that the use of computers in administrative activities allows an alternative control mechanism for management. Management may not actually relinquish control to lower level operatives, but substitute more sophisticated control mechanisms for centralization of decision making.

Percentage Direct Workers

Manufacturing firms yield a larger correlation between technology and percentage direct workers than do service organizations. However, the correlation is negative for manufacturing firms and positive for service organizations. The signs of these correlations holds up for all four technology concepts. The negative correlation for manufacturers supports the finding of Woodward (1965).

Type of Measure and Level of Analysis

Table XIV-1 indicates that the relationship of technology to percentage clerical workers is moderated by both the type of measure used and the level of analysis. However, the moderator effect for the type of measure is due to the single questionnaire study by Leatt and Schneck (1982). This study was identified in Chapter VII an an extreme correlation in the distribution of 13 correlations. Since this is the only analysis in which the type of measure appeared to have an effect, and that effect was based upon a relatively small sample, the possibility must be considered that the Leatt and Schneck study is an anomaly.

Notice in Table XIV-1 that level of analysis still has a moderating effect among studies using institutional measures. However, organization level studies have the higher correlation so there is no support for the hypothesis that technology will have a stronger impact on structure at the subunit level.

Confidence in Findings

Table XIV-1 also includes the 95 percent confidence intervals for the mean corrected correlations. These reflect the degree of confidence that we can place in the results of these meta-analyses due to the fact that we have a limited number of studies available. This is not a limitation of meta-analysis per se. It applies to primary research, too.

These confidence intervals may be narrowed by including additional studies in future meta-analyses. They highlight the structural variables that should be included in future primary research studies of the technology-structure relationship. Specifically, those variables with wide confidence intervals and, especially those that include zero, need further study.

Summary of Hypotheses Tested

Table XIV-2 summarizes the hypotheses tested in Chapters VI through XII.

Hypothesis 1, which posited that all observed variance between correlations is caused by artifacts, was supported in 17 of the 30 meta-analyses performed in Chapter VI. If over 90 percent of the variance was explained by artifacts the conclusion was that all variance was due to artifacts. For the other 13 structural variables there was a sufficiently large residual variance to suggest that moderators might be present.

Hypothesis 2 was also rejected in Chapter VI. This hypothesis stated that technology would have a stronger relationship with the structural variables linked to the workflow. However, the stronger correlations were found between technology and division of labor, functional specialization, standardization, and formalization.

Hypothesis 3 proposes that the different operational definitions of technology used in a study will affect the size of the technology-structure correlation observed. It was supported in the cases of standardization, percentage workflow planning and control, division of labor, functional specialization, overall formalization, formalization of roles, centralization, and percentage direct workers. The largest correlations tend to appear with measures of automation (i.e., information technology, and workflow integration).

Hypothesis 4, which states that the technology-structure relationship is stronger in small organizations than in large organizations, was rejected when small organizations are defined as those with less than 1,000 personnel, and large organizations are those with more than 1,000 personnel. Organization size does not appear to moderate the technology-structure relationship. Thus, the failure of subsequent researchers to replicate the findings of Woodward (1965) is not due to their having larger organizations in their samples.

Hypothesis 5 proposes that the type of organization studied will affect the size of the technology structure correlation. This hypothesis was supported in the case of supervisor's span of control, percentage supervisors, percentage administration, functional specialization, formalization of roles, centralization, and percentage direct workers. Manufacturers tend to yield larger correlations than service organization do.

Hypothesis 6a states that the results of technology-structure studies conducted at the subunit level of analysis will be more consistent than those conducted at the individual level or the organization level, while hypothesis 6b posits that subunit level studies will yield larger correlations than will organization level studies. Hypothesis 6a was supported in Chapter XI. The mean residual variance for studies conducted at the subunit level of analysis was consistently lower than the residual variance for the combined studies. This could not be said for either individual level studies or organization level studies. However, the differences between the corrected mean correlations at each level of analysis do not support Hypothesis 6b. There was only one case in which the correlation at subunit level was larger than that at organization level. That was for the correlation of task routineness with division of labor (Table XIV-1). Thus, subunit level studies are more internally consistent, but do not yield higher correlations. Therefore, level of analysis is not a moderator.

Hypothesis 7, which states that the type of measure used will influence the size of the technology-structure correlation, was rejected. The type of measure used only appeared to have an impact in the case of percentage clerical personnel, but that difference is based upon a single study. That study was identified in Chapter VII as a possible anomaly.

Conclusion

This chapter summarizes the results of meta-analyses of the relationship between technology and organization structure. The major source of variance in the study outcomes is sampling error variance. Only two moderators were detected with any consistency. Those were the technology concept, and the type of organization studied. Organization size, type of measure, and level of analysis are not important moderators of the relationship between technology and structure.

These results have important implications for future research. Chapter XV will address those issues.

Table XIV-1. Summary of Meta-Analyses: Technology and Organization Structure

Variable	k	N	Observed Mean r	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlat Mean	Corrected Correlat s.d.	Corrected Correlat s.e
No Moderator:										
Vertical Span:	29	2964	.268	.0292	.0146	49.8	.121	.342	.154	.036
CEO Span of Control:	20	2081	.189	.0116	-.0009	100+	0	.244	.000	.027
% Workflow Supervisors:	7	210	-.088	.0132	-.0220	100+	0	-.113	.000	.090
% Nonworkflow Personnel:	9	369	.131	.0100	-.0160	100+	0	.169	.000	.066
% Public Relations:	3	148	.121	.0164	-.0050	100+	0	.157	.000	.105
% Sales and Service:	5	186	.097	.0046	-.0239	100+	0	.126	.000	.094
% Transportation:	5	180	.212	.0104	-.0210	100+	0	.272	.000	.092
% Personnel:	3	142	.062	.0150	-.0064	100+	0	.050	.000	.109
% Training & Development:	4	155	.143	.0075	-.0212	100+	0	.154	.000	.102
% Welfare and Security:	4	153	.202	.0104	-.0199	100+	0	.259	.000	.101
% Purchasing and Stock Control:	5	180	.049	.0039	-.0255	100+	0	.064	.000	.097
% Facility Maintenance:	7	310	.239	.0190	-.0069	100+	0	.306	.000	.069
% Financial Control:	5	188	.034	.0063	-.0216	100+	0	.044	.000	.095
% Quality Evaluation and Control:	5	180	.126	.0213	-.0081	100+	0	.163	.000	.096
% Work Study:	3	140	.000	.0017	-.0202	100+	0	.000	.000	.110
% Design & Development:	5	167	.059	.0045	-.0273	100+	0	.076	.000	.101
% Legal and Insurance:	2	122	.180	.0038	-.0146	100+	0	.232	.000	.113
% Market Research:	3	148	.128	.0146	-.0070	100+	0	.166	.000	.105
One Moderator:										
Standardization:										
Workflow Continuity	6	147	.057	.0832	.0471	43.3	.217	.067	.257	.144
Task Routineness	7	342	.132	.0341	.0139	59.2	.118	.165	.148	.087
Workflow Integration	12	528	.220	.0441	.0157	64.4	.125	.333	.190	.063
Information Technology	5	537	.334	.0236	.0125	46.9	.112	.403	.135	.076
% Workflow Planning and Control:										
Workflow Continuity	4	118	-.350	.0739	.0366	50.4	.191	-.364	.199	.131
Task Routineness	2	131	-.190	.0025	-.0130	100+	0	-.208	.000	.093
Workflow Integration	3	155	-.142	.0758	.0564	25.5	.235	-.190	.318	.211
Information Technology	3	126	.138	.0283	.0078	72.5	.088	.146	.093	.107
Supervisor's Span of Control:										
Mixed	1	75	-.096					-.136	n.a.	.112
Manufacturing	15	719	-.053	.0133	-.0079	100+	0	-.071	.000	.049
Service	8	1507	.134	.0042	-.0014	100+	0	.178	.000	.030
% Supervisors:										
Service	4	1255	-.151	.0016	-.0033	100+	0	-.200	.000	.036
Mixed	2	154	-.065	.0000	-.0134	100+	0	-.084	.000	.104
Manufacturing (w/o Harvey, 1968)	4	337	.013	.0112	-.0006	100+	0	.017	.000	.072
% Administration:										
Service	4	209	-.104	.0186	-.0009	100+	0	-.138	.000	.0920
Manufacturing	10	556	.145	.0290	.0100	65.4	.100	.191	.132	.0692

y and Organization Structure

Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval	Range
49.8	.121	.342	.154	.0361	.065 to .596	.27 to .41	
100+	0	.244	.000	.0273	.244	.19 to .30	
100+	0	-.113	.000	.0901	-.113	-.29 to .06	
100+	0	.169	.000	.0669	.169	.04 to .30	
100+	0	.157	.000	.1057	.157	-.05 to .36	
100+	0	.126	.000	.0946	.126	-.06 to .31	
100+	0	.272	.000	.0927	.272	.09 to .45	
100+	0	.050	.000	.1094	.050	-.13 to .29	
100+	0	.154	.000	.1025	.154	-.02 to .35	
100+	0	.259	.000	.1010	.259	.06 to .46	
100+	0	.064	.000	.0976	.064	-.13 to .26	
100+	0	.306	.000	.0694	.306	.17 to .44	
100+	0	.044	.000	.0956	.044	-.14 to .23	
100+	0	.163	.000	.0960	.163	-.02 to .35	
100+	0	.000	.000	.1107	.000	-.22 to .22	
100+	0	.076	.000	.1013	.076	-.12 to .28	
100+	0	.232	.000	.1137	.232	.01 to .45	
100+	0	.166	.000	.1054	.166	-.04 to .37	
43.3	.217	.067	.257	.1445	-.355 to .490	-.22 to .35	
59.2	.116	.165	.145	.0876	-.078 to .409	-.01 to .34	
64.4	.125	.333	.190	.0638	.021 to .645	.17 to .50	
46.9	.112	.403	.135	.0761	.181 to .625	.25 to .55	
50.4	.191	-.364	.199	.1312	-.691 to -.036	-.62 to -.11	
100+	0	-.208	.000	.0934	-.208	-.39 to -.02	
25.5	.235	-.190	.318	.2119	-.713 to .332	-.61 to .22	
72.5	.065	.146	.093	.1075	-.007 to .299	-.06 to .36	
		-.136	n.a.	.1122		-.36 to .08	
100+	0	-.071	.000	.0497	-.071	-.17 to .03	
100+	0	.178	.000	.0305	.178	.12 to .24	
100+	0	-.200	.000	.0362	-.200	-.27 to -.13	
100+	0	-.054	.000	.1045	-.054	-.29 to .12	
100+	0	.017	.000	.0725	.017	-.12 to .16	
100+	0	-.138	.000	.0920	-.138	-.32 to .04	
65.4	.100	.191	.132	.0692	-.026 to .406	.06 to .33	

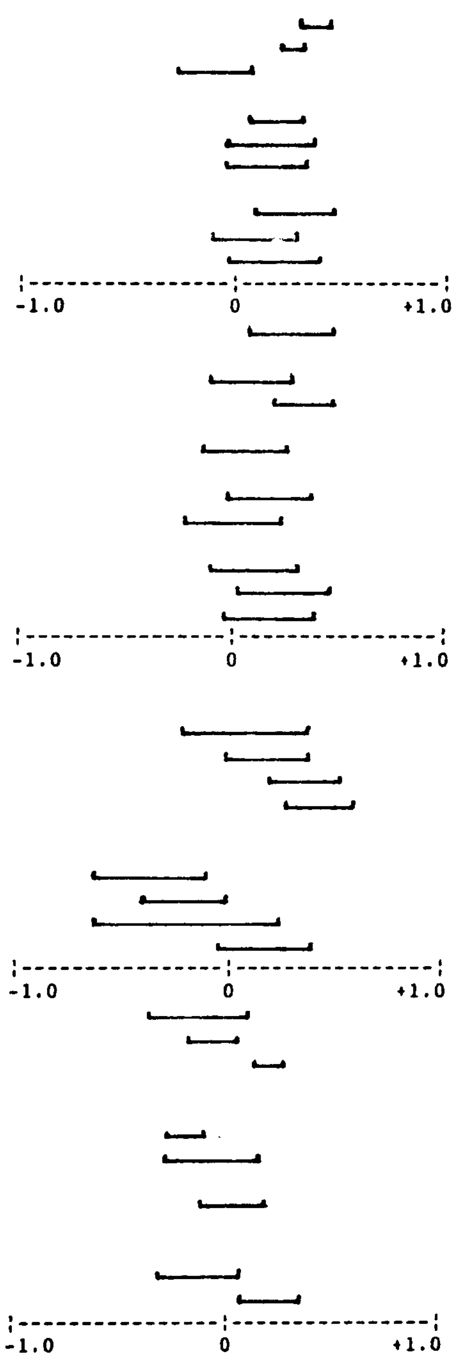

Table XIV-1--continued

Variable	k	N	Observed Mean r	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correla Mean	s.d.	s.
Multiple Moderators:										
<u>Division of Labor:</u>										
Workflow Continuity	5	122	.077	.1098	.0776	29.4	.279	.092	.330	.18
Organization	5	122	.077	.1098	.0776	29.4	.278	.092	.330	.18
Task Routineness	16	833	.117	.0817	.0649	2[illegible].5	.255	.147	.320	.09
Organization	11	582	.079	.1043	.0892	14.5	.299	.099	.376	.12
Subunit	5	251	.205	.0180	-.0031	100+	0	.258	.000	.07
Workflow Integration	11	602	.225	.0460	.0236	48.7	.154	.341	.233	.09
Subunit	2	101	-.026	.0327	.0139	57.4	.118	-.041	.161	.20
Organization	9	501	.276	.0333	.0083	75.2	.091	.416	.137	.07
Information Technology	6	1759	.384	.0024	-.0024	100+	0	.464	.000	.02
Subunit	2	1496	.373	.0001	-.0033	100+	0	.451	.000	.02
Organization	4	263	.444	.0113	-.0016	100+	0	.536	.000	.06
<u>Overall Formalization:</u>										
Individual	2	329	-.013	.0102	.0042	59.1	.064	-.019	.095	.10
Workflow Integration	2	329	.018	.0168	.0109	35.4	.104	.027	.160	.14
Task Routineness	1	174	.025					.032	n.a.	.07
Subunit	10	995	.179	.0173	.0041	76.2	.064	.263	.094	.05
Workflow Integration	5	539	-.032	.0402	.0314	21.9	.177	-.049	.272	.13
Information Technology	1	400	.302					.364	n.a.	.04
Task Routineness	7	341	.318	.0474	.0247	47.9	.157	.400	.197	.09
Organization	31	1529	.209	.0344	.0119	65.4	.109	.306	.160	.04
Task Routineness	15	715	.139	.0708	.0517	27.0	.227	.175	.286	.08
Workflow Continuity	16	628	.174	.0682	.0454	33.3	.213	.206	.253	.07
Workflow Integration	18	936	.227	.0277	.0046	83.2	.068	.343	.103	.05
Information Technology	8	535	.367	.0225	.0106	53.2	.103	.443	.124	.06
<u>Functional Specialization:</u>										
Task Routineness	18	689	.048	.0759	.0526	30.6	.229	.059	.278	.08
Service	9	375	-.015	.0385	.0163	57.7	.128	-.020	.173	.09
Manufacturing	12	314	.127	.0916	.0571	37.6	.239	.152	.288	.10
Workflow Continuity	16	559	.156	.0305	.0015	95.0	.039	.178	.045	.04
Manufacturing	14	460	.148	.0368	.0069	81.3	.083	.170	.095	.05
Service	1	6	.172					.209	n.a.	.42
Mixed	1	93	.190					.231	n.a.	.09
Workflow Integration	32	1401	.221	.0468	.0221	52.7	.149	.324	.218	.05
Mixed	5	288	.112	.0370	.0199	46.2	.141	.166	.208	.12
Service	8	255	.129	.0188	-.0132	100+	0	.207	.000	.09
Manufacturing	22	842	.230	.0417	.0136	67.3	.117	.356	.150	.06
Information Technology	15	1336	.406	.0204	.0122	40.3	.110	.473	.129	.04
Mixed	3	189	.321	.0108	-.0027	100+	0	.374	.000	.07
Service	4	611	.322	.0122	.0062	49.4	.079	.375	.092	.06
Manufacturing	9	536	.544	.0090	-.0014	100+	0	.634	.000	.03

Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
29.4	.278	.092	.330	.1836	-.452 to .636	-.27 to .45
29.4	.278	.092	.330	.1836	-.452 to .636	-.27 to .45
20.5	.255	.147	.320	.0911	-.380 to .674	-.03 to .32
14.5	.299	.099	.376	.1245	-.519 to .717	-.14 to .34
100+	0	.258	.000	.0765	.255	.11 to .41
48.7	.154	.341	.233	.0919	-.042 to .725	.16 to .52
57.4	.118	-.041	.151	.2004	-.339 to .257	-.43 to .35
75.2	.091	.416	.137	.0777	.191 to .642	.26 to .57
100+	0	.464	.000	.0246	.464	.42 to .51
100+	0	.451	.000	.0269	.451	.40 to .50
100+	0	.536	.000	.0603	.536	.42 to .65
59.1	.064	-.019	.095	.1060	-.176 to .137	-.23 to .19
35.4	.104	.027	.160	.1413	-.236 to .290	-.25 to .30
		.032	n.a.	.0760		-.12 to .18
76.2	.064	.263	.094	.0543	.108 to .418	.16 to .37
21.9	.177	-.049	.272	.1384	-.496 to .398	-.32 to .22
		.364	n.a.	.0434		.28 to .45
47.9	.157	.400	.197	.0968	.075 to .724	.21 to .59
65.4	.109	.306	.160	.0462	.043 to .569	.22 to .40
27.0	.227	.175	.286	.0872	-.295 to .645	.00 to .34
33.3	.213	.206	.253	.0784	-.210 to .621	.05 to .36
93.2	.068	.343	.103	.0533	.173 to .513	.24 to .45
53.2	.103	.443	.124	.0630	.239 to .647	.32 to .57
30.6	.229	.059	.278	.0806	-.399 to .517	-.10 to .22
57.7	.128	-.020	.173	.0912	-.304 to .264	-.20 to .16
37.6	.239	.152	.288	.1074	-.320 to .626	-.06 to .36
95.0	.039	.178	.045	.0492	.104 to .252	.08 to .27
81.3	.083	.170	.095	.0588	.014 to .326	.05 to .28
		.209	n.a.	.4277		-.63 to 1.00
		.231	n.a.	.0987		.04 to .42
52.7	.149	.324	.218	.0538	-.034 to .682	.22 to .43
46.2	.141	.166	.208	.1272	-.177 to .509	-.08 to .42
100+	0	.207	.000	.0999	.207	.01 to .40
67.3	.117	.356	.150	.0639	.059 to .652	.23 to .48
40.3	.110	.473	.129	.0427	.261 to .684	.39 to .56
100+	0	.374	.000	.0766	.374	.22 to .52
49.4	.079	.375	.092	.0624	.224 to .525	.25 to .50
100+	0	.634	.000	.0357	.634	.56 to .70

Range

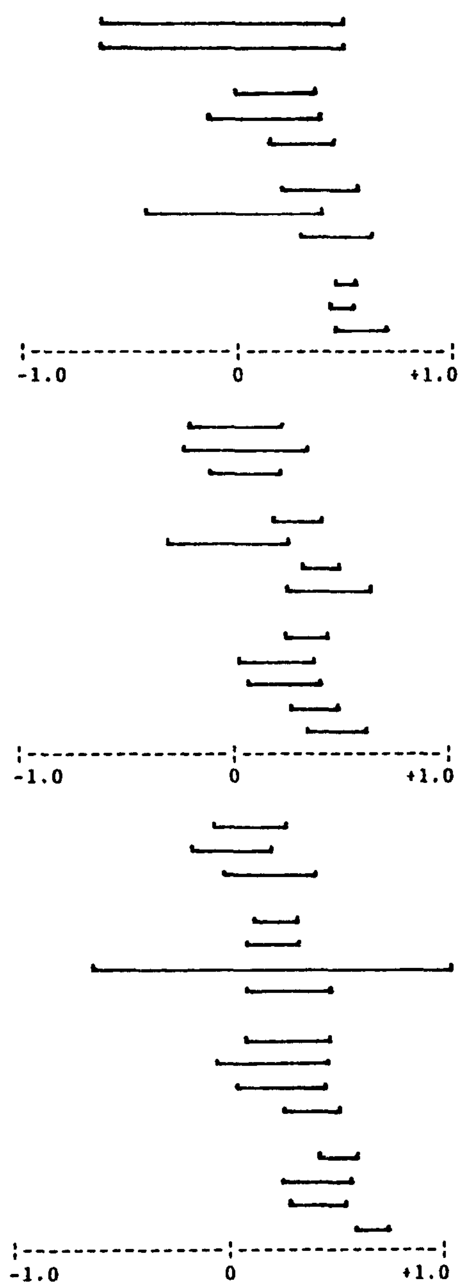

Table XIV-1--continued

Variable	k	N	Observed Mean r	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correl Mean	Corrected Correl s.d.	s
<u>Formalization of Roles:</u>										
Service	7	273	.148	.0223	-.0023	100+	0	.230	.000	.0
Task Routineness	5	216	.035	.0279	.0066	76.1	.082	.051	.120	.1
Workflow Integration	5	74	.261	.0598	.0010	98.4	.031	.443	.053	.1
Information Technology	1	51	.331					.485	n.a.	.1
Manufacturing	18	558	.208	.0425	.0090	78.9	.095	.317	.144	.0
Task Routineness	14	385	.164	.0904	.0588	34.9	.242	.214	.316	.1
Workflow Continuity	3	52	.209	.0475	-.0102	100+	0	.254	.000	.1
Workflow Integration	15	463	.184	.0290	-.0050	100+	0	.310	.000	.0
Information Technology	1	20	.320					.469	n.a.	.1
Mixed	3	181	.350	.0176	-.0090	100+	0	.517	.000	.0
Workflow Integration	3	181	.350	.0176	-.0090	100+	0	.517	.000	.0
<u>Centralization:</u>										
Mixed	11	845	-.097	.0605	.0688	14.6	.262	-.139	.376	.1
Workflow Integration	9	670	-.177	.0522	.0368	29.5	.192	-.262	.284	.1
Information Technology	4	294	-.146	.0905	.0791	12.5	.281	-.172	.330	.1
Workflow Continuity	2	196	-.120	.0090	-.0025	100+	0	-.138	.000	.0
Task Routineness	1	82	.473					.679	n.a.	.0
Manufacturing	24	973	.020	.0154	-.0092	100+	0	.029	.000	.0
Information Technology	6	353	-.081	.0139	-.0028	100+	0	-.095	.000	.0
Workflow Integration	15	701	-.010	.0142	-.0068	100+	0	-.016	.000	.0
Task Routineness	9	226	.071	.0125	-.0280	100+	0	.086	.000	.0
Workflow Continuity	16	583	.105	.0283	.0008	97.1	.029	.120	.033	.0
Service	23	1613	.095	.0436	.0296	32.1	.172	.141	.254	.0
Information Technology	3	195	-.246	.0605	.0480	20.5	.219	-.289	.257	.1
Workflow Integration	11	836	-.011	.0365	.0237	35.2	.154	-.018	.249	.0
Task Routineness	19	1397	.161	.0342	.0205	40.0	.143	.219	.195	.0
Workflow Continuity	1	6	.166					.236	n.a.	.4
<u>% Direct Workers:</u>										
Manufacturing	11	458	-.246	.0612	.0339	44.6	.184	-.322	.240	.0
Workflow Continuity	11	447	-.271	.0792	.0522	34.1	.228	-.282	.238	.0
Information Technology	3	192	-.166	.0117	-.0032	100+	0	-.175	.000	.0
Workflow Integration	10	373	-.116	.0330	.0054	83.8	.073	-.165	.104	.0
Task Routineness	6	173	-.096	.0446	.0116	74.0	.108	-.105	.118	.0
Service	3	47	.170	.0108	-.0587	100+	0	.225	.000	.1
Information Technology	1	26	.105					.117	n.a.	.1
Task Routineness	2	41	.189	.0052	-.0416	100+	0	.231	.000	.1
Workflow Integration	3	47	.161	.1546	.1107	28.4	.333	.232	.480	.3
Workflow Continuity	1	6	.791					.883	n.a.	.47
<u>% Clerical Personnel:</u>										
Questionnaire	1	148	-.212					-.297	n.a.	.07
Subunit	1	148	-.212					-.297	n.a.	.07
Institutional	12	1848	.020	.0077	.0012	84.2	.035	.025	.045	.03
Subunit	1	1201	-.022					-.032	n.a.	.02
Organization	11	647	.097	.0127	-.0050	100+	0	.125	.000	.05

Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	s.d.	s.e.	90 % Credibility Interval	95 % Confidence Interval
100+	0	.230	.000	.0929	.230	.05 to .41
76.1	.082	.051	.120	.1142	-.146 to .248	-.17 to .27
98.4	.031	.443	.053	.1921	.356 to .530	.07 to .82
		.485	n.a.	.1082		.27 to .70
78.9	.095	.317	.144	.0716	.080 to .555	.18 to .46
34.9	.242	.214	.316	.1072	-.306 to .734	.00 to .42
100+	0	.254	.000	.1655	.254	-.07 to .58
100+	0	.310	.000	.0768	.310	.16 to .46
		.469	n.a.	.1790		.12 to .82
100+	0	.517	.000	.0970	.517	.33 to .71
100+	0	.517	.000	.0970	.517	.33 to .71
14.6	.262	-.139	.576	.1238	-.758 to .480	-.38 to .10
29.5	.192	-.262	.284	.1099	-.729 to .205	-.48 to -.05
12.5	.281	-.172	.330	.1783	-.714 to .371	-.52 to .18
100+	0	-.138	.000	.0816	-.138	-.30 to .02
		.679	n.a.	.0599		.56 to .80
100+	0	.029	.000	.0477	.029	-.06 to .12
100+	0	-.095	.000	.0626	-.095	-.22 to .03
100+	0	-.016	.000	.0604	-.016	-.13 to .10
100+	0	.086	.000	.0818	.086	-.07 to .25
97.1	.029	.120	.033	.0486	.066 to .175	.02 to .22
32.1	.172	.141	.254	.0646	-.278 to .560	.01 to .27
20.5	.219	-.289	.257	.1685	-.712 to .134	-.62 to .04
35.2	.154	-.018	.249	.0938	-.428 to .391	-.20 to .16
40.0	.143	.219	.195	.0572	-.101 to .540	.11 to .33
		.236	n.a.	.4226		-.59 to 1.00
44.6	.184	-.322	.240	.0927	-.717 to .073	-.50 to -.14
34.1	.228	-.282	.238	.0852	-.672 to .109	-.45 to -.11
100+	0	-.175	.000	.0747	-.175	-.32 to -.03
83.8	.073	-.165	.104	.0804	-.335 to .006	-.32 to -.01
74.0	.108	-.105	.118	.0964	-.298 to .088	-.29 to .08
100+	0	.225	.000	.1940	.225	-.16 to .60
		.117	n.a.	.1973		-.27 to .50
100+	0	.231	.000	.1587	.231	-.14 to .60
28.4	.333	.232	.450	.3489	-.557 to 1.000	-.45 to .92
		.853	n.a.	.4796		-.06 to 1.00
		-.297	n.a.	.0747		-.44 to -.15
		-.297	n.a.	.0747		-.44 to -.15
84.2	.035	.025	.045	.0329	-.049 to .100	-.04 to .09
		-.032	n.a.	.0288		-.09 to .02
100+	0	.125	.000	.0508	.125	.02 to .22

Range

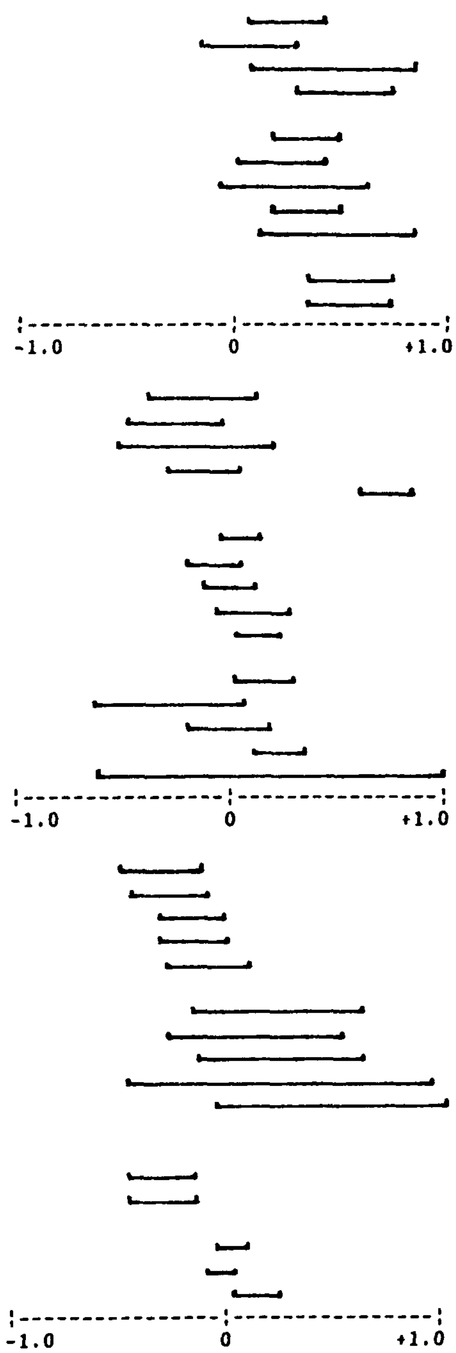

Table XIV-2. Summary of Hypotheses

	Hypotheses	Summary
Hypothesis 1	All variance between observed correlations is caused by artifacts.	Partial Support
Hypothesis 2	The effect of technology will be stronger for structural variables linked with workflow such as job-counts than for more remote administrative and hierarchical structural variables.	Rejected
Hypothesis 3	Different operational definitions of technology result in significantly different correlations with measures of structure thus contributing to the variance observed between studies.	Partial Support
Hypothesis 4	The correlation between technology and organization structure is stronger in small organizations than in large organizations.	Rejected
Hypothesis 5	The correlation between technology and structure is affected by whether the sample includes manufacturing organizations, service providers, or a combination of both.	Partial Support
Hypothesis 6a	The findings of studies at the subunit level of analysis will be more consistent than those for studies at the individual or organization level of analysis (i.e., variance between studies will be lower).	Supported
Hypothesis 6b	Studies conducted at the subunit level of analysis will have larger correlations than will studies using the organization level of analysis.	Rejected
Hypothesis 7	Questionnaire measures result in significantly different correlations from those obtained with institutional measures.	Rejected

CHAPTER XV
IMPLICATIONS OF FINDINGS

This study represents only a first step toward a theoretical explanation of the complex web of relationships between organization structure and context. Its major contribution to organization theory is a clarification of the relationship between technology and organization structure. No claim is made here that technology is the most important factor in determining organization structure as Woodward (1958/1966) did, but there does appear to be a consistent relationship between technology and structure.

This chapter will address some of the more significant conclusions reached in this study and the implications of these findings for future research.

Significance of Findings

As we discussed in Chapter II, several researchers who tried to replicate Woodward's (1965) findings obtained inconsistent results (e.g., Child & Mansfield, 1972; Hickson et al., 1969). Zwerman (1970) did claim to have many findings that supported Woodward's thesis, but this claim was later refuted by Donaldson (1976). Donaldson's review concluded that the inconsistencies in published research results "disconfirms core aspects of the original Woodward thesis" (1976: 273). This conclusion went beyond noting the inconsistencies in the research literature; it challenges the very existence of any technology-structure relationship.

Other reviewers of the technology-structure literature have reached a different conclusion than Donaldson (1976) did. Rather than challenging the existence of a relationship between technology and structure, these reviewers proposed moderators to explain the inconsistencies in research findings (e.g., Ford & Slocum, 1977; Fry, 1982; Gerwin, 1979b; Reimann & Inzerilli, 1979). As a result, a theory of moderators of the basic technology-structure relationship has evolved to explain inconsistencies.

Thus, the most significant findings of this study are that the results obtained in studies of the relationship between technology and structure are more consistent than previously believed, and the moderators that were observed are theoretical rather than methodological. However, it is also noted that the zero-order correlation between technology and structure is generally small.

Consistency in Study Results

The second order meta-analysis in Chapter VI indicates that artifacts explain an average of 87 percent of the variance observed between study correlations. Sampling error explained 70 percent of the variance by itself. The small proportion of variance that is unexplained suggests that moderators may not be a significant cause of variance, and those moderators suggested in previous reviews of the literature may be what Hunter et al. referred to as "apparitions composed of the ectoplasm of sampling error and other artifacts" (1982: 19).

These results indicate that most of the inconsistency observed in the results of technology-structure research are caused by small sample sizes, differences between studies in the reliability of measures, and differences between studies in the extent of range restriction.

Correlations Are Small

Chapter VI also notes that the average size of the zero-order correlations between technology and structure is only r = .18. This small correlation, coupled with the small sample sizes endemic to the technology-structure literature, explains why researchers tend not to find statistically significant results.

Statistical Power

The combination of small samples and small effect size indicates that the typical study in the technology-structure literature has low statistical power. If the true correlation is .18 and the sample sizes average 100, then a statistically significant correlation should be expected less than 50 percent of the time; about the same as the odds of observing tails on the flip of a fair coin.

The traditional vote counting procedure used in literature reviews would conclude that since less than one half of the studies yield statistically significant results, there is no relationship between technology and structure. However, this would be false. It also fails to recognize the theoretical importance of small correlations.

Theoretical Importance of Small Correlations

Hunter et al. point out that "the size of the correlation is relative to the context in which it is considered; partial correlations and beta weights may be much larger than zero-order correlations" (1982: 156). A small zero-order correlation can have significant direct and/or indirect effects when other variables are controlled.

Even a small correlation can have significant theoretical importance. This is especially true when competing theories are compared. For example, several contextual factors have been suggested as determinants of organization structure (e.g., organization size, environmental uncertainty, dependence on other organizations). The question addressed by many researchers is the relative importance of each of these contextual factors.

Moderators Are Theoretical

Another important finding of this study is that organization size, level of analysis, and the type of measure used do not appear to be important moderators. However, what is perhaps more important is that those factors that do have a moderating effect are not methodological factors, but variables that lend themselves to theoretical interpretation.

Methodological Factors

Neither the level of analysis of the study nor the type of measure used in the study have a significant effect on the results observed in studies of technology and structure. In Chapter XIII it was shown that these two factors are generally correlated with each other and also with the technology concept measured. Both tend to be spurious moderators when the technology concept is controlled.

These two methodological factors have long been accepted as causes for the differences in study outcomes. These meta-analyses have rejected them as moderators of the relationship between technology and structure, leaving only theoretical moderators.

Theoretical Moderators

Organization Size

The finding that organization size did not moderate the relationship between technology and structure is very important. It suggests that differences in findings between studies are not due to whether organizations are large or small. The idea that technology effects are seen most clearly in smaller organizations where technology pervades throughout affecting many aspects of structure is not supported. This is consistent with our finding that technology effects are not stronger on aspects of structure in close contact with the workflow. Technology effects are pervasive throughout the structure and can therefore be detected in large organizations as well as in small organizations (at least when a cutoff of 1,000 organization members distinguishes large from small).

Technology Concept

Gillespie and Mileti commented that "a universally applicable definition of technology should take into account machine sophistication, the nature of raw materials, and the nature of task characteristics including degrees of control or discretion" (1977: 8). All of the technology measures found in the literature appear to have at least some face validity with respect to these criteria, but no study could be found that encompasses all of them.

The technology concept operationalized in a study does make a difference in the size and even the sign of the correlation observed. For example, in Chapter VIII several cases were noted in which information processing technology (computerization) resulted in significantly larger correlations than did other technology concepts (i.e., division of labor, functional specialization, standardization, overall formalization, centralization, and supervisor's span of control). The difference between the largest and the smallest correlations for the four technology concepts can be quite significant. For example, the difference between the mean corrected correlation of division of labor with workflow continuity ($\bar{r}$ = .09) and that with information technology ($\bar{r}$ = .46) represents a difference of .37. A similar difference is observed between the correlation of task routineness with centralization ($\bar{r}$ = .20) and that for information technology ($\bar{r}$ = -.18).

The finding that the technology concept measured does affect the correlation obtained raises the issue of construct validity. These results suggest that the different measures of technology in use may be capturing different factors or dimensions of technology. It also suggests that an organization's technology may be described on several dimensions, and any one organization may differ on each dimension.

Organization Type

The finding that organization type moderates several relationships between technology and structure is particularly relevant given the shift from manufacturing to service economies in many Western nations (Davis, 1983). It implies that a successful shift from a product manufacturing economy to a service providing economy will be accompanied by changes in the types of organization structures that will be found.

However, the more immediate concern for theory development is not the manufacturing-service dichotomy, but the variables that are captured by this dichotomy. The organizational characteristics that vary from one organization to another and also discriminate between manufacturing and service organizations will allow an explanation of this moderator effect within the contingency theory framework.

Bowen et al. (1989) suggested that manufacturing and service organizations differ on five basic dimensions. They point out that "because goods-producing and service-producing firms are not dichotomies, sometimes service organizations can resemble manufacturing organizations in both the nature of their output and their organizational arrangements" (1989: 77). They therefore describe prototypes of the service organization and the manufacturing organization as extreme points on five continua.

First, the prototype service organization has an intangible output, while manufacturers have tangible output. Second, service organizations provide a customized output, but manufacturers have a standardized output. Third, customers participate in the delivery of services, but manufacturers buffer the technical core from the customer. Fourth, production and consumption are simultaneous in service organizations, but manufacturers hold inventories for later consumption. Finally, service organizations are labor intensive, but manufacturers are capital intensive. Bowen et al. claim that "each characteristic exists on a continuum, and any firm could potentially be profiled by all five characteristics at different points on their respective continua" (1989: 76).

Larsson and Bowen expand on the role of customer participation as a source of input uncertainty in service organizations and develop a "typology of service interdependence patterns" (1989: 221). This typology draws heavily from the work of Thompson (1967) who proposed that it is the interdependence created by an organization's technology that determines structure. However, customer participation in service organizations is a source of interdependence "external to the organization, constituting constraints and contingencies to which the design of the organization must adapt" (Larsson & Bowen, 1989: 219).

The constraint placed on organization design by customer participation may explain the moderator effect observed for organization type. It also has implications for how researchers define the boundaries and the size of the organization. If we continue to treat customers as external to the organization it may not be appropriate to compare the structures of organizations which have high levels of customer participation with those of organizations with low customer participation. However, this can be controlled in future research by including measures of the degree of customer participation in organizational activities. Thus, operational definitions of organization size may need to be revised to include the participation of customers.

Recommendations for Future Research

The finding that the variation in technology-structure relationship is due in large part to artifacts and that there does appear to be a consistent relationship between technology and structure, suggests that this area warrants additional primary research. In addition to including variables that discriminate between manufacturing and service organizations, several other specific recommendations can be made.

Assess the Construct Validity of Technology Measures

The results obtained in these meta-analyses suggest that the four technology concepts analyzed may have quite different factor structures. Recall that in Chapter VIII it was shown that the different concepts of technology often resulted in significantly different correlations with the same measures of structure. In some cases (e.g., centralization) the technology concept measured affected the sign of the correlation (i.e., workflow integration and information technology had negative correlations, while workflow continuity and task routineness had positive correlations).

Future research should address the construct validity of the several technology measures in use. As Nunnally points out, "for statements of relationship to have any meaning, each measure must, in some sense, validly measure what it is purported to measure" (1978: 95). One issue that needs to be addressed is the extent to which the different measures supply the same information (i.e., "tend to correlate with one another and be similarly affected by experimental treatments" (Nunnally, 1978: 103)).

However, an equally important issue is the extent to which the different measures supply different information (i.e., measure different constructs). The suggestion here is that organization technology has many dimensions and the extant measures of technology do a more or less adequate job of measuring those dimensions. The challenge is to find those that do a more adequate job, so that an organization's technology can be described both quantitatively and qualitatively along its several dimensions.

Include Performance Measures

Past research has tended to ignore the fundamental role of performance in structural contingency theory. As a result, there have been few true tests of the technological imperative hypothesis. It is performance that is contingent upon the proper fit between technology and structure.

Chapter V pointed out that performance may be a moderator of the relationship between technology and structure (Woodward, 1958/1966). If so, it is a source of some variance between study outcomes. Until researchers include performance indicators in their models it will remain a source of some inconsistency. However, the finding in this study that artifacts account for a majority of the variance observed between studies, suggests that only a small amount of variance could possibly be attributable to performance differences.

Provide Data for Future Meta-Analyses

Sampling error has been identified as the most significant cause of variance among study outcomes. However, it can only be reduced by increasing the size of the samples included in organization research. Small sample sizes are endemic to organization research and to recommend that researchers should solve this problem by using large samples would be foolish. The alternative would be no research at all.

However, researchers can recognize this source of error in their interpretation of results. Researchers and journal editors can also facilitate correction for sampling error and other artifacts in future meta-analyses by including the data needed to make those corrections in published studies.

Correlations

All studies should include the full correlation matrix; not just statistically significant correlations. This recommendation also applies to those researchers who use multiple regression analysis. This technique is based on the full zero-order correlation matrix, but unfortunately most researchers omit the correlation matrix. This practice is unfortunate because multiple regression weights generally cannot be accumulated across studies meta-analytically, but correlation coefficients can. As a result, the incremental knowledge provided to the field by these multiple regression studies becomes landlocked between the covers of the journals.

Artifacts

Researchers should also take care to provide information about the reliability of their measures and the means and standard deviations for their measures. This will allow correction for the effects of measurement error and range restriction in future meta-analyses, and can be provided in three columns added to the correlation matrix.

By providing these data each researcher can contribute to the accumulation of the increments of knowledge provided in each primary research study.

Meta-Analyses

The meta-analyses in this study have addressed only one contextual variable (i.e., technology) and its relationship to organization structure. Other meta-analyses are needed to address other contextual variables such as organization size, environmental uncertainty, and dependence on other organizations to determine the nature of their relationship with structure.

The results of those meta-analyses could then be combined with the results of this one to form a full matrix of corrected correlations between the several contextual variables and organization structure. This corrected matrix could be used to test different theoretical models using path analysis techniques.

Conclusion

Technology is only one of several contextual variables that have been proposed to be determinants of organization structure. The inconsistency in past research has led many researchers to abandon contingency theory in general, and technology in particular. The results of meta-analyses conducted in this study suggest that that decision may have been hasty. There does appear to be a relationship between technology and structure.

However, there is still much work to be done before the tattered garment of contingency theory can be declared whole. This will require a workmanlike attitude to glean the knowledge accumulated in 30 years of research. Meta-analyses are needed to accumulate the results of studies addressing the relationship of other contextual variables to structure.

The number and the quality of primary research studies also needs to be increased. Researchers need to be more aware of the effects of artifacts on study outcomes, and include the information needed to allow an accumulation of study results in future years. If they don't, they will be condemned to creating theoretical explanations for sampling error.

APPENDIX A

DISSERTATIONS REQUESTED

Al-Jibouri, S. J. J. 1983. Size, technology, and organizational structure in the manufacturing industry of a developing country: Iraq. Unpublished doctoral dissertation, Mississippi State University.

Ayoubi, Z. M. 1975. Technology, size, and organization structure in the industry of a developing country: Jordan. Unpublished doctoral dissertation, Indiana University, Graduate School of Business.

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APPENDIX C

BIBLIOGRAPHY OF STUDIES INCLUDED

1. Aiken, M., Bacharach, S. B., & French, J. L. 1980. Organizational structure, work process, and proposal making in administrative bureaucracies. Academy of Management Journal, 23: 631-652.

   Sample: 44 service organizations in Belgium.
   Technology measure: Task variety. This study provides no correlations but does include reliability coefficients for the scales.

2. Alexander, J. W., & Randolph, W. A. 1985. The fit between technology and structure as a predictor of performance in nursing subunits. Academy of Management Journal, 28: 844-859.

   Sample: 27 nursing subunits.
   Technology measure: 21 item instrument developed by Leatt and Schneck (1981) to assess three dimensions of the task: instability, variability, and uncertainty. No correlations were provided, but scale reliabilities were provided.

3. Al-Jibouri, S. J. J. 1983. Size, technology, and organizational structure in the manufacturing industry of a developing country: Iraq. Unpublished doctoral dissertation, Mississippi State University, Mississippi State.

   Sample: 27 manufacturers in Iraq.
   Technology measure: Workflow integration, automaticity of data processing, and the Aston revision of Woodward's scale workflow continuity.

4. Aston Data Bank. 1976 [Machine-readable data file]. Birmingham, England: University of Aston Management Centre Research Unit (Producer). Essex, England: University of Essex, ESRC Data Archive (Distributor). (Databank of Information from the Aston Programme of Organization Studies; Study Number 922.)

   The Aston Data Bank contains the raw data for 21 studies conducted between 1962 and 1973. Much of this data has never been published. For this meta-analysis correlations were computed from this raw data for studies conducted by the following researchers:

   a. Glueck: A study of 12 hospitals in the English Midlands conducted during 1970-71.

   b. Hickson and Inkson: A study of 44 manufacturing and service organizations in Birmingham, England conducted during 1967-68.

c-e. McMillan (three studies): a study of 12 British manufacturers conducted during 1971 (study 4c), a study of 14 Swedish manufacturers conducted during 1972 (study 4d), and a study of 51 Japanese manufacturers conducted during 1972 and 1973 (study 4e).

f. Pheysey: A study of 10 British manufacturers conducted during 1971 and 1972.

g. Pugh and Loveridge: A study of 16 manufacturing and service firms in Britain conducted in 1971.

h. Tauber: A study of two mental and four general hospitals in Britain conducted in 1967 and 1968.

In addition, correlations were computed to supplement published reports for the following studies:

i. Child: The "National Study" of 82 manufacturing and service firms conducted during 1967 through 1969.

j. Lee: A study of nine engineering and manufacturing firms in Coventry, England conducted in 1966 and 1967.

k. Pugh, et al.: The "Aston Study" of 52 manufacturing and service organizations in Birmingham, England conducted during 1962 and 1963. Published data on this study is limited to 46 of the 52 organizations, and a subsample of 31 manufacturers.

l. Payne and Mansfield: A study of 14 British manufacturers conducted in 1969 and 1970.

m. Reimann: A study of 20 Ohio manufacturers conducted during 1970 and 1971.

n. Schwitter: A study of 21 Ohio manufacturers conducted during 1968.

5. Ayoubi, Z. M. 1975. Technology, size, and organization structure in the industry of a developing country: Jordan. Unpublished doctoral dissertation, Indiana University, Bloomington.

Sample: 34 manufacturers in Jordan.
Technology measure: Workflow integration and workflow continuity.

6. Ayoubi, Z. M. 1981. Technology, size and organization structure in a developing country: Jordan. In D. J. Hickson & C. J. McMillan (Eds.), Organization and nation: The Aston Programme IV: 95-114. Westmead, England: Gower.

Sample: 34 manufacturers in Jordan. See Ayoubi (1975).

7. Badran, M., & Hinings, C. R. 1981. Strategies of administrative control and contextual constraints in a less developed country:

The case of Egyptian public enterprise. In D. J. Hickson & C. J. McMillan (Eds.), Organization and nation: The Aston Programme IV: 115-131. Westmead, England: Gower.

Sample: 31 organizations in Egypt.
Technology measure: Workflow integration.

8. Beckett, G. E. 1972. Technology, structure and maladaptation in a civil addict program: An organizational field study. Unpublished master's thesis, California State University, Fullerton.

Sample: 20 separately administered organizational units within the California Civil Addict program.
Technology measure: Task variety and analyzability, and materials variability and understandability. No correlations were provided, but raw scores were provided to allow computation of correlations.

9. Bell, G. D. 1967. Determinants of span of control. American Journal of Sociology, 73: 100-109.

Sample: 30 departments in one community hospital.
Technology measure: The degree of complexity composed of four factors: (a) degree of predictability of work demands, (b) amount of discretion they exercise, (c) extent of responsibility they have, and (d) number of different tasks they perform.

10. Beyer, J. M., & Trice, H. M. 1979. A reexamination of the relations between size and various components of organizational complexity. Administrative Science Quarterly, 24: 48-64.

Sample: 71 U.S. federal government organizations with more than 50 employees; 47 of these were categorized as routine, while the other 24 were categorized as nonroutine.; t-statistics were converted to point-biserial correlations for inclusion in this analysis.
Technology measure: Task routineness.

11. Blau, P. M. 1973. The organization of academic work: 48-77 and 258-270. New York: McGraw-Hill.

Sample: 115 universities and colleges in the United States.
Technology measure: Use of mechanical teaching aids such as TV or video tapes, language labs, programmed learning machines, and computers. This is viewed as an index of automaticity of the teaching function and in that respect is mechanization of the workflow. The second measure of technology relates to the extent of computer use in student and financial affairs. This relates more closely to information technology.

12. Blau, P. M., Falbe, C. M., McKinley, W., & Tracy, P. K. 1976. Technology and organization in manufacturing. Administrative Science Quarterly, 21: 20-40.

Sample: 110 New Jersey manufacturers. This sample is used by

other researchers at later dates. The correlations published in this study are included in the meta-analysis to the exclusion of duplicated relationships published later. See Collins (1986); Collins, Hage, and Hull (1988); Collins and Hull (1986); and McKinley (1987).
Technology measure: Production continuity, mechanization of production equipment, and the number of functions using a computer.

13. Blau, P. M., & Schoenherr, R. A. 1971. The structure of organizations. New York: Basic Books.

Sample: 53 employment security agencies (study 13a), 416 finance departments in American cities and states (study 13b), and 1,201 local offices of employment security (study 13c).
Technology measure: For the employment security agencies and the local offices the measure reflected the use of computers. For the finance departments the measure of mechanization was the use of electric typewriters; a somewhat primitive measure.

14. Budde, A., Child, J. Francis, A., & Kieser, A. 1982. Corporate goals, managerial objectives, and organizational structures in British and West German companies. Organization Studies, 3: 1-32.

Sample: 40 manufacturing firms in England. These are the 40 manufacturers in the National study. See Child and Mansfield (1972). This study also includes results for 51 manufacturers in Germany, which are also included in the Aston Data Bank (1976).
Technology measure: Workflow integration.

15. Carter, N. H. 1981. Computerization viewed as organizational technology: Its impact on the structure of newspaper organizations. Unpublished doctoral dissertation, University of Nebraska, Lincoln.

Sample: 68 daily newspapers.
Technology measure: Extent of computer use on specific tasks in newspaper operations. In this study, the use of computers is more directly tied to the workflow of the newspaper than to information processing at the administrative level, but there is one measure specifically addressing the use of computers in administration.

16. Carter, N. M. 1984. Computerization as a predominate technology: Its influence on the structure of newspaper organizations. Academy of Management Journal, 27: 247-270.

Sample: 68 daily newspapers. See Carter (1981).

17. Child, J., & Kieser, A. 1979. Organization and managerial roles in British and West German companies: An examination of the culture-free thesis. In C. J. Lammers & D. J. Hickson (Eds.), Organizations Alike and Unlike: International and inter-institutional studies in the sociology of organizations: 251-271. London: Routledge & Kegan Paul.

Sample: 82 English firms also discussed in Child and Mansfield (1972) and 51 West German firms. See Budde, Child, Francis, and Kieser (1982) for further comparison of these two studies.
Technology measure: Workflow integration.

18. Child, J., & Mansfield, R. 1972. Technology, size and organization structure. Sociology, 6: 369-393.

Sample: 82 organizations. This is referred to as the National study and is included in the Aston Data Bank (1976). The sample consists of 40 pure manufacturing firms, 15 daily newspapers, and 27 service providers.
Technology measure: Production continuity and workflow integration.

19. Collins, P. D., & Hull, F. 1986. Technology and span of control: Woodward revisited. Journal of Management Studies, 23: 143-164.

Sample: 95 of the manufacturing firms included in the Blau, Falbe, McKinley and Tracy (1976) sample of 110 New Jersey manufacturers.
Technology measure: In addition to the measure of automaticity of production equipment, they include two more. Task complexity was operationalized as the percentage of craftsmen in the production system. Task variability was operationalized as the extent to which production is oriented to customer specifications. The correlations with their measure of task variety is included, but the proportion of craftsmen is not included on the grounds that it is a characteristic of structure and not technology.

20. Comstock, D. E., & Scott, W. R. 1977. Technology and the structure of subunits: Distinguishing individual and workgroup effects. Administrative Science Quarterly, 22: 177-202.

Sample: 142 patient care wards in 16 hospitals.
Technology measure: Workflow predictability and task predictability.

21. Conaty, J., Mahmoudi, H., & Miller, G. A. 1983. Social structure and bureaucracy: A comparison of organizations in the United States and prerevolutionary Iran. Organization Studies, 4: 105-128.

Sample: 65 U.S. firms (study 21a), and 64 Iranian firms (study 21b).
Technology measure: Automaticity of production equipment and Blau's measure of computer use in information processing (Blau and Schoenherr, 1971).

22. Cox, T. H., Jr. 1981. Manufacturing policy and structure as affected by environment, size and technology: A contingency approach. Unpublished doctoral dissertation, University of Arizona, Tucson.

Sample: 20 manufacturing firms located in Tucson, Phoenix, Los Angeles, and Detroit engaged primarily in mass production, and with over 1,000 employees.
Technology measure: Khandwalla's scale of mass output orientation.

23. Daft, R. L., & Macintosh, N. B. 1981. A tentative exploration into the amount and equivocality of information processing in organizational work units. Administrative Science Quarterly, 26: 207-224.

24. Davis, L. L. 1985. Nursing technology, organizational control structures and nurse practitioner practice activities. Unpublished doctoral dissertation, University of Maryland, College Park.

Sample: 118 nurse practitioners in various practice settings.
Technology measure: Task routineness and variability. High scores indicate nonroutine and variable.

25. Dewar, R., & Hage, J. 1978. Size, technology, complexity, and structural differentiation: Toward a theoretical synthesis. Administrative Science Quarterly, 23: 111-136.

Sample: 16 social service agencies. See Hage and Aiken (1969).

26. Dewar, R. D., & Simet, D. P. 1981. A level specific prediction of spans of control examining the effects of size, technology, and specialization. Academy of Management Journal, 24: 5-24.

Sample: 16 social service agencies. See Hage and Aiken (1969).

27. Dewar, R. D., Whetten, D. A., & Boje, D. 1980. An examination of the reliability and validity of the Aiken and Hage scales of centralization, formalization, and task routineness. Administrative Science Quarterly, 25: 120-128.

Sample: 16 social service agencies. See Hage and Aiken (1969). Also 72 manpower organizations.
Technology measure: Task routineness.

28. Drazin, R., & Van de Ven, A. H. 1985. Alternative forms of fit in contingency theory. Administrative Science Quarterly, 30: 514-539.

29. Duncan, R. B., 1971. The effects of perceived environmental uncertainty on organization decision unit structure. Unpublished doctoral dissertation, Yale University, New Haven, CT.

30. Fernandez, R. R. 1974. Technology as an explanation for organizational structure. Unpublished master's thesis, California State University, Fullerton.

Sample: 8 juvenile probation camps.
Technology measure: Two measures--stimuli and response--correspond to task variety and analyzability. The researcher

provides no correlations but does provide scatter plots of the variables. The value of these points were used to calculate correlation coefficients.

31. Ford, J. D. 1975. An empirical investigation of the relationship of size, technology, workflow interdependence, and perceived environmental uncertainty to selected dimensions of subunit structure. Unpublished doctoral dissertation, Ohio State University, Columbus.

Sample: 86 subunits from 8 Ohio organizations (2 manufacturing and 6 service organizations).
Technology measure: Workflow interdependence. The extent to which persons are interdependent in the process of doing their work. Type I: Pooled; Type II: Sequential; Type III: Reciprocal. A second measure of technology assesses the extent of task variety.

32. Freeman, J. H. 1973. Environment, technology, and the administrative intensity of manufacturing organiza-tions. American Sociological Review, 38: 750-763.

Sample: 41 California manufacturers.
Technology measure: Automaticity of production system.

33. Fry, L. W., & Slocum, J. W., Jr. 1984. Technology, structure, and workgroup effectiveness: A test of a contingency model. Academy of Management Journal, 27: 221-246.

Sample: 61 lower and middle level work groups of a large metropolitan police department.
Technology measure: Interdependence, task variety, and task analyzability.

34. Garthright-Petelle, K. M. 1981. Communication processes and organizational structure as mechanisms of organizational control: A contingency perspective. Unpublished doctoral dissertation, University of Nebraska, Lincoln.

Sample: 28 task units from 12 major divisions of a service-regulatory agency (Office of Highway Safety).
Technology measure: Task uncertainty on three dimensions (i.e., variability, number of activities in the search process, and complexity). A review of the scale indicates it most closely relates to task variety. The author provides no correlations, but does provide enough data so that the point-biserial correlation can be estimated.

35. Glisson, C. A. 1978. Dependence of technological routinization on structural variables in human service organizations. Administrative Science Quarterly, 23: 383-395.

Sample: 30 human service organizations with at least two clearly identified hierarchical levels.
Technology measure: Technological routine; scale developed by Lynch (1974).

36. Hage, J., & Aiken, M. 1969. Routine technology, social structure and organization goals. Administrative Science Quarterly, 14: 366-376.

Sample: 16 social service agencies in the midwestern United States. This was the second wave of data collection for a panel study. Data was collected in 1964, 1967, and 1970. Correlations for all three waves are reported in Dewar and Hage (1978). Also see Dewar and Simet (1981); and Dewar, Whetten and Boje (1980). Technology measure: They refer to the measure as task routineness, but Withey, Daft, and Cooper (1983) conducted a factor analysis of this scale and labeled it a scale of exceptions rather than the broader routineness.

37. Harvey, E. 1968. Technology and the structure of organizations. American Sociological Review, 33: 247-259.

Sample: 43 industrial organizations.
Technology measure: Technical specificity; operationalized as the number of product changes over a 10 year period.

38. Hickson, D. J., Pugh, D. S., & Pheysey, D. C. 1969. Operations technology and organization structure: An empirical reappraisal. Administrative Science Quarterly, 14: 378-397.

Sample: 46 organizations in England; 31 manufacturers and 15 service providers. This is the original Aston study.
Technology measure: Production continuity and workflow integration.

39. Hinings, C. R., & Lee, G. L. 1971. Dimensions of organization structure and their context: A replication. Sociology, 5: 83-93.

Sample: 9 manufacturers in Coventry, England. This sample is included in the Aston Data Bank (1976).
Technology measure: Production continuity and workflow integration.

40. Hrebiniak, L. G. 1974. Job technology, supervision and work-group structure. Administrative Science Quarterly, 19: 395-410.

Sample: 174 workers plus 36 supervisors in one hospital.
Technology measure: Task predictability and task manageability.

41. Hsu, C-K., Marsh, R. M., & Mannari, H. 1983. An examination of the determinants of organizational structure. American Journal of Sociology, 88: 975-996.

Sample: 50 Japanese manufacturers. The Okayama project.
Technology measure: Khandwalla's scale of mass production orientation, and workflow integration.

42. Hull, F. M., & Collins, P. D. 1987. High-technology batch production systems: Woodward's missing type. Academy of Management Journal, 30: 786-797.

Sample: 110 New Jersey manufacturers reported in Blau, Falbe, McKinley, and Tracy (1976). Also see Collins and Hull (1986); and McKinley (1987) for others using this sample.
Technology measure: Automaticity of production equipment. This study does provide a correlation not previously reported. Those correlations have been included in this meta-analysis.

43. Inkson, J. H. K., Pugh, D. S., & Hickson, D. J. 1970. Organizational context and structure: An abbreviated replication. Administrative Science Quarterly, 15: 318-329.

Sample: 40 organizations in the English Midlands. This is the first replication of the Aston study (Hickson, Pugh, & Pheysey, 1969) and is included in the Aston Data Bank (1976).
Technology measure: Workflow integration. This article provides only one correlation.

44. Inkson, J. H. K., Schwitter, J. P., Pheysey, D. C., & Hickson, D. J. 1970. A comparison of organization structure and managerial roles: Ohio, U.S.A., and the Midlands, England. Journal of Management Studies, 7: 347-363.

Sample: This study compares matched data from a subsample of Inkson, Pugh, and Hickson (1970) and 21 manufacturers in the State of Ohio. Data for the 21 Ohio manufacturers was taken from this published source, but the subsample is not independent and therefore not duplicated in this meta-analysis. The sample of 21 Ohio manufacturers is also in the Aston Data Bank (1976).
Technology measure: Workflow integration.

45. Jester, J. C. 1982. An analysis of the relationship between technology and organizational structure in community supervision agencies. Unpublished doctoral dissertation, State University of New York at Albany.

Sample: 8 groups of probation and parole officers.
Technology measure: Variability of case load and task variety. Task variety related to the types of clients severed. Measures of search behavior were also included. No correlations were presented in this study, but the raw scores for the 8 groups were. This allowed calculation of the correlation.

46. Kedia, B. L. 1976. Organization context, environment, structure and effectiveness. Unpublished doctoral dissertation, Case Western Reserve University, Cleveland, OH.

Sample: 23 pharmaceutical and chemical firms in Bombay, India.
Technology measure: Modification of Khandwalla's scale of mass output orientation.

47. Khandwalla, P. N. 1970. The influence of the techno-economic environment on the organizational structure of firms. Unpublished doctoral dissertation, Carnegie-Mellon University, Pittsburgh.

Sample: 101 manufacturers in the United States. Data on 79 of these organizations is published in Khandwalla (1974).

48. Khandwalla, P. N. 1974. Mass output orientation of operations technology and organizational structure. Administrative Science Quarterly, 19: 74-97.

Sample: 79 manufacturing firms in the United States. This is a subsample of 101 firms included in Khandwalla's dissertation. See Khandwalla (1970).
Technology measure: Mass production orientation. This is a modified version of the Woodward scale of production continuity that attempts to assess an organization average, rather than only a measure of the dominant core technology.

49. Khandwalla, P. N. 1977. The design of organizations. New York: Harcourt Brace Jovanovich.

Sample: 103 Canadian firms; both manufacturing and service.
Technology measure: Mass production orientation (a modification of the Woodward scale), automaticity of operations, and a 7-point scale assessing the use of electronic data processing information technology.

50. Kimberly, J. R., & Rottman, D. B. 1987. Environment, organization and effectiveness: A biographical approach. Journal of Management Studies, 24: 595-621.

Sample: 123 sheltered work shops in New York, New Jersey and Pennsylvania.
Technology measure: Technical complexity operationalized as the total number of services and programs offered to clients.

51. Kmetz, J. L. 1975. Technology and organization structure: The relationship between contextual variables and structure variables in manufacturing and service organizations. Unpublished doctoral dissertation, University of Maryland, College Park.

Sample: 131 line and staff departments in 53 firms.
Technology measure: Workflow integration.

52. Kmetz, J. L. 1977. A critique of the Aston studies and results with a new measure of technology. Organization and Administrative Sciences, 8(4): 123-144.

Sample: 74 line and staff functions in 27 manufacturing and service firms. These 74 are a subsample of the 131 in Kmetz (1975). This study reports no zero order correlations between technology and structure.

53. Kmetz, J. L. 1981. Comparative prediction of organizational structure and effectiveness from four models of structure. Paper presented at the annual meeting of the National Academy of Management, San Diego, CA.

Sample: 27 organizational elements within the federal

government.
Technology measure: Unit interdependence, task variability, and task difficulty. In addition he assessed the perceived influence over interdependence, variability, and difficulty. This appears to capture the analyzability dimension, and has been treated as such.

54. Kuc, B., Hickson, D. J., & McMillan, C. J. 1981. Centrally planned development: A comparison of Polish factories with equivalents in Britain, Japan and Sweden. In D. J. Hickson & C. J. McMillan (Eds.), Organization and nation: The Aston Programme IV: 75-91. Westmead, England: Gower.

    Sample: 11 Polish manufacturers, 11 British manufacturers, 11 Swedish manufacturers, and 11 Japanese manufacturers. The British, Swedish, and Japanese samples are reported on elsewhere, but the Polish sample is not.
    Technology measure: Production continuity.

55. Leatt, P., & Schneck, R. 1981. Nursing subunit technology: A replication. Administrative Science Quarterly, 26: 225-236.

    Sample: 148 subunits of hospitals in Canada. Purpose of this study was to develop a scale of nursing technology.
    Technology measure: Instability, uncertainty, and variability.

56. Leatt, P., & Schneck, R. 1982. Technology, size, environment, and structure in nursing subunits. Organization Studies, 3: 221-242.

    Sample: 148 subunits of hospitals in Canada. See Leatt and Schneck (1981).

57. Loveridge, C. E. 1982. The relationship of nursing organizational structure to effectiveness: A technological perspective. Unpublished doctoral dissertation, University of Colorado Health Sciences Center, Boulder.

    Sample: 62 medical nursing care units of acute care general hospitals.
    Technology measure: Task instability, complex patients, task variability, and task uncertainty.

58. Lynch, B. P. 1974. An empirical assessment of Perrow's technology construct. Administrative Science Quarterly, 19: 338-356.

    Sample: 15 functional departments in 3 academic libraries.
    Technology measure: Interdependence, predictability, routineness, and insufficient knowledge.

59. Mahmoudi, H., & Miller, G. A. 1985. A causal model of hospital structure. Group & Organization Studies, 10(2): 209-223.

    Sample: 10 hospitals in the Salt Lake City area.
    Technology measure: Use of computers operationalized as the

number of functions, out of a list of 16, for which computers are used.

60. Mark, B. A. 1982. Task complexity, organizational structure, and organizational effectiveness in private psychiatric hospitals. Unpublished doctoral dissertation, Case Western Reserve University, Health Sciences, Cleveland, OH.

Sample: 86 private psychiatric hospitals.
Technology measure: Task complexity. This measure was based on three scales derived from the Organizational Assessment Inventory of Van de Ven and Delbecq (1974); Van de Ven, Delbecq, and Koenig (1976); and Van de Ven and Ferry (1980). Those scales are task difficulty, task variability, and task interdependence.

61. McKinley, W. 1987. Complexity and administrative intensity: The case of declining organizations. Administrative Science Quarterly, 32: 87-105.

Sample: 110 New Jersey manufacturers previously reported in Blau, Falbe, McKinley, and Tracy (1976). Also see Collins and Hull (1986); as well as Hull and Collins (1987) for additional analyses of this sample.

62. McMillan, C. J., Hickson, D. J., Hinings, C. R., & Schneck, R. E. 1973. The structure of work organizations across societies. Academy of Management Journal, 16: 555-569.

Sample: 24 Canadian manufacturers. Also see Hickson, Hinings, McMillan, and Schwitter (1974).
Technology measure: Automaticity of production.

63. Meyer, M. W. 1968. Automation and bureaucratic structure. American Journal of Sociology, 74: 256-264.

Sample: 254 city, county, and state departments of finance. This is a subsample of the 416 finance departments reported in Blau and Schoenherr, 1971 (Study 13 above). Since this is not an independent sample, it was not included in the meta-analysis.
Technology measure: Use of computers. The t-statistic between automated and nonautomated departments was provided.

64. Middlemist, R. D., & Hitt, M. A. 1981. Technology as a moderator of the relationship between perceived work environment and subunit effectiveness. Human Relations, 34: 517-532.

65. Miller, D., & Droege, C. 1986. Psychological and traditional determinants of structure. Administrative Science Quarterly, 31: 539-560.

Sample: 93 firms in Canada (62% manufacturing).
Technology measure: Modified version of Khandwalla's scale of mass production orientation.

66. Mills, P. K., Turk, T., & Margulies, N. 1987. Value structures, formal structures, and technology for lower participants in

service organizations. Human Relations, 40: 177-198.

Sample: 337 lower level employees from four service organizations.
Technology measure: Task uncertainty from the scale of Van de Ven and Delbecq (1974).

67. Mohr, L. B. 1971. Organizational technology and organizational structure. Administrative Science Quarterly, 16: 444-459.

Sample: 144 work groups in 13 local health departments.
Technology measure: Interdependence, task manageability, and noise level.

68. Moorhead, G. 1981. Organizational analysis: An integration of the macro and micro approaches. Journal of Management Studies, 18: 191-207.

Sample: 16 medical departments of a large general hospital.
Technology measure: Task routineness scale developed by Lynch (1974).

69. Negandhi, A. R., & Reimann, B. C. 1973. Correlates of decentralization: Closed and open systems perspectives. Academy of Management Journal, 16: 570-582.

Sample: 30 manufacturing firms in India, (15 U.S. subsidiaries and 15 locally owned).
Technology measure: A 3-point scale of Woodward's production continuity.

70. Paulson, S. K. 1980. Organizational size, technology and structure: Replication of a study of social service agencies among small retail firms. Academy of Management Journal, 23: 341-347.

Sample: 77 small retail firms in the United States.
Technology measure: Task scope operationalized as the variety of possible customer needs that the firm can satisfy.

71. Payne, R. L., & Mansfield, R. 1973. Relationships of perceptions of organizational climate to organiza-tional structure, context, and hierarchical position. Administrative Science Quarterly, 18: 515-526.

Sample: 14 manufacturing organizations in England. This sample is also included in the Aston Data Bank (1976).
Technology measure: Workflow integration.

72. Pennings, J. M. 1975. Interdependence and complementarity--the case of a brokerage office. Human Relations, 28: 825-840.

Sample: 40 branch offices of a large brokerage firm.
Technology measure: Interdependence.

73. Pfeffer, J., & Leblebici, H. 1977. Information technology and

organizational structure. Pacific Sociological review, 20: 241-261.

Sample: 38 manufacturing firms in the United States.
Technology measure: Computer technology operationalized as monthly cost of computers, number of employees in computer or data processing activities, and the budget of the computer or data processing group.

74. Piernot, C. A. 1979. Organization technology and structure: Determinants of corporate response to environmental uncertainty. Unpublished doctoral dissertation, Colorado State University, Fort Collins.

Sample: A non random sample of 31 corporations in California (service providers).
Technology measure: Task routineness: includes dimensions of uncertainty, variety, and general routineness.

75. Pitsiladis, P. E. 1979. Task-structure consonance and organizational performance: A subsystem perspective. Unpublished doctoral dissertation, University of Washington, Seattle.

Sample: 16 manufacturing firms. Separate analyses were conducted for procurement (study 75a), operations (study 75b), and marketing subsystems (study 75c) in each firm.
Technology measure: Task complexity defined as task variety plus task diversity (i.e., scope).

76. Ramsey, V. J. 1979. Organizational structure of academic departments as a function of environmental uncertainty or task routineness: Methodological and measurement issues. Unpublished doctoral dissertation, University of Michigan, Ann Arbor.

Sample: 21 academic departments in two colleges of a single university.
Technology measure: Task uncertainty developed by Van de Ven and Delbecq (1974). This study assesses the reliability of this scale.

77. Reimann, B. C. 1972. Management concern, context, and organization structure. Unpublished doctoral dissertation, Kent State University, Kent, OH.

Sample: 19 Ohio manufacturers. These organizations plus one more are included in the Aston Data Bank (1976).
Technology measure: Production continuity, workflow integration, and a measure of information processing technology.

78. Reimann, B. C. 1980. Organization structure and technology in manufacturing: System versus work flow level perspectives. Academy of Management Journal, 23: 61-77.

Sample: 20 Ohio manufacturers. See Reimann (1972).
Technology measure: This study provides the results of applying the Khandwalla scale of mass production orientation and a measure

of information processing technology.

79. Rousseau, D. M. 1977. The relationship of structure, technology and job characteristics to organizational behavior. Unpublished doctoral dissertation, University of California, Berkeley.

80. Rousseau, D. M. 1978. Characteristics of departments, positions, and individuals: Contexts for attitudes and behavior. Administrative Science Quarterly, 23: 521-540.

Sample: 19 departments drawn from an electronics firm and a local radio station.
Technology measure: Interdependence and automaticity of workflow.

81. Routamaa, V. 1985. Organizational structuring: An empirical analysis of the relationships and dimensions of structures in certain Finnish companies. Journal of Management Studies, 22: 498-522.

Sample: 122 clothing and shoe firms in Finland.
Technology measure: Automation of production and automation of administration.

82. Sathe, V. 1978. Institutional versus questionnaire measures of organizational structure. Academy of Management Journal, 21: 227-238.

83. Shenoy, S. 1981. Organization structure and context: A replication of the Aston study in India. In D. J. Hickson & C. J. McMillan (Eds.), Organization and nation: The Aston Programme IV: 133-154. Westmead, England: Gower.

Sample: 35 manufacturing organizations in India.
Technology measure: Production continuity.

84. Shrader, C. B. 1984. An investigation of the relationships among organization context, structure, and internal network properties. Unpublished doctoral dissertation, Indiana University, Bloomington.

Sample: 36 youth service agencies in the Indianapolis area.
Technology measure: The routineness of work.

85. Sutton, R. I., & Rousseau, D. M. 1979. Structure, technology, and dependence on a parent organization: Organizational and environmental correlates of individual responses. Journal of Applied Psychology, 64: 675-687.

Sample: 155 individuals in 14 northern California organizations of various types.
Technology measure: Thompson's classification scheme: long-linked, mediating, and intensive. Eight organizations were found to have mediating technology; the other six had intensive technology.

86. Tracy, P., & Azumi, K. 1976. Determinants of administrative control: A test of a theory with Japanese factories. American Sociological Review, 41: 80-94.

Sample: 44 Japanese manufacturers.
Technology measure: Production automaticity and task variability. Task variability operationalized as the degree of customer orientation in production. See Collins & Hull, 1986 for a similar operationalization.

87. Ungson, G. R. 1978. The relationship between task-environment contingency, structure, organizational role, and performance: An empirical and contextual analysis. Unpublished doctoral dissertation, Pennsylvania State University, University Park.

88. Van de Ven, A. A. 1977. A panel study on the effects of task uncertainty, interdependence, and size on unit decision making. Organization and Administrative Sciences, 8(2&3): 237-253.

89. Van de Ven, A. H., & Delbecq, A. L. 1974. A task contingent model of work-unit structure. Administrative Science Quarterly, 19: 183-197.

90. Van de Ven, A. H., Delbecq, A. L., & Koenig, R., Jr. 1976. Determinants of coordination modes within organizations. American Sociological Review, 41: 322-338.

Sample: 197 organizational units.
Technology measure: Task uncertainty (i.e., difficulty and variability) and task interdependence.

91. Vazzana, G. S. 1987. The mediating effect of innovative culture on the relationship between organizational structure and information-processing technology. Unpublished doctoral dissertation, University of Missouri, Columbia.

Sample: 298 personnel departments in medium to large cities and counties in the United States.
Technology measure: Information processing technology. All forms of computer-based management information systems.

92. Victor, B., & Blackburn, R. S. 1987. Determinants and consequences of task uncertainty: A laboratory and field investigation. Journal of Management Studies, 24: 387-404.

93. Williams, M. J. 1984. Organizational control: A study of variance in the control structure of private secondary schools in the United States. Unpublished doctoral dissertation, Columbia University Teachers College, New York.

Sample: 454 schools.
Technology measure: Operations technology--number of programs, courses, credit, etc.; materials technology--number and extent of facilities and classroom space. This measure appears to combine task variety and materials variability.

94. Withey, M., Daft, R. L., & Cooper, W. H. 1983. Measures of Perrow's work unit technology: An empirical assessment and a new scale. Academy of Management Journal, 26: 45-63.

95. Wong, G. Y. Y., & Birnbaum, P. H. (1989). Impact of culture on organization structure of banks in Hong Kong. Unpublished manuscript, University of Southern California, Los Angeles.

Sample: 39 multinational banks operating in Hong Kong.
Technology measure: Automaticity mode and range.

96. Woodward, J. 1965. Industrial organization: Theory and practice. London: Oxford University Press.

Sample: 80 manufacturing firms in England.
Technology measure: Production continuity. Correlations calculated from data presented in tables and graphs.

97. Worley, J. K. 1983. An analysis of relationships among size, technology and structure in a contextually limited setting. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University, Blackburg.

Sample: 15 construction firms classified as custom technology, and 21 manufacturing firms classified as mass technology.
Technology measure: Custom and mass technology; t-statistics for the difference between technology types were converted to point-biserial correlations.

98. Zeffane, R. 1981. Context, technology and organization structure revisited: A tri-national study. In R. Mansfield & M. Poole, International perspective on management and organization: 84-96. Aldershot, Hampshire: Gower Press.

Sample: Three samples were reported: 70 in Britain (study 98a); 50 in Algeria (study 98b); and, 61 in France (study 98c). All were industrial organizations of varying sizes, operating in a variety of sectors of industry.
Technology measure: The extent to which electronic devices are used in production, and use of computers in such activities as production control, accounting and finance, market research, and so forth.

99. Zwerman, W. 1970. New perspectives on organization theory. Westport, CT: Greenwood Publishing Corporation.

Sample: 54 manufacturing firms in the United States.
Technology measure: Production continuity. Correlations were estimated from data presented in tables and graphs.

APPENDIX D

BASIC PROGRAM FOR META-ANALYSES

USING ARTIFACT DISTRIBUTIONS

```
10 REM V.G. WITH ARTIFACT DISTRIBUTIONS; NONINTERACTIVE V.G.
20 REM THIS IS PROGRAM VG-NONINTERACTIVE; DATE JAN. 14, 1985
25 REM WRITTEN BY FRANK SCHMIDT
30 REM CONVERTED BY JEC, MARCH 1988 (CALLED NEWVGNON.BAS)
40 REM FOR IBM COMPATIBLE PC'S USING GW BASIC VERSION 2.0
50 REM PROGRAM ASSUMES UNRES. SD=1.00
55 REM PROGRAM REQUIRES SEQUENTIAL DATA FILES
60 DIM R(150,2),RC(100,2),RX(100,2),SD(100,2)
70 PRINT"YOU MUST ENTER 4 DISK FILE NAMES IN THIS ORDER"
80 PRINT"FIRST, THE FILE WITH R'S & N'S":PRINT
90 PRINT"SECOND, THE FILE WITH RYY'S & FREQ'S":PRINT
100 PRINT"THIRD, THE FILE WITH RXX'S & FREQ'S":PRINT
110 PRINT"FOURTH, THE FILE WITH RR'S & FREQ'S":PRINT
120 PRINT"KEEP TRACK OF THIS ORDER":PRINT
130 PRINT"R AND N FILE"
140 INPUT "DISK/DATA FILE NAME";N$
150 INPUT "NUMBER OF ROWS";NR
160 INPUT "NUMBER OF COLUMNS";NC
170 OPEN "I",2,N$
180 REM READ IN R AND N MATRIX
190 FOR I=1 TO NR:FOR J=1 TO NC
200 INPUT#2,R(I,J)
210 NEXT J:NEXT I
220 CLOSE 2
270 REM READ IN RYY MATRIX
280 PRINT:PRINT "RYY AND FREQ'S FILE"
290 INPUT "DISK/DATA FILE NAME";M$
300 INPUT "NUMBER OF ROWS";N1
310 INPUT "NUMBER OF COLUMNS";N2
320 OPEN "I",3,M$
330 FOR I=1 TO N1:FOR J=1 TO N2
340 INPUT#3,RC(I,J)
350 NEXT J:NEXT I
360 CLOSE 3
410 REM READ IN RXX MATRIX
420 PRINT:PRINT "RXX AND FREQ'S FILE"
430 INPUT "DISK/DATA FILE NAME";P$
440 INPUT "NUMBER OF ROWS";N3
450 INPUT "NUMBER OF COLUMNS";N4
460 OPEN "I",4,P$
470 FOR I=1 TO N3:FOR J=1 TO N4
480 INPUT#4,RX(I,J)
490 NEXT J:NEXT I
```

```
500 CLOSE 4
550 REM READ IN RES. SD MATRIX
560 PRINT:PRINT "RR AND FREQ'S FILE"
570 INPUT "DISK/DATA FILE NAME";Q$
580 INPUT "NUMBER OF ROWS";N5
590 INPUT "NUMBER OF COLUMNS";N6
600 OPEN "I",5,Q$
610 FOR I=1 TO N5:FOR J=1 TO N6
620 INPUT#5,SD(I,J)
630 NEXT J:NEXT I
640 CLOSE 5
690 REM COMPUTING MEAN OBSERVED R
700 TN=0:SUM=0
710 FOR I=1 TO NR
720 SUM=SUM+R(I,2)*R(I,1)
730 TN=TN+R(I,2):NEXT I
740 MR=SUM/TN
750 REM COMPUTING SAMPLING ERROR VAR.
760 RN=0:SS=0
770 FOR I=1 TO NR
780 S2=((1-R(I,1)^2)^2)/(R(I,2)-1)
790 SC=S2*R(I,2)
800 SS=SS+SC:RN=RN+1
810 NEXT I
820 VS=SS/TN
830 REM COMPUTING VAR OF OBSERVED R'S
840 ND=0:TD=0
850 FOR I=1 TO NR
860 ND=R(I,2)*(R(I,1)-MR)^2
870 TD=TD+ND
880 NEXT I
890 VAR=TD/TN:SO=SQR(VAR)
900 VP=(VS/VAR)*100
910 REM COMPUTING MEAN OF SQR OF RYY
920 Y1=0:Z1=0
930 FOR I=1 TO N1
940 X1=SQR(RC(I,1))*RC(I,2)
950 Y1=Y1+X1
960 Z1=Z1+RC(I,2)
970 NEXT I
980 CM=Y1/Z1
990 REM COMPUTING MEAN OF SQR OF RXX
1000 Y2=0:X2=0:Z2=0
1010 FOR I=1 TO N3
1020 X2=SQR(RX(I,1))*RX(I,2)
1030 Y2=Y2+X2
1040 Z2=Z2+RX(I,2)
1050 NEXT I
1060 XM=Y2/Z2
1070 REM COMPUTING MEAN RESTRICTED SD
1080 Y3=0:X3=0:Z3=0
1090 FOR I=1 TO N5
1100 X3=SD(I,1)*SD(I,2)
1110 Y3=Y3+X3
1120 Z3=Z3+SD(I,2)
1130 NEXT I
```

```
1140 SM=Y3/Z3
1150 REM COMPUTING TRUE SCORE MEAN R
1160 REM ASSUMES RXX & RYY ARE APPL. POOL VALUES
1170 U=1/SM
1180 RR=MR*U/SQR((U^2)*(MR^2)-MR^2+1)
1190 RS=RR/(CM*XM)
1200 REM COMPUTING VAR DUE TO RYY DIFFS
1210 X4=0:Y4=0:Z4=0:F4=0
1220 FOR I=1 TO N1
1230 RA=RS*SQR(RC(I,1))
1240 X4=RA*RC(I,2)
1250 Y4=Y4+X4
1260 Z4=Z4+RA^2*RC(I,2)
1270 F4=F4+RC(I,2)
1280 NEXT I
1290 VC=(Z4/F4)-(Y4/F4)^2
1300 REM COMPUTING VAR DUE TO RXX DIFFS
1310 X5=0:Y5=0:Z5=0:F5=0
1320 RB=RS*SQR(CM)
1330 FOR I=1 TO N3
1340 RD=RB*SQR(RX(I,1))
1350 X5=RD*RX(I,2)
1360 Y5=Y5+X5
1370 Z5=Z5+RD^2*RX(I,2)
1380 F5=F5+RX(I,2)
1390 NEXT I
1400 VX=(Z5/F5)-(Y5/F5)^2
1410 REM COMPUTING VAR DUE TO RR DIFFS
1420 X6=0:Y6=0:Z6=0:F6=0
1430 FOR I=1 TO N5
1440 V=SD(I,1)/1!
1450 RE=RR*V/SQR(1-RR^2+(V^2)*RR^2)
1460 X6=RE*SD(I,2)
1470 Y6=Y6+X6
1480 Z6=Z6+RE^2*SD(I,2)
1490 F6=F6+SD(I,2)
1500 NEXT I
1510 VR=(Z6/F6)-(Y6/F6)^2
1520 REM COMPUTING RESIDUAL VAR & SD
1530 S3=VAR-VS-VC-VX-VR
1540 IF S3<0 THEN S4=0
1550 IF S3>0 THEN S4=SQR(S3)
1560 REM COMPUTING SD-PREDICTED
1570 S5=SQR(VS+VC+VX+VR)
1580 REM COMPUTING PERCENT VAR ACC FOR
1590 S6=(S5^2/VAR)*100
1600 REM COMPUTE SD OF TRUE SCORE R
1610 S7=(RS/MR)*S4
1620 REM COMPUTE SD OF TRUE VALIDITY
1630 S8=S7*SQR(XM)
1640 REM COMPUTE MEAN TRUE VALIDITY
1650 R8=RS*SQR(XM)
1651 REM COMPUTE VAR OF TRUE VALIDITY
1652 V8=S4^2
1653 REM COMPUTE SAMPLING ERROR FOR CORRECTED R
1654 SE=(R8/MR)*SQR(((1-MR^2)^2/(TN-RN))+(V8/RN))
```

```
1660 REM BEST & WORST CASES--TRUE VAL.
1670 BC=R8+1.645*S8
1680 WC=R8-1.645*S8
1681 REM COMPUTE 80 PERCENT CI
1682 L80=R8-1.28*SE
1683 H80=R8+1.28*SE
1684 REM COMPUTE 90 PERCENT CI
1685 L90=R8-1.645*SE
1686 H90=R8+1.645*SE
1687 REM COMPUTE 95 PERCENT CI
1688 L95=R8-1.96*SE
1689 H95=R8+1.96*SE
1690 REM PRINT OUTPUT ON PRINTER
1700 PRINT:INPUT "WHEN PRINTER IS READY ANSWER Y  ";Y$
1701 IF Y$="Y" THEN 1702 ELSE 1990
1702 INPUT "REPORT NAME";J$
1704 LPRINT "REPORT:  ";J$:LPRINT
1706 LPRINT "USING R AND N FILE:  ";N$;"    ";NR;"x";NC:LPRINT
1707 LPRINT "  Ryy FILE:  ";M$;"    ";N1;"x";N2
1708 LPRINT "  Rxx FILE:  ";P$;"    ";N3;"x";N4
1709 LPRINT "  RR  FILE:  ";Q$;"    ";N5;"x";N6:LPRINT
1710 LPRINT"VALIDITY GENERALIZATION RESULTS"
1720 LPRINT"NONINTERACTIVE PROGRAM":LPRINT
1730 LPRINT"MEAN OBSERVED R=";MR
1740 LPRINT"SD OF OBSERVED R'S=";SO
1750 LPRINT"PREDICTED SD=";S5
1760 LPRINT"% VAR ACC FOR=";S6
1770 LPRINT"RESIDUAL SD=";S4
1780 LPRINT"RESIDUAL VAR=";S3
1790 LPRINT"NUMBER OF R'S=";RN
1800 LPRINT"TOTAL N=";TN:LPRINT
1810 LPRINT"MEAN TRUE SCORE R=";RS
1820 LPRINT"SD OF TRUE SCORE R=";S7
1830 LPRINT"MEAN TRUE VALIDITY=";R8
1840 LPRINT"SD OF TRUE VALIDITY=";S8
1850 LPRINT"BEST CASE=";BC
1860 LPRINT"WORST CASE=";WC:LPRINT:LPRINT
1870 LPRINT"SUPPLEMENTARY RESULTS":LPRINT
1880 LPRINT"TOTAL VARIANCE=";VAR
1890 LPRINT"SAMPLING ERROR VAR=";VS
1900 LPRINT"% VAR DUE TO SAMPLING ERROR=";VP
1910 LPRINT"VAR DUE TO CRITERION REL DIFFS=";VC
1920 LPRINT"VAR DUE TO TEST REL DIFFS=";VX
1930 LPRINT"VAR DUE TO RANGE RES DIFFS=";VR
1940 LPRINT"MEAN OF SQR OF CRITERION REL=";CM
1950 LPRINT"MEAN OF SQR OF TEST REL=";XM
1960 LPRINT"MEAN RESTRICTED SD=";SM:LPRINT
1970 LPRINT"MEAN R CORRECTED FOR RANGE RES=";RR:LPRINT
1971 LPRINT"SAMPLING ERROR FOR TRUE VALIDITY =   ";SE:LPRINT
1972 LPRINT"80 PERCENT CONFIDENCE INTERVAL:"
1973 LPRINT"   FROM ";L80;" TO ";H80:LPRINT:LPRINT
1975 LPRINT"90 PERCENT CONFIDENCE INTERVAL:"
1976 LPRINT"   FROM ";L90;" TO ";H90:LPRINT:LPRINT
1978 LPRINT"95 PERCENT CONFIDENCE INTERVAL:"
1979 LPRINT"   FROM ";L95;" TO ";H95
1990 END
```

APPENDIX E

CALCULATION OF THE STANDARD ERROR OF THE MEAN CORRELATION AND STATISTICAL SIGNIFICANCE TESTS

Standard Error of the Mean Correlation

According to Schmidt, Hunter, and Raju "the best estimate of the study population correlation and the most accurate estimate of its confidence interval is yielded by a Bayesian analysis using the mean and standard deviation of population correlations as determined from the meta-analysis of studies" (1988: 668). When the results of the meta-analysis indicate that there is a true standard deviation of population correlations (i.e., residual s.d. is greater than zero), then there are two components in the sampling error variance in the mean correlation. The first component is second order sampling error caused by having less than an infinite number of studies in the analysis. The second component is real variance in population correlations. The following formula is provided by Schmidt et al. (1988) and is used in this study to compute sampling error variance for mean correlations:

$$\sigma_e^2 = (1 - \bar{r}^2)^2 / (N - K) + \sigma_p^2 / K,$$

where N is total sample size, K is the number of studies, and σ_p^2 is the variance of population correlations (i.e., residual variance). The square root of this formula is the standard error in the mean correlation, and is used to construct confidence intervals in this meta-analysis.

The formula had to be modified slightly to arrive at a confidence interval for the corrected mean correlation. The standard error was computed and then increased by the ratio of the corrected mean correlation to the observed mean correlation. This process is the same as correcting the end points of the confidence intervals for the mean reliability of the independent and dependent variables, and for the average level of range restriction in the independent variable. It is also important to note that when the residual variance is negative, then σ_p^2 is set to zero for this calculation, and the element to the right of the plus sign drops out of the calculation. When all variance is explained by artifacts the studies included in the meta-analysis are considered to be a homogeneous sample from a single population. Only second order sampling error is considered in the confidence interval.

Statistical Significance Tests

The Z tests used to determine the extent to which confidence intervals do not overlap use a formula that includes the two correlations being compared and the standard error for the two combined studies. If $\bar{r}_1$ and $\bar{r}_2$ have standard errors of se_1 and se_2 respectively, then Z-tests can be used to test the statistical significance of the difference between $\bar{r}_1$ and $\bar{r}_2$ using the following formula:

$$Z = (\bar{r}_1 - \bar{r}_2) / \sqrt{(se_1^2 + se_2^2)}$$

All Z scores computed in this study use this formula.

APPENDIX F

DIVISION OF MIXED SAMPLES INTO MANUFACTURING AND SERVICE SUBSAMPLES

Table F-1. Split of Mixed Samples

Structural Variable	Total r	Total n	Manufacturing r	Manufacturing n	Service r	Service n
Division of Labor:						
4i Child, 1967: Information Technology	.346	82	.555	55	.180	27
Task Variability	.240	82	.012	55	.181	27
Workflow Integration					.174	27
18 Child & Mansfield, 1972:						
Production Continuity	-.240	40	-.240	40		
Workflow Integration	.390	82	.190	40		
Average	.246	72	.154	48	.178	27
4k Pugh et al., 1962-63: Task Variability	-.069	52	.139	37	-.294	15
Workflow Integration					-.085	15
38 Hickson, Pugh & Pheysey, 1969:						
Production Continuity	.520	31	.520	31		
Workflow Integration	.380	46	.250	31		
Average	.233	43	.293	33	-.190	15
Functional Specialization:						
4i Child, 1967: Information Technology	.351	82	.572	55	.153	27
Task Variability	.329	82	.139	55	.291	27
Workflow Integration					.174	27
18 Child & Mansfield, 1972:						
Production Continuity	-.170	40	-.170	40		
Workflow Integration	.410	82	.190	40		
Average	.289	72	.210	48	.206	27
4k Pugh et al., 1962-63: Task Variability	-.191	52	.063	37	-.316	15
Workflow Integration					-.089	15
38 Hickson, Pugh & Pheysey, 1969:						
Production Continuity	.340	31	.340	31		
Workflow Integration	.440	46	.190	31		
Average	.162	43	.190	33	-.202	15
4b Hickson & Inkson, 1967-68:						
Task Variability	-.040	44	.097	30	.022	14
Workflow Integration	.594	44	.256	30	.431	14
Average	.277	44	.176	30	.226	14
4g Pugh & Loveridge, 1971:						
Workflow Integration	.517	16	.481	15	n.a.	1

Table F-1--continued

Structural Variable	Total r	Total n	Manufacturing r	Manufacturing n	Service r	Service n
Standardization:						
4i Child, 1967: Information Technology	.327	82	.456	55	.212	27
Task Variability	.204	82	.080	55	.074	27
Workflow Integration					-.098	27
18 Child & Mansfield, 1972:						
Production Continuity	-.260	40	-.260	40		
Workflow Integration	.260	82	.150	40		
Average	.190	72	.132	48	.063	27
4k Pugh et al., 1962-63: Task Variability	-.137	52	-.044	37	-.102	15
Workflow Integration					.469	15
38 Hickson, Pugh & Pheysey, 1969:						
Production Continuity	.350	31	.350	31		
Workflow Integration	.460	46	.190	31		
Average	.193	43	.153	33	.184	15
Overall Formalization:						
4i Child, 1967: Information Technology	.387	82	.499	55	.166	27
Task Variability	.114	82	.047	55	.013	27
Workflow Integration					-.094	27
18 Child & Mansfield, 1972:						
Production Continuity	-.270	40	-.270	40		
Workflow Integration	.100	82	.120	40		
Average	.134	72	.126	48	.028	27
4k Pugh et al., 1962-63: Task Variability	-.152	52	-.084	37	-.102	15
Workflow Integration					.103	15
38 Hickson, Pugh & Pheysey, 1969:						
Production Continuity	.270	31	.270	31		
Workflow Integration	.170	46	.040	31		
Average	.064	43	.066	33	.000	15
Role Formalization:						
4i Child, 1967: Task Variability	.144	82	.108	55	.105	27
Workflow Integration	.091	82	.091	55	.053	27
Average	.118	82	.100	55	.079	27
4k Pugh et al., 1962-63: Task Variability	-.007	52	.000	37	-.061	15
Workflow Integration	.102	52	.250	37	.109	15
Average	.048	52	.125	37	.024	15
4b Hickson & Inkson, 1967-68:						
Task Variability	-.066	44	.022	30	-.211	14
Workflow Integration	.314	44	.236	30	.435	14
Average	.124	44	.129	30	.112	14
4g Pugh & Loveridge, 1971:						
Workflow Integration	.206	16	.148	15	n.a.	1
Vertical Span:						
4i Child, 1967: Information Technology	.203	82	.240	55	.163	27
Task Variability	.217	82	.148	55	.331	27
Workflow Integration					.169	27
18 Child & Mansfield, 1972:						
Production Continuity	-.190	40	-.190	40		
Workflow Integration	.170	82	.060	40		
Average	.142	72	.085	48	.221	27

Table F-1--continued

Structural Variable		Total r	Total n	Manufacturing r	Manufacturing n	Service r	Service n
4k Pugh et al., 1962-63:	Task Variability	-.063	52	-.114	37	.121	15
	Workflow Integration					.016	15
38 Hickson, Pugh & Pheysey, 1969:							
	Production Continuity	.510	31	.510	31		
	Workflow Integration	.090	46	.150	31		
Average		.129	43	.164	33	.068	15
Centralization:							
4i Child, 1967:	Information Technology	-.167	82	-.295	55	.337	27
	Task Variability	.138	82	-.032	55	.442	27
	Workflow Integration					.213	27
18 Child & Mansfield, 1972:							
	Production Continuity	.220	40	.220	40		
	Workflow Integration	.130	82	-.100	40		
Average		.060	72	-.069	48	.331	27
4k Pugh et al., 1962-63:	Task Variability	.306	52	.134	37	.549	15
	Workflow Integration					.094	15
38 Hickson, Pugh & Pheysey, 1969:							
	Production Continuity	.000	31	.000	31		
	Workflow Integration	-.160	46	-.050	31		
Average		.066	43	.034	33	.322	15
Supervisor's Span:							
4i Child, 1967:	Information Technology	-.136	80	-.149	55	.175	25
	Task Variability	.108	82	-.129	55	.323	27
	Workflow Integration					.231	27
18 Child & Mansfield, 1972:							
	Production Continuity	.020	40	.020	40		
	Workflow Integration	.140	82	-.210	40		
Average		.036	71	-.120	48	.245	26
4k Pugh et al., 1962-63:	Task Variability	-.266	50	-.102	37	-.382	15
	Workflow Integration					.170	15
38 Hickson, Pugh & Pheysey, 1969:							
	Production Continuity	-.090	31	-.090	31		
	Workflow Integration	.350	46	.020	31		
Average		.000	42	-.060	33	-.106	15
% Direct Workers:							
4i Child, 1967:	Information Technology	-.243	81	-.301	55	.105	26
	Task Variability	.036	81	-.235	55	.258	26
	Workflow Integration					.421	26
18 Child & Mansfield, 1972:							
	Production Continuity	.000	40	.000	40		
	Workflow Integration	.230	82	-.190	40		
Average		.007	71	-.195	48	.261	26
4k Pugh et al., 1962-63:	Task Variability	-.063	52	-.196	37	.070	15
	Workflow Integration					.091	15
38 Hickson, Pugh & Pheysey, 1969:							
	Production Continuity	-.140	31	-.140	31		
	Workflow Integration	-.180	46	-.170	31		
Average		-.123	43	-.170	33	.080	15

Table F-1--continued

Structural Variable		Total r	Total n	Manufacturing r	Manufacturing n	Service r	Service n
% Supervisors:							
4i Child, 1967:	Information Technology	-.048	81	-.141	55	-.080	26
	Task Variability	-.244	80	-.008	55	-.244	25
	Workflow Integration	-.232	80	.131	55	-.018	25
	Production Continuity	-.150	54	-.150	54		
Average		-.170	74	-.042	55	-.114	25
% Clerical Workers:							
4i Child, 1967:	Information Technology	.199	81	.202	55	.135	26
	Task Variability	-.124	81	.144	55	.122	26
	Workflow Integration	-.321	81	.013	55	.116	26
	Production Continuity	-.078	54	-.078	54		
Average		-.081	74	.071	55	.124	26
4k Pugh et al., 1962-63:	Task Variability	.184	52	.186	37	.224	15
	Workflow Integration	.051	52	-.017	37	.136	15
	Production Continuity	.052	36	.052	36		
Average		.101	47	.074	37	.180	15
% Workflow Planning & Control:							
4i Child, 1967:	Information Technology	.027	79	.006	52	.031	27
	Task Variability	-.230	72	-.081	52	-.543	27
	Workflow Integration					-.399	27
18 Child & Mansfield, 1972:							
	Production Continuity	-.650	40	-.650	40		
	Workflow Integration	-.360	82	-.340	40		
Average		-.256	70	-.236	46	-.304	27
4k Pugh et al., 1962-63:	Task Variability	-.128	52	-.370	37	.290	15
	Workflow Integration					.458	15
38 Hickson, Pugh & Pheysey, 1969:							
	Production Continuity	-.440	31	-.440	31		
	Workflow Integration	.270	46	-.170	31		
Average		-.061	43	-.329	33	.374	15
% Administration:							
4i Child, 1967:	Information Technology	.244	81	.393	54	.009	27
	Task Variability	.080	81	.242	54	.189	27
	Workflow Integration	-.086	81	.021	54	.285	27
	Production Continuity	.337	53	.337	53		
Average		.125	74	.248	54	.161	27
4k Pugh et al., 1962-63:	Task Variability	.090	52	-.062	37	.079	15
	Workflow Integration	-.110	52	-.000	37	.098	15
	Production Continuity	-.072	36	-.072	36		
Average		-.026	47	-.044	37	.088	15

APPENDIX G

CORRELATION BETWEEN MODERATORS

The 13 correlation matrices in this appendix were constructed by coding the characteristics of each of the studies included in the meta-analyses reported in this dissertation. A matrix is provided for each of the structural variables for which moderator tests were performed.

DOL: Division of labor
FS: Functional specialization
ST: Standardization
OF: Overall formalization
RF: Role formalization
VS: Vertical span
CENT: Centralization
SUB_SUP: Supervisor's span of control
PDIR: % Direct workers
PSUP: % Supervisors
PCLERKS: % Clerical personnel
PWFPC: % Workflow planning and control
PADMIN: % Administration

The dummy coding used for study characteristics was as follows:

Technology measure: 1 = yes; 0 = no
WFINT = Workflow Integration
WFCONT = Workflow Continuity
INFO = Information Technology
TASK = Task Routineness
Size = Organization size
1 = Large (>1,000)
0 = Small (<1,000)
. = Unknown size (missing data)
Organization Type: 1 = yes; 0 = no
MAN = Manufacturing organizations
SVC = Service organizations
MIX = Mixed sample of manufacturing and service organizations
Level of Analysis: 1 = yes; 0 = no
ORG = Organization level of analysis
SUB = Subunit level of analysis
IND = Individual level of analysis
MEAS = Type of measure used
1 = Institutional
0 = Questionnaire

Correlation between these coded study characteristics indicates the extent to which the five moderator variables are independent of one another. Examination of these matrices indicates that several of the proposed moderators are highly correlated.

DOL=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000 0.0000 26	0.40849 0.0383 26	0.13380 0.5146 26	-0.21958 0.2811 26	-0.03178 0.8855 23	-0.04014 0.8456 26	0.52705 0.0057 26	-0.38095 0.0548 26	0.18712 0.3600 26	-0.18712 0.3600 26	0.00000 1.0000 26	0.18712 0.3600 26
WFCONT	0.40849 0.0383 26	1.00000 0.0000 26	0.07916 0.7007 26	-0.12990 0.5271 26	0.18981 0.3857 23	0.28496 0.1582 26	0.19599 0.3373 26	-0.40849 0.0383 26	0.39853 0.0437 26	-0.39853 0.0437 26	0.00000 1.0000 26	0.39853 0.0437 26
INFO	0.13380 0.5146 26	0.07916 0.7007 26	1.00000 0.0000 26	-0.58954 0.0015 26	-0.08626 0.6955 23	-0.17293 0.3982 26	0.36387 0.0676 26	-0.13380 0.5146 26	0.07711 0.7081 26	-0.07711 0.7081 26	0.00000 1.0000 26	0.44164 0.0239 26
TASK	-0.21958 0.2811 26	-0.12990 0.5271 26	-0.58954 0.0015 26	1.00000 0.0000 26	0.27222 0.2089 23	-0.05484 0.7902 26	-0.01543 0.9404 26	0.06099 0.7672 26	-0.07670 0.7096 26	0.07670 0.7096 26	0.00000 1.0000 26	-0.40905 0.0380 26
SIZE	-0.03178 0.8855 23	0.18981 0.3857 23	-0.08626 0.6955 23	0.27222 0.2089 23	1.00000 0.0000 23	0.50892 0.0131 23	0.05774 0.7936 23	-0.51646 0.0116 23	0.02440 0.9120 23	-0.02440 0.9120 23	0.00000 1.0000 23	-0.11214 0.6105 23
MAN	-0.04014 0.8456 26	0.28496 0.1582 26	-0.17293 0.3982 26	-0.05484 0.7902 26	0.50892 0.0131 23	1.00000 0.0000 26	-0.29617 0.1418 26	-0.65561 0.0003 26	-0.10515 0.6092 26	0.10515 0.6092 26	0.00000 1.0000 26	-0.10515 0.6092 26
MIX	0.52705 0.0057 26	0.19599 0.3373 26	0.36387 0.0676 26	-0.01543 0.9404 26	0.05774 0.7936 23	-0.29617 0.1418 26	1.00000 0.0000 26	-0.52705 0.0057 26	0.35504 0.0751 26	-0.35504 0.0751 26	0.00000 1.0000 26	0.35504 0.0751 26
SVC	-0.38095 0.0548 26	-0.40849 0.0383 26	-0.13380 0.5146 26	0.06099 0.7672 26	-0.51646 0.0116 23	-0.65561 0.0003 26	-0.52705 0.0057 26	1.00000 0.0000 26	-0.18712 0.3600 26	0.18712 0.3600 26	0.00000 1.0000 26	-0.18712 0.3600 26
ORG	0.18712 0.3600 26	0.39853 0.0437 26	0.07711 0.7081 26	-0.07670 0.7096 26	0.02440 0.9120 23	-0.10515 0.6092 26	0.35504 0.0751 26	-0.18712 0.3600 26	1.00000 0.0000 26	-1.00000 0.0001 26	0.00000 1.0000 26	0.49020 0.0110 26
SUB	-0.18712 0.3600 26	-0.39853 0.0437 26	-0.07711 0.7081 26	0.07670 0.7096 26	-0.02440 0.9120 23	0.10515 0.6092 26	-0.35504 0.0751 26	0.18712 0.3600 26	-1.00000 0.0001 26	1.00000 0.0000 26	0.00000 1.0000 26	-0.49020 0.0110 26
IND	0.00000 1.0000 26	0.00000 1.0000 26	0.00000 1.0000 26	0.00000 1.0000 26	0.00000 1.0000 23	0.00000 1.0000 26	0.00000 1.0000 26	0.00000 1.0000 26	0.00000 1.0000 26	0.00000 1.0000 26	0.00000 1.0000 26	0.00000 1.0000 26
MEAS	0.18712 0.3600 26	0.39853 0.0437 26	0.44164 0.0239 26	-0.40905 0.0380 26	-0.11214 0.6105 23	-0.10515 0.6092 26	0.35504 0.0751 26	-0.18712 0.3600 26	0.49020 0.0110 26	-0.49020 0.0110 26	0.00000 1.0000 26	1.00000 0.0000 26

FS=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000	0.03858	0.11744	0.01873	0.18759	0.13003	0.21033	-0.35355	0.23927	-0.23927	0.00000	0.24903
	0.0000	0.8037	0.4477	0.9039	0.2342	0.4002	0.1706	0.0186	0.1178	0.1178	1.0000	0.1031
	44	44	44	44	42	44	44	44	44	44	44	44
WFCONT	0.03858	1.00000	-0.14498	0.00867	-0.18400	0.34396	-0.07174	-0.32733	0.20448	-0.20448	0.00000	0.11528
	0.8037	0.0000	0.3478	0.9555	0.2434	0.0222	0.6435	0.0301	0.1830	0.1830	1.0000	0.4562
	44	44	44	44	42	44	44	44	44	44	44	44
INFO	0.11744	-0.14498	1.00000	-0.43339	0.05738	0.01527	0.06761	-0.08305	0.00432	-0.00432	0.00000	0.10968
	0.4477	0.3478	0.0000	0.0033	0.7182	0.9216	0.6628	0.5920	0.9778	0.9778	1.0000	0.4785
	44	44	44	44	42	44	44	44	44	44	44	44
TASK	0.01873	0.00867	-0.43339	1.00000	0.07001	-0.08560	-0.03484	0.13245	-0.12825	0.12825	0.00000	-0.17493
	0.9039	0.9555	0.0033	0.0000	0.6595	0.5806	0.8224	0.3914	0.4067	0.4067	1.0000	0.2561
	44	44	44	44	42	44	44	44	44	44	44	44
SIZE	0.18759	-0.18400	0.05738	0.07001	1.00000	0.01381	0.08069	-0.10050	-0.03227	0.03227	0.00000	0.13525
	0.2342	0.2434	0.7182	0.6595	0.0000	0.9308	0.6115	0.5265	0.8392	0.8392	1.0000	0.3931
	42	42	42	42	42	42	42	42	42	42	42	42
MAN	0.13003	0.34396	0.01527	-0.08560	0.01381	1.00000	-0.56756	-0.60422	0.28309	-0.28309	0.00000	0.15960
	0.4002	0.0222	0.9216	0.5806	0.9308	0.0000	0.0001	0.0001	0.0626	0.0626	1.0000	0.3008
	44	44	44	44	42	44	44	44	44	44	44	44
MIX	0.21033	-0.07174	0.06761	-0.03484	0.08069	-0.56756	1.00000	-0.31311	0.14670	-0.14670	0.00000	0.08270
	0.1706	0.6435	0.6628	0.8224	0.6115	0.0001	0.0000	0.0385	0.3420	0.3420	1.0000	0.5935
	44	44	44	44	42	44	44	44	44	41	44	44
SVC	-0.35355	-0.32733	-0.08305	0.13245	-0.10050	-0.60422	-0.31311	1.00000	-0.46852	0.46852	0.00000	-0.26414
	0.0186	0.0301	0.5920	0.3914	0.5265	0.0001	0.0385	0.0000	0.0013	0.0013	1.0000	0.0832
	44	44	44	44	42	44	44	44	44	44	44	44
ORG	0.23927	0.20448	0.00432	-0.12825	-0.03227	0.28309	0.14670	-0.46852	1.00000	-1.00000	0.00000	-0.04125
	0.1178	0.1830	0.9778	0.4067	0.8392	0.0626	0.3420	0.0013	0.0000	0.0001	1.0000	0.7903
	44	44	44	44	42	44	44	44	44	44	44	44
SUB	-0.23927	-0.20448	-0.00432	0.12825	0.03227	-0.28309	-0.14670	0.46852	-1.00000	1.00000	0.00000	0.04125
	0.1178	0.1830	0.9778	0.4067	0.8392	0.0626	0.3420	0.0013	0.0001	0.0000	1.0000	0.7903
	44	44	44	44	42	44	44	44	44	44	44	44
IND	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	44	44	44	44	42	44	44	44	44	44	44	44
MEAS	0.24903	0.11528	0.10968	-0.17493	0.13525	0.15960	0.08270	-0.26414	-0.04125	0.04125	0.00000	1.00000
	0.1031	0.4562	0.4785	0.2561	0.3931	0.3008	0.5935	0.0832	0.7903	0.7903	1.0000	0.0000
	44	44	44	44	42	44	44	44	44	44	44	44

ST=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000	0.40825	0.00000	-0.20045	0.33710	0.00000	0.35355	-0.35355	0.70711	-0.70711	0.00000	0.78446
	0.0000	0.1309	1.0000	0.4738	0.2600	1.0000	0.1961	0.1961	0.0032	0.0032	1.0000	0.0005
	15	15	15	15	13	15	15	15	15	15	15	15
WFCONT	0.40825	1.00000	0.00000	0.05455	0.21958	0.28868	0.00000	-0.28868	0.57735	-0.57735	0.00000	0.32026
	0.1309	0.0000	1.0000	0.8469	0.4710	0.2967	1.0000	0.2967	0.0242	0.0242	1.0000	0.2445
	15	15	15	15	13	15	15	15	15	15	15	15
INFO	0.00000	0.00000	1.00000	-0.37796	-0.30000	-0.20000	0.40000	-0.20000	0.20000	-0.20000	0.00000	0.27735
	1.0000	1.0000	0.0000	0.1648	0.3193	0.4748	0.1396	0.4748	0.4748	0.4748	1.0000	0.3169
	15	15	15	15	13	15	15	15	15	15	15	15
TASK	-0.20045	0.05455	-0.37796	1.00000	0.35000	-0.09449	-0.09449	0.18898	-0.47246	0.47246	0.00000	-0.41931
	0.4738	0.8469	0.1648	0.0000	0.2411	0.7377	0.7377	0.5000	0.0753	0.0753	1.0000	0.1197
	15	15	15	15	13	15	15	15	15	15	15	15
SIZE	0.33710	0.21958	-0.30000	0.35000	1.00000	0.02500	0.35000	-0.43301	0.43301	-0.43301	0.00000	0.22822
	0.2600	0.4710	0.3193	0.2411	0.0000	0.9354	0.2411	0.1394	0.1394	0.1394	1.0000	0.4533
	13	13	13	13	13	13	13	13	13	13	13	13
MAN	0.00000	0.28868	-0.20000	-0.09449	0.02500	1.00000	-0.50000	-0.50000	0.20000	-0.20000	0.00000	-0.13868
	1.0000	0.2967	0.4748	0.7377	0.9354	0.0000	0.0577	0.0577	0.4748	0.4748	1.0000	0.6221
	15	15	15	15	13	15	15	15	15	15	15	15
MIX	0.35355	0.00000	0.40000	-0.09449	0.35000	-0.50000	1.00000	-0.50000	0.50000	-0.50000	0.00000	0.27735
	0.1961	1.0000	0.1396	0.7377	0.2411	0.0577	0.0000	0.0577	0.0577	0.0577	1.0000	0.3169
	15	15	15	15	13	15	15	15	15	15	15	15
SVC	-0.35355	-0.28868	-0.20000	0.18898	-0.43301	-0.50000	-0.50000	1.00000	-0.70000	0.70000	0.00000	-0.13868
	0.1961	0.2967	0.4748	0.5000	0.1394	0.0577	0.0577	0.0000	0.0037	0.0037	1.0000	0.6221
	15	15	15	15	13	15	15	15	15	15	15	15
ORG	0.70711	0.57735	0.20000	-0.47246	0.43301	0.20000	0.50000	-0.70000	1.00000	-1.00000	0.00000	0.55470
	0.0032	0.0242	0.4748	0.0753	0.1394	0.4748	0.0577	0.0037	0.0000	0.0001	1.0000	0.0319
	15	15	15	15	13	15	15	15	15	15	15	15
SUB	-0.70711	-0.57735	-0.20000	0.47246	-0.43301	-0.20000	-0.50000	0.70000	-1.00000	1.00000	0.00000	-0.55470
	0.0032	0.0242	0.4748	0.0753	0.1394	0.4748	0.0577	0.0037	0.0001	0.0000	1.0000	0.0319
	15	15	15	15	13	15	15	15	15	15	15	15
IND	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	15	15	15	15	13	15	15	15	15	15	15	15
MEAS	0.78446	0.32026	0.27735	-0.41931	0.22822	-0.13868	0.27735	-0.13868	0.55470	-0.55470	0.00000	1.00000
	0.0005	0.2445	0.3169	0.1197	0.4533	0.6221	0.3169	0.6221	0.0319	0.0319	1.0000	0.0000
	15	15	15	15	13	15	15	15	15	15	15	15

OF=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000	0.16557	0.20481	-0.09051	-0.18682	-0.07131	0.35551	-0.23556	-0.04535	-0.04271	0.18741	0.20241
	0.0000	0.2887	0.1877	0.5638	0.2826	0.6495	0.0193	0.1284	0.7727	0.7856	0.2288	0.1930
	43	43	43	43	35	43	43	43	43	43	43	43
WFCONT	0.16557	1.00000	-0.04126	-0.28389	0.05338	0.54700	0.03178	-0.55567	0.50674	-0.45134	-0.17002	0.42376
	0.2887	0.0000	0.7928	0.0651	0.7607	0.0001	0.8397	0.0001	0.0005	0.0024	0.2757	0.0046
	43	43	43	43	35	43	43	43	43	43	43	43
INFO	0.20481	-0.04126	1.00000	-0.46313	-0.00890	-0.13668	0.39336	-0.20481	0.21421	-0.17063	-0.11363	0.28322
	0.1877	0.7928	0.0000	0.0018	0.9595	0.3821	0.0091	0.1877	0.1678	0.2740	0.4681	0.0657
	43	43	43	43	35	43	43	43	43	43	43	43
TASK	-0.09051	-0.28389	-0.46313	1.00000	0.14622	-0.13482	-0.28614	0.37528	-0.27981	0.30701	-0.02586	-0.37895
	0.5638	0.0651	0.0018	0.0000	0.4019	0.3887	0.0629	0.0131	0.0692	0.0452	0.8693	0.0122
	43	43	43	43	35	43	43	43	43	43	43	43
SIZE	-0.18682	0.05338	-0.00890	0.14622	1.00000	0.18682	-0.00890	-0.18168	-0.20672	0.25214	-0.10090	-0.14678
	0.2826	0.7607	0.9595	0.4019	0.0000	0.2826	0.9595	0.2962	0.2335	0.1440	0.5641	0.4001
	35	35	35	35	35	35	35	35	35	35	35	35
MAN	-0.07131	0.54700	-0.13668	-0.13482	0.18682	1.00000	-0.40291	-0.62106	0.16307	-0.09363	-0.16166	0.05641
	0.6495	0.0001	0.3821	0.3887	0.2826	0.0000	0.0074	0.0001	0.2961	0.5504	0.3004	0.7194
	43	43	43	43	35	43	43	43	43	43	43	43
MIX	0.35551	0.03178	0.39336	-0.28614	-0.00890	-0.40291	1.00000	-0.46710	0.12265	-0.19658	0.13982	0.17273
	0.0193	0.8397	0.0091	0.0629	0.9595	0.0074	0.0000	0.0016	0.4333	0.2064	0.3712	0.2680
	43	43	43	43	35	43	43	43	43	43	43	43
SVC	-0.23556	-0.55567	-0.20481	0.37528	-0.18168	-0.62106	-0.46710	1.00000	-0.26258	0.25880	0.03644	-0.20241
	0.1284	0.0001	0.1877	0.0131	0.2962	0.0001	0.0016	0.0000	0.0889	0.0938	0.8165	0.1930
	43	43	43	43	35	43	43	43	43	43	43	43
ORG	-0.04535	0.50674	0.21421	-0.27981	-0.20672	0.16307	0.12265	-0.26258	1.00000	-0.89066	-0.33552	0.47666
	0.7727	0.0005	0.1678	0.0692	0.2335	0.2961	0.4333	0.0889	0.0000	0.0001	0.0278	0.0012
	43	43	43	43	35	43	43	43	43	43	43	43
SUB	-0.04271	-0.45134	-0.17063	0.30701	0.25214	-0.09363	-0.19658	0.25880	-0.89066	1.00000	-0.12949	-0.30808
	0.7856	0.0024	0.2740	0.0452	0.1440	0.5504	0.2064	0.0938	0.0001	0.0000	0.4079	0.0444
	43	43	43	43	35	43	43	43	43	43	43	43
IND	0.18741	-0.17002	-0.11363	-0.02586	-0.10090	-0.16166	0.13982	0.03644	-0.33552	-0.12949	1.00000	-0.40122
	0.2288	0.2757	0.4681	0.8693	0.5641	0.3004	0.3712	0.8165	0.0278	0.4079	0.0000	0.0077
	43	43	43	43	35	43	43	43	43	43	43	43
MEAS	0.20241	0.42376	0.28322	-0.37895	-0.14678	0.05641	0.17273	-0.20241	0.47666	-0.30808	-0.40122	1.00000
	0.1930	0.0046	0.0657	0.0122	0.4001	0.7194	0.2680	0.1930	0.0012	0.0444	0.0077	0.0000
	43	43	43	43	35	43	43	43	43	43	43	43

RF=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000	0.20412	-0.05455	0.04167	0.24960	-0.04029	0.31180	-0.32733	0.32733	-0.32733	0.00000	0.58977
	0.0000	0.3277	0.7956	0.8432	0.2507	0.8484	0.1292	0.1102	0.1102	0.1102	1.0000	0.0019
	25	25	25	25	23	25	25	25	25	25	25	25
WFCONT	0.20412	1.00000	0.31180	0.10206	-0.21375	0.23028	-0.14548	-0.13363	0.35635	-0.35635	0.00000	0.24077
	0.3277	0.0000	0.1292	0.6274	0.3274	0.2681	0.4878	0.5242	0.0804	0.0804	1.0000	0.2463
	25	25	25	25	23	25	25	25	25	25	25	25
INFO	-0.05455	0.31180	1.00000	-0.12729	0.20966	-0.05275	-0.02916	0.10714	0.19048	-0.19048	0.00000	0.12870
	0.7956	0.1292	0.0000	0.5443	0.3370	0.8022	0.8900	0.6102	0.3618	0.3618	1.0000	0.5398
	25	25	25	25	23	25	25	25	25	25	25	25
TASK	0.04167	0.10206	-0.12729	1.00000	0.21453	0.34247	-0.27469	-0.12729	0.12729	-0.12729	0.00000	-0.22116
	0.8432	0.6274	0.5443	0.0000	0.3256	0.0938	0.1839	0.5443	0.5443	0.5443	1.0000	0.2880
	25	25	25	25	23	25	25	25	25	25	25	25
SIZE	0.24960	-0.21375	0.20966	0.21453	1.00000	-0.23262	0.37058	-0.14608	0.32233	-0.32233	0.00000	0.22268
	0.2507	0.3274	0.3370	0.3256	0.0000	0.2855	0.0817	0.5060	0.1336	0.1336	1.0000	0.3071
	23	23	23	23	23	23	23	23	23	23	23	23
MAN	-0.04029	0.23028	-0.05275	0.34247	-0.23262	1.00000	-0.70353	-0.49237	0.27256	-0.27256	0.00000	0.03564
	0.8484	0.2681	0.8022	0.0938	0.2855	0.0000	0.0001	0.0124	0.1875	0.1875	1.0000	0.8657
	25	25	25	25	23	25	25	25	25	25	25	25
MIX	0.31180	-0.14548	-0.02916	-0.27469	0.37058	-0.70353	1.00000	-0.27217	-0.21384	0.21384	0.00000	0.18389
	0.1292	0.4878	0.8900	0.1839	0.0817	0.0001	0.0000	0.1881	0.3047	0.3047	1.0000	0.3789
	25	25	25	25	23	25	25	25	25	25	25	25
SVC	-0.32733	-0.13363	0.10714	-0.12729	-0.14608	-0.49237	-0.27217	1.00000	-0.10714	0.10714	0.00000	-0.27348
	0.1102	0.5242	0.6102	0.5443	0.5060	0.0124	0.1881	0.0000	0.6102	0.6102	1.0000	0.1859
	25	25	25	25	23	25	25	25	25	25	25	25
ORG	0.32733	0.35635	0.19048	0.12729	0.32233	0.27256	-0.21384	-0.10714	1.00000	-1.00000	0.00000	0.67566
	0.1102	0.0804	0.3618	0.5443	0.1336	0.1875	0.3047	0.6102	0.0000	0.0001	1.0000	0.0002
	25	25	25	25	23	25	25	25	25	25	25	25
SUB	-0.32733	-0.35635	-0.19048	-0.12729	-0.32233	-0.27256	0.21384	0.10714	-1.00000	1.00000	0.00000	-0.67566
	0.1102	0.0804	0.3618	0.5443	0.1336	0.1875	0.3047	0.6102	0.0001	0.0000	1.0000	0.0002
	25	25	25	25	23	25	25	25	25	25	25	25
IND	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	25	25	25	25	23	25	25	25	25	25	25	25
MEAS	0.58977	0.24077	0.12870	-0.22116	0.22268	0.03564	0.18389	-0.27348	0.67566	-0.67566	0.00000	1.00000
	0.0019	0.2463	0.5398	0.2880	0.3071	0.8657	0.3789	0.1859	0.0002	0.0002	1.0000	0.0000
	25	25	25	25	23	25	25	25	25	25	25	25

VS=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000 0.0000 29	0.23924 0.2113 29	0.19418 0.3128 29	0.07042 0.7166 29	0.06847 0.7292 28	0.10048 0.6040 29	0.28922 0.1281 29	-0.37447 0.0454 29	0.24268 0.2046 29	-0.24268 0.2046 29	0.00000 1.0000 29	0.20966 0.2750 29
WFCONT	0.23924 0.2113 29	1.00000 0.0000 29	-0.30921 0.1026 29	0.12015 0.5347 29	0.11323 0.5662 28	0.58571 0.0009 29	-0.01762 0.9277 29	-0.63888 0.0002 29	0.21392 0.2652 29	-0.21392 0.2652 29	0.00000 1.0000 29	0.19562 0.3092 29
INFO	0.19418 0.3128 29	-0.30921 0.1026 29	1.00000 0.0000 29	-0.31492 0.0961 29	0.09129 0.6441 28	-0.16910 0.3805 29	0.08940 0.6447 29	0.10803 0.5770 29	-0.07001 0.7182 29	0.07001 0.7182 29	0.00000 1.0000 29	0.15878 0.4107 29
TASK	0.07042 0.7166 29	0.12015 0.5347 29	-0.31492 0.0961 29	1.00000 0.0000 29	0.24183 0.2151 28	-0.02503 0.8974 29	-0.01235 0.9493 29	0.03918 0.8401 29	0.29019 0.1267 29	-0.29019 0.1267 29	0.00000 1.0000 29	-0.26049 0.1723 29
SIZE	0.06847 0.7292 28	0.11323 0.5662 28	0.09129 0.6441 28	0.24183 0.2151 28	1.00000 0.0000 28	-0.20381 0.2982 28	0.05505 0.7808 28	0.18257 0.3524 28	-0.19365 0.3235 28	0.19365 0.3235 28	0.00000 1.0000 28	0.12172 0.5372 28
MAN	0.10048 0.6040 29	0.58571 0.0009 29	-0.16910 0.3805 29	-0.02503 0.8974 29	-0.20381 0.2982 28	1.00000 0.0000 29	-0.52868 0.0032 29	-0.63888 0.0002 29	0.21392 0.2652 29	-0.21392 0.2652 29	0.00000 1.0000 29	0.19562 0.3092 29
MIX	0.28922 0.1281 29	-0.01762 0.9277 29	0.08940 0.6447 29	-0.01235 0.9493 29	0.05505 0.7808 28	-0.52868 0.0032 29	1.00000 0.0000 29	-0.31524 0.0958 29	-0.04256 0.8265 29	0.04256 0.8265 29	0.00000 1.0000 29	0.09652 0.6184 29
SVC	-0.37447 0.0454 29	-0.63888 0.0002 29	0.10803 0.5770 29	0.03918 0.8401 29	0.18257 0.3524 28	-0.63888 0.0002 29	-0.31524 0.0958 29	1.00000 0.0000 29	-0.20059 0.2968 29	0.20059 0.2968 29	0.00000 1.0000 29	-0.30619 0.1062 29
ORG	0.24268 0.2046 29	0.21392 0.2652 29	-0.07001 0.7182 29	0.29019 0.1267 29	-0.19365 0.3235 28	0.21392 0.2652 29	-0.04256 0.8265 29	-0.20059 0.2968 29	1.00000 0.0000 29	-1.00000 0.0001 29	0.00000 1.0000 29	-0.07559 0.6967 29
SUB	-0.24268 0.2046 29	-0.21392 0.2652 29	0.07001 0.7182 29	-0.29019 0.1267 29	0.19365 0.3235 28	-0.21392 0.2652 29	0.04256 0.8265 29	0.20059 0.2968 29	-1.00000 0.0001 29	1.00000 0.0000 29	0.00000 1.0000 29	0.07559 0.6967 29
IND	0.00000 1.0000 29	0.00000 1.0000 29	0.00000 1.0000 29	0.00000 1.0000 29	0.00000 1.0000 28	0.00000 1.0000 29	0.00000 1.0000 29	0.00000 1.0000 29	0.00000 1.0000 29	0.00000 1.0000 29	0.00000 1.0000 29	0.00000 1.0000 29
MEAS	0.20966 0.2750 29	0.19562 0.3092 29	0.15878 0.4107 29	-0.26049 0.1723 29	0.12172 0.5372 28	0.19562 0.3092 29	0.09652 0.6184 29	-0.30619 0.1062 29	-0.07559 0.6967 29	0.07559 0.6967 29	0.00000 1.0000 29	1.00000 0.0000 29

CENT=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000	0.03585	0.35569	-0.21938	0.00426	-0.02674	0.35569	-0.28322	0.10508	-0.12666	0.02900	0.38156
	0.0000	0.7931	0.0071	0.1043	0.9779	0.8449	0.0071	0.0344	0.4409	0.3523	0.8320	0.0037
	56	56	56	56	45	56	56	56	56	56	56	56
WFCONT	0.03585	1.00000	-0.03669	-0.18858	-0.03992	0.50472	-0.03669	-0.47717	0.47312	-0.41373	-0.17049	0.45322
	0.7931	0.0000	0.7883	0.1640	0.7946	0.0001	0.7883	0.0002	0.0002	0.0015	0.2090	0.0005
	56	56	56	56	45	56	56	56	56	56	56	56
INFO	0.35569	-0.03669	1.00000	-0.38066	0.15202	0.07732	0.19857	-0.25117	0.36302	-0.31745	-0.13082	0.34775
	0.0071	0.7883	0.0000	0.0038	0.3188	0.5711	0.1424	0.0619	0.0060	0.0171	0.3366	0.0086
	56	56	56	56	45	56	56	56	56	56	56	56
TASK	-0.21938	-0.18858	-0.38066	1.00000	-0.05125	-0.21938	-0.29607	0.47951	-0.42720	0.41239	0.07931	-0.55340
	0.1043	0.1640	0.0038	0.0000	0.7381	0.1043	0.0267	0.0002	0.0010	0.0016	0.5612	0.0001
	56	56	56	56	45	56	56	56	56	56	56	56
SIZE	0.00426	-0.03992	0.15202	-0.05125	1.00000	0.28175	-0.01659	-0.29439	0.04583	-0.00266	-0.11747	0.04583
	0.9779	0.7946	0.3188	0.7381	0.0000	0.0608	0.9139	0.0496	0.7650	0.9861	0.4422	0.7650
	45	45	45	45	45	45	45	45	45	45	45	45
MAN	-0.02674	0.50472	0.07732	-0.21938	0.28175	1.00000	-0.44229	-0.62309	0.29252	-0.21110	-0.19138	0.26594
	0.8449	0.0001	0.5711	0.1043	0.0608	0.0000	0.0006	0.0001	0.0287	0.1183	0.1577	0.0476
	56	56	56	56	45	56	56	56	56	56	56	56
MIX	0.35569	-0.03669	0.19857	-0.29607	-0.01659	-0.44229	1.00000	-0.42591	0.08706	-0.12210	0.05702	0.25413
	0.0071	0.7883	0.1424	0.0267	0.9139	0.0006	0.0000	0.0011	0.5235	0.3700	0.6764	0.0588
	56	56	56	56	45	56	56	56	56	56	56	56
SVC	-0.28322	-0.47717	-0.25117	0.47951	-0.29439	-0.62309	-0.42591	1.00000	-0.37102	0.31944	0.14334	-0.48990
	0.0344	0.0002	0.0619	0.0002	0.0496	0.0001	0.0011	0.0000	0.0049	0.0164	0.2919	0.0001
	56	56	56	56	45	56	56	56	56	56	56	56
ORG	0.10508	0.47312	0.36302	-0.42720	0.04583	0.29252	0.08706	-0.37102	1.00000	-0.87447	-0.36035	0.61406
	0.4409	0.0002	0.0060	0.0010	0.7650	0.0287	0.5235	0.0049	0.0000	0.0001	0.0064	0.0001
	56	56	56	56	45	56	56	56	56	56	56	56
SUB	-0.12666	-0.41373	-0.31745	0.41239	-0.00266	-0.21110	-0.12210	0.31944	-0.87447	1.00000	-0.13736	-0.45644
	0.3523	0.0015	0.0171	0.0016	0.9861	0.1183	0.3700	0.0164	0.0001	0.0000	0.3127	0.0004
	56	56	56	56	45	56	56	56	56	56	56	56
IND	0.02900	-0.17049	-0.13082	0.07931	-0.11747	-0.19138	0.05702	0.14334	-0.36035	-0.13736	1.00000	-0.37618
	0.8320	0.2090	0.3366	0.5612	0.4422	0.1577	0.6764	0.2919	0.0064	0.3127	0.0000	0.0043
	56	56	56	56	45	56	56	56	56	56	56	56
MEAS	0.38156	0.45322	0.34775	-0.55340	0.04583	0.26594	0.25413	-0.48990	0.61406	-0.45644	-0.37618	1.00000
	0.0037	0.0005	0.0086	0.0001	0.7650	0.0476	0.0588	0.0001	0.0001	0.0004	0.0043	0.0000
	56	56	56	56	45	56	56	56	56	56	56	56

SUB_SUP=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 22

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000	0.49796	-0.09221	0.29277	-0.16190	0.22555	0.27145	-0.45817	0.67730	-0.67730	0.00000	0.12344
	0.0000	0.0184	0.6832	0.1861	0.4716	0.3128	0.2217	0.0320	0.0005	0.0005	1.0000	0.5842
WFCONT	0.49796	1.00000	-0.21429	0.00000	0.11066	0.52414	0.02503	-0.59793	0.59793	-0.59793	0.00000	0.41833
	0.0184	0.0000	0.3383	1.0000	0.6240	0.0123	0.9120	0.0033	0.0033	0.0033	1.0000	0.0527
INFO	-0.09221	-0.21429	1.00000	-0.37796	0.29508	-0.13977	-0.02503	0.17359	0.03858	-0.03858	0.00000	0.23905
	0.6832	0.3383	0.0000	0.0829	0.1825	0.5350	0.9120	0.4398	0.8647	0.8647	1.0000	0.2840
TASK	0.29277	0.00000	-0.37796	1.00000	0.09759	-0.09245	0.39736	-0.20412	0.00000	0.00000	0.00000	-0.31623
	0.1861	1.0000	0.0829	0.0000	0.6657	0.6824	0.0671	0.3622	1.0000	1.0000	1.0000	0.1516
SIZE	-0.16190	0.11066	0.29508	0.09759	1.00000	-0.22555	0.29730	0.01992	-0.01992	0.01992	0.00000	0.21602
	0.4716	0.6240	0.1825	0.6657	0.0000	0.3128	0.1791	0.9299	0.9299	0.9299	1.0000	0.3343
MAN	0.22555	0.52414	-0.13977	-0.09245	-0.22555	1.00000	-0.47757	-0.73598	0.32081	-0.32081	0.00000	0.38006
	0.3128	0.0123	0.5350	0.6824	0.3128	0.0000	0.0246	0.0001	0.1455	0.1455	1.0000	0.0810
MIX	0.27145	0.02503	-0.02503	0.39736	0.29730	-0.47757	1.00000	-0.24333	0.24333	-0.24333	0.00000	0.12566
	0.2217	0.9120	0.9120	0.0671	0.1791	0.0246	0.0000	0.2752	0.2752	0.2752	1.0000	0.5774
SVC	-0.45817	-0.59793	0.17359	-0.20412	0.01992	-0.73598	-0.24333	1.00000	-0.54167	0.54167	0.00000	-0.51640
	0.0320	0.0033	0.4398	0.3622	0.9299	0.0001	0.2752	0.0000	0.0092	0.0092	1.0000	0.0139
ORG	0.67730	0.59793	0.03858	0.00000	-0.01992	0.32081	0.24333	-0.54167	1.00000	-1.00000	0.00000	0.51640
	0.0005	0.0033	0.8647	1.0000	0.9299	0.1455	0.2752	0.0092	0.0000	0.0001	1.0000	0.0139
SUB	-0.67730	-0.59793	-0.03858	0.00000	0.01992	-0.32081	-0.24333	0.54167	-1.00000	1.00000	0.00000	-0.51640
	0.0005	0.0033	0.8647	1.0000	0.9299	0.1455	0.2752	0.0092	0.0001	0.0000	1.0000	0.0139
IND	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
MEAS	0.12344	0.41833	0.23905	-0.31623	0.21602	0.38006	0.12566	-0.51640	0.51640	-0.51640	0.00000	1.00000
	0.5842	0.0527	0.2840	0.1516	0.3343	0.0810	0.5774	0.0139	0.0139	0.0139	1.0000	0.0000

PDIR=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 12

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000 0.0000	0.00000 1.0000	0.17408 0.5884	0.30151 0.3409	0.17408 0.5884	-0.17408 0.5884	0.13484 0.6761	0.09091 0.7787	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000
WFCONT	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000
INFO	0.17408 0.5884	0.00000 1.0000	1.00000 0.0000	-0.19245 0.5490	0.11111 0.7310	-0.11111 0.7310	0.25820 0.4178	-0.17408 0.5884	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000
TASK	0.30151 0.3409	0.00000 1.0000	-0.19245 0.5490	1.00000 0.0000	0.57735 0.0493	-0.19245 0.5490	0.44721 0.1449	-0.30151 0.3409	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000
SIZE	0.17408 0.5884	0.00000 1.0000	0.11111 0.7310	0.57735 0.0493	1.00000 0.0000	-0.55556 0.0607	0.77460 0.0031	-0.17408 0.5884	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000
MAN	-0.17408 0.5884	0.00000 1.0000	-0.11111 0.7310	-0.19245 0.5490	-0.55556 0.0607	1.00000 0.0000	-0.77460 0.0031	-0.52223 0.0816	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000
MIX	0.13484 0.6761	0.00000 1.0000	0.25820 0.4178	0.44721 0.1449	0.77460 0.0031	-0.77460 0.0031	1.00000 0.0000	-0.13484 0.6761	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000
SVC	0.09091 0.7787	0.00000 1.0000	-0.17408 0.5884	-0.30151 0.3409	-0.17408 0.5884	-0.52223 0.0816	-0.13484 0.6761	1.00000 0.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000
ORG	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000
SUB	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000
IND	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000
MEAS	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000	0.00000 1.0000

PSUP=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 /.N = 10

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000	0.40825	0.40825	-0.21822	0.00000	0.40825	0.21822	-0.65465	0.50000	-0.50000	0.00000	0.00000
	0.0000	0.2415	0.2415	0.5447	1.0000	0.2415	0.5447	0.0400	0.1411	0.1411	1.0000	1.0000
WFCONT	0.40825	1.00000	-0.16667	-0.08909	0.10206	0.16667	0.35635	-0.53452	0.40825	-0.40825	0.00000	0.00000
	0.2415	0.0000	0.6454	0.8067	0.7791	0.6454	0.3122	0.1114	0.2415	0.2415	1.0000	1.0000
INFO	0.40825	-0.16667	1.00000	-0.35635	0.40825	-0.16667	0.08909	0.08909	0.10206	-0.10206	0.00000	0.00000
	0.2415	0.6454	0.0000	0.3122	0.2415	0.6454	0.8067	0.8067	0.7791	0.7791	1.0000	1.0000
TASK	-0.21822	-0.08909	-0.35635	1.00000	0.21822	-0.08909	0.04762	0.04762	-0.21822	0.21822	0.00000	0.00000
	0.5447	0.8067	0.3122	0.0000	0.5447	0.8067	0.8961	0.8961	0.5447	0.5447	1.0000	1.0000
SIZE	0.00000	0.10206	0.40825	0.21822	1.00000	-0.40825	0.21822	0.21822	0.25000	-0.25000	0.00000	0.00000
	1.0000	0.7791	0.2415	0.5447	0.0000	0.2415	0.5447	0.5447	0.4860	0.4860	1.0000	1.0000
MAN	0.40825	0.16667	-0.16667	-0.08909	-0.40825	1.00000	-0.53452	-0.53452	0.40825	-0.40825	0.00000	0.00000
	0.2415	0.6454	0.6454	0.8067	0.2415	0.0000	0.1114	0.1114	0.2415	0.2415	1.0000	1.0000
MIX	0.21822	0.35635	0.08909	0.04762	0.21822	-0.53452	1.00000	-0.42857	0.32733	-0.32733	0.00000	0.00000
	0.5447	0.3122	0.8067	0.8961	0.5447	0.1114	0.0000	0.2165	0.3559	0.3559	1.0000	1.0000
SVC	-0.65465	-0.53452	0.08909	0.04762	0.21822	-0.53452	-0.42857	1.00000	-0.76376	0.76376	0.00000	0.00000
	0.0400	0.1114	0.8067	0.8961	0.5447	0.1114	0.2165	0.0000	0.0101	0.0101	1.0000	1.0000
ORG	0.50000	0.40825	0.10206	-0.21822	0.25000	0.40825	0.32733	-0.76376	1.00000	-1.00000	0.00000	0.00000
	0.1411	0.2415	0.7791	0.5447	0.4860	0.2415	0.3559	0.0101	0.0000	0.0001	1.0000	1.0000
SUB	-0.50000	-0.40825	-0.10206	0.21822	-0.25000	-0.40825	-0.32733	0.76376	-1.00000	1.00000	0.00000	0.00000
	0.1411	0.2415	0.7791	0.5447	0.4860	0.2415	0.3559	0.0101	0.0001	0.0000	1.0000	1.0000
IND	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
MEAS	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

PCLERKS=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000 0.0000 13	0.69282 0.0087 13	-0.14086 0.6462 13	-0.03043 0.9214 13	-0.15811 0.6236 12	0.50709 0.0769 13	0.23355 0.4425 13	-0.69282 0.0087 13	0.77850 0.0017 13	-0.77850 0.0017 13	0.00000 1.0000 13	0.52705 0.0642 13
WFCONT	0.69282 0.0087 13	1.00000 0.0000 13	-0.41476 0.1588 13	0.18447 0.5463 13	0.12500 0.6987 12	0.41476 0.1588 13	0.33710 0.2600 13	-0.67500 0.0114 13	0.53936 0.0571 13	-0.53936 0.0571 13	0.00000 1.0000 13	0.36515 0.2199 13
INFO	-0.14086 0.6462 13	-0.41476 0.1588 13	1.00000 0.0000 13	-0.38576 0.1930 13	-0.11952 0.7114 12	-0.07143 0.8166 13	-0.03290 0.9150 13	0.09759 0.7511 13	0.03290 0.9150 13	-0.03290 0.9150 13	0.00000 1.0000 13	0.31180 0.2997 13
TASK	-0.03043 0.9214 13	0.18447 0.5463 13	-0.38576 0.1930 13	1.00000 0.0000 13	0.81650 0.0012 12	-0.28289 0.3490 13	0.63960 0.0186 13	-0.18447 0.5463 13	-0.17767 0.5614 13	0.17767 0.5614 13	0.00000 1.0000 13	-0.43301 0.1394 13
SIZE	-0.15811 0.6236 12	0.12500 0.6987 12	-0.11952 0.7114 12	0.81650 0.0012 12	1.00000 0.0000 12	-0.35355 0.2596 12	0.63246 0.0273 12	-0.12500 0.6987 12	0.21320 0.5059 12	-0.21320 0.5059 12	0.00000 1.0000 12	0.00000 1.0000 12
MAN	0.50709 0.0769 13	0.41476 0.1588 13	-0.07143 0.8166 13	-0.28289 0.3490 13	-0.35355 0.2596 12	1.00000 0.0000 13	-0.39477 0.1819 13	-0.73193 0.0045 13	0.39477 0.1819 13	-0.39477 0.1819 13	0.00000 1.0000 13	0.26726 0.3774 13
MIX	0.23355 0.4425 13	0.33710 0.2600 13	-0.03290 0.9150 13	0.63960 0.0186 13	0.63246 0.0273 12	-0.39477 0.1819 13	1.00000 0.0000 13	-0.33710 0.2600 13	0.18182 0.5522 13	-0.18182 0.5522 13	0.00000 1.0000 13	0.12309 0.6887 13
SVC	-0.69282 0.0087 13	-0.67500 0.0114 13	0.09759 0.7511 13	-0.18447 0.5463 13	-0.12500 0.6987 12	-0.73193 0.0045 13	-0.33710 0.2600 13	1.00000 0.0000 13	-0.53936 0.0571 13	0.53936 0.0571 13	0.00000 1.0000 13	-0.36515 0.2199 13
ORG	0.77850 0.0017 13	0.53936 0.0571 13	0.03290 0.9150 13	-0.17767 0.5614 13	0.21320 0.5059 12	0.39477 0.1819 13	0.18182 0.5522 13	-0.53936 0.0571 13	1.00000 0.0000 13	-1.00000 0.0001 13	0.00000 1.0000 13	0.67700 0.0110 13
SUB	-0.77850 0.0017 13	-0.53936 0.0571 13	-0.03290 0.9150 13	0.17767 0.5614 13	-0.21320 0.5059 12	-0.39477 0.1819 13	-0.18182 0.5522 13	0.53936 0.0571 13	-1.00000 0.0001 13	1.00000 0.0000 13	0.00000 1.0000 13	-0.67700 0.0110 13
IND	0.00000 1.0000 13	0.00000 1.0000 13	0.00000 1.0000 13	0.00000 1.0000 13	0.00000 1.0000 12	0.00000 1.0000 13	0.00000 1.0000 13	0.00000 1.0000 13	0.00000 1.0000 13	0.00000 1.0000 13	0.00000 1.0000 13	0.00000 1.0000 13
MEAS	0.52705 0.0642 13	0.36515 0.2199 13	0.31180 0.2997 13	-0.43301 0.1394 13	0.00000 1.0000 12	0.26726 0.3774 13	0.12309 0.6887 13	-0.36515 0.2199 13	0.67700 0.0110 13	-0.67700 0.0110 13	0.00000 1.0000 13	1.00000 0.0000 13

PWFPC=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 4

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
WFCONT	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
INFO	0.00000	0.00000	1.00000	-0.33333	-0.33333	0.57735	-0.57735	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	0.0000	0.6667	0.6667	0.4226	0.4226	1.0000	1.0000	1.0000	1.0000	1.0000
TASK	0.00000	0.00000	-0.33333	1.00000	1.00000	-0.57735	0.57735	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	0.6667	0.0000	0.0000	0.4226	0.4226	1.0000	1.0000	1.0000	1.0000	1.0000
SIZE	0.00000	0.00000	-0.33333	1.00000	1.00000	-0.57735	0.57735	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	0.6667	0.0000	0.0000	0.4226	0.4226	1.0000	1.0000	1.0000	1.0000	1.0000
MAN	0.00000	0.00000	0.57735	-0.57735	-0.57735	1.00000	-1.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	0.4226	0.4226	0.4226	0.0000	0.0001	1.0000	1.0000	1.0000	1.0000	1.0000
MIX	0.00000	0.00000	-0.57735	0.57735	0.57735	-1.00000	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	0.4226	0.4226	0.4226	0.0001	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SVC	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
ORG	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SUB	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
IND	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
MEAS	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

PADMIN=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / N = 12

	WFINT	WFCONT	INFO	TASK	SIZE	MAN	MIX	SVC	ORG	SUB	IND	MEAS
WFINT	1.00000	0.07559	0.07559	0.31623	-0.07559	0.15811	0.20000	-0.40000	0.00000	0.00000	0.00000	0.00000
	0.0000	0.8154	0.8154	0.3166	0.8154	0.6236	0.5331	0.1976	1.0000	1.0000	1.0000	1.0000
WFCONT	0.07559	1.00000	-0.02857	0.23905	0.02857	0.11952	0.37796	-0.52915	0.00000	0.00000	0.00000	0.00000
	0.8154	0.0000	0.9298	0.4543	0.9298	0.7114	0.2258	0.0769	1.0000	1.0000	1.0000	1.0000
INFO	0.07559	-0.02857	1.00000	-0.11952	0.02857	-0.23905	-0.07559	0.37796	0.00000	0.00000	0.00000	0.00000
	0.8154	0.9298	0.0000	0.7114	0.9298	0.4543	0.8154	0.2258	1.0000	1.0000	1.0000	1.0000
TASK	0.31623	0.23905	-0.11952	1.00000	0.83666	-0.25000	0.63246	-0.31623	0.00000	0.00000	0.00000	0.00000
	0.3166	0.4543	0.7114	0.0000	0.0007	0.4332	0.0273	0.3166	1.0000	1.0000	1.0000	1.0000
SIZE	-0.07559	0.02857	0.02857	0.83666	1.00000	-0.47809	0.52915	0.07559	0.00000	0.00000	0.00000	0.00000
	0.8154	0.9298	0.9298	0.0007	0.0000	0.1159	0.0769	0.8154	1.0000	1.0000	1.0000	1.0000
MAN	0.15811	0.11952	-0.23905	-0.25000	-0.47809	1.00000	-0.63246	-0.63246	0.00000	0.00000	0.00000	0.00000
	0.6236	0.7114	0.4543	0.4332	0.1159	0.0000	0.0273	0.0273	1.0000	1.0000	1.0000	1.0000
MIX	0.20000	0.37796	-0.07559	0.63246	0.52915	-0.63246	1.00000	-0.20000	0.00000	0.00000	0.00000	0.00000
	0.5331	0.2258	0.8154	0.0273	0.0769	0.0273	0.0000	0.5331	1.0000	1.0000	1.0000	1.0000
SVC	-0.40000	-0.52915	0.37796	-0.31623	0.07559	-0.63246	-0.20000	1.00000	0.00000	0.00000	0.00000	0.00000
	0.1976	0.0769	0.2258	0.3166	0.8154	0.0273	0.5331	0.0000	1.0000	1.0000	1.0000	1.0000
ORG	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
SUB	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
IND	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
MEAS	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

APPENDIX H

MULTIPLE MODERATORS

Table H-1. Multiple Moderators: Division of Labor

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Correcte Mean
Total	26	2726	.291	.0418	.0244	41.6	.156	.423
Technology Concept with Organization Type, Level of Analysis, and Type of Measure:								
Workflow Continuity	5	122	.077	.1098	.0776	29.4	.278	.092
Manufacturing	4	116	.043	.0915	.0603	34.2	.246	.051
Service	1	6	.741					.979
Organization and Institutional	5	122	.077	.1098	.0776	29.4	.278	.092
Workflow Integration	11	602	.225	.0460	.0236	48.7	.154	.341
Manufacturing	5	241	.255	.0115	-.0180	100+	0	.407
Service	5	149	-.025	.0504	.0223	55.7	.149	-.041
Mixed	3	197	.239	.0309	.0097	68.7	.098	.363
Subunit	2	101	-.026	.0327	.0139	57.4	.118	-.041
Organization	9	501	.276	.0333	.0083	75.2	.091	.416
Institutional	9	501	.276	.0333	.0083	75.2	.091	.416
Questionnaire	2	101	-.026	.0327	.0139	57.4	.118	-.041
Task Routineness	16	833	.117	.0817	.0649	20.5	.255	.147
Manufacturing	6	150	.040	.0117	-.0293	100+	0	.049
Service	11	601	.167	.0905	.0746	17.6	.273	.233
Mixed	1	82	-.228					-.286
Subunit	5	251	.205	.0150	-.0031	100+	0	.258
Organization	11	582	.079	.1043	.0892	14.5	.299	.099
Institutional	8	399	.131	.1197	.1039	13.2	.322	.165
Questionnaire	8	434	.104	.0464	.0287	38.1	.170	.130
Information Technology	6	1759	.384	.0024	-.0024	100+	0	.464
Manufacturing	1	55	.555					.671
Service	4	1575	.379	.0031	-.0011	100+	0	.458
Mixed	2	129	.425	.0002	-.0135	100+	0	.514
Subunit	2	1496	.373	.0001	-.0033	100+	0	.451
Organization	4	263	.444	.0113	-.0016	100+	0	.536
Institutional	6	1759	.384	.0024	-.0024	100+	0	.464

ision of Labor

n r erved	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	s.d.	s.e.	90 % Credibility Interval	95 % Confidence Interval
291	.0418	.0244	41.6	.156	.423	.228	.0515	.049 to .798	.32 to .52
el of Analysis, and Type of Measure:									
077	.1098	.0776	29.4	.278	.092	.330	.1836	-.452 to .636	-.27 to .45
043	.0915	.0603	34.2	.246	.051	.291	.1837	-.428 to .530	-.31 to .41
741					.979	n.a.	.1017		.68 to 1.00
077	.1098	.0776	29.4	.278	.092	.330	.1836	-.452 to .636	.27 to .45
225	.0460	.0236	48.7	.154	.341	.233	.0919	-.042 to .725	.16 to .52
255	.0115	-.0180	100+	0	.407	0	.0970	.407	.22 to .60
025	.0504	.0223	55.7	.149	-.041	.249	.1776	-.451 to .368	-.39 to .31
239	.0309	.0097	68.7	.098	.363	.149	.1339	.117 to .608	.10 to .62
026	.0327	.0139	57.4	.118	-.041	.181	.2004	-.339 to .257	-.43 to .35
276	.0333	.0083	75.2	.091	.416	.137	.0777	.191 to .642	.26 to .57
276	.0333	.0083	75.2	.091	.416	.137	.0777	.191 to .642	.26 to .57
026	.0327	.0139	57.4	.118	-.041	.181	.2004	-.339 to .257	-.43 to .35
117	.0817	.0649	20.5	.255	.147	.320	.0911	-.380 to .674	-.03 to .32
040	.0117	-.0293	100+	0	.049	0	.1038	.049	-.15 to .25
167	.0905	.0746	17.6	.273	.233	.382	.1281	-.395 to .862	-.02 to .48
228					-.286	n.a.	.1020		-.48 to -.09
205	.0150	-.0031	100+	0	.258	0	.0768	.258	.11 to .41
079	.1043	.0892	14.5	.299	.099	.376	.1248	-.519 to .717	-.14 to .34
131	.1197	.1039	13.2	.322	.165	.405	.1564	-.502 to .832	-.14 to .47
104	.0464	.0287	38.1	.170	.130	.213	.0965	-.220 to .481	-.06 to .32
384	.0024	-.0024	100+	0	.464	0	.0246	.464	.42 to .51
555					.671	n.a.	.0748		.52 to .82
379	.0031	-.0011	100+	0	.458	0	.0261	.458	.41 to .51
425	.0002	-.0135	100+	0	.514	0	.0878	.514	.34 to .69
373	.0001	-.0033	100+	0	.451	0	.0269	.451	.40 to .50
144	.0113	-.0016	100+	0	.536	0	.0603	.536	.42 to .65
384	.0024	-.0024	100+	0	.464	0	.0246	.464	.42 to .51

Table H-1--continued

Variable	Number of Corre-lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Mean	s
Type of Measure with Organization Type and Level of Analysis:									
Institutional	18	2327	.323	.0338	.0163	51.8	.128	.468	.
Manufacturing	6	287	.212	.0217	-.0037	100+	0	.317	
Service	11	1851	.340	.0363	.0209	42.4	.144	.505	.
Mixed	3	197	.266	.0287	.0080	72.0	.090	.388	.
Subunit	2	1496	.373	.0001	-.0155	100+	0	.535	
Organization	16	831	.232	.0816	.0601	26.4	.245	.340	.
Questionnaire	9	474	.070	.0515	.0332	35.5	.182	.103	.
Manufacturing	3	48	-.011	.0255	-.0379	100+	0	-.017	
Service	5	344	.152	.0385	.0232	39.8	.152	.231	.
Mixed	1	82	-.228					-.286	n
Subunit	6	291	.136	.0398	.0178	55.3	.133	.201	.
Organization	3	183	-.036	.0516	.0372	28.0	.193	-.053	.
Type of Organization with Level of Analysis:									
Manufacturing	9	335	.180	.0283	-.0019	100+	0	.270	
Subunit	3	48	-.011	.0255	-.0379	100+	0	-.017	
Organization	6	287	.212	.0217	-.0037	100+	0	.317	
Service	16	2195	.311	.0413	.0262	36.5	.162	.463	.
Subunit	5	1739	.344	.0105	-.0032	100+	0	.511	
Organization	11	456	.182	.1379	.1164	15.6	.341	.276	.
Mixed: Organization	3	204	.204	.0579	.0409	29.3	.202	.300	.

ean r bserved	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
evel of Analysis:									
.323	.0339	.0163	51.8	.128	.468	.185	.0513	.164 to .773	.37 to .57
.212	.0217	-.0037	100+	0	.317	0	.0853	.317	.15 to .48
.340	.0363	.0209	42.4	.144	.505	.214	.0716	.152 to .858	.36 to .64
.266	.0287	.0080	72.0	.090	.388	.131	.1232	.173 to .603	.15 to .63
.373	.0001	-.0155	100+	0	.535	0	.0321	.535	.47 to .60
.232	.0816	.0601	26.4	.245	.340	.359	.1020	-.250 to .931	.14 to .54
.070	.0515	.0332	35.5	.182	.103	.269	.1128	-.340 to .547	-.12 to .32
-.011	.0255	-.0379	100+	0	-.017	0	.2255	-.017	-.46 to .42
.152	.0385	.0232	39.8	.152	.231	.231	.1309	-.149 to .611	-.03 to .49
-.228					-.286	n.a.	.1020		-.48 to -.09
.136	.0398	.0178	55.3	.133	.201	.197	.1175	-.122 to .525	-.03 to .43
-.036	.0516	.0372	28.0	.193	-.053	.285	.1982	-.523 to .416	-.44 to .34
.180	.0283	-.0019	100+	0	.270	0	.0805	.270	.11 to .43
-.011	.0255	-.0379	100+	0	-.017	0	.2255	-.017	-.46 to .42
.212	.0217	-.0037	100+	0	.317	0	.0853	.317	.15 to .48
.311	.0413	.0262	36.5	.162	.463	.241	.0669	.066 to .860	.33 to .59
.344	.0105	-.0032	100+	0	.511	0	.0314	.511	.45 to .57
.182	.1379	.1164	15.6	.341	.276	.516	.1704	-.573 to 1.000	-.06 to .61
.204	.0579	.0409	29.3	.202	.300	.297	.1981	-.189 to .788	-.09 to .69

Table H-2. Multiple Moderators: Functional Specialization

Variable	Number of Correlations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Mean
Total	44	2378	.239	.0372	.0160	57.0	.126	.338
Technology Concept with Size of Organization, Type of Organization, and Type of Measure:								
Workflow Continuity	16	559	.156	.0305	.0015	95.0	.039	.178
Small	11	424	.164	.0167	-.0102	100+	0	.188
Large	5	135	.128	.0728	.0372	48.9	.193	.147
Manufacturing	14	460	.148	.0368	.0069	81.3	.083	.170
Service	1	6	.172	n.a.				.209
Mixed	1	93	.190	n.a.				.231
Institutional	16	559	.156	.0305	.0015	95.0	.039	.178
Workflow Integration	32	1401	.221	.0468	.0221	52.7	.149	.324
Small	18	949	.149	.0286	.0088	69.4	.094	.219
Large	13	425	.397	.0450	.0071	84.1	.084	.567
Unknown Size	1	27	.010					.016
Manufacturing	22	842	.230	.0417	.0136	67.3	.117	.356
Service	8	255	.129	.0188	-.0132	100+	0	.207
Mixed	5	288	.112	.0370	.0199	46.2	.141	.166
Institutional	32	1401	.221	.0468	.0221	52.7	.149	.324
Task Routineness	18	689	.048	.0759	.0526	30.6	.229	.059
Small	8	295	-.044	.1134	.0904	20.2	.301	-.053
Large	8	251	.115	.0566	.0276	51.2	.166	.140
Unknown Size	2	143	.120	.0016	-.0129	100+	0	.146
Manufacturing	12	314	.127	.0916	.0571	37.6	.239	.152
Service	9	375	-.015	.0385	.0163	57.7	.128	-.020
Institutional	17	618	.051	.0845	.0603	28.7	.245	.062
Questionnaire	1	71	.023					.034
Information Technology	15	1336	.406	.0204	.0122	40.3	.110	.473
Small	10	1086	.399	.0182	.0114	37.5	.107	.465
Large	5	250	.435	.0291	.0147	49.2	.121	.507
Manufacturing	9	536	.544	.0090	-.0014	100+	0	.634
Service	4	611	.322	.0122	.0062	49.4	.079	.375
Mixed	3	189	.321	.0108	-.0027	100+	0	.374
Institutional	15	1336	.406	.0204	.0122	40.3	.110	.473

unctional Specialization

ean r bserved	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	s.d.	s.e.	90 % Credibility Interval	95 % Confidence Interval
.239	.0372	.0160	57.0	.126	.338	.179	.0385	.044 to .632	.26 to .41
, Type of Organization, and Type of Measure:									
.156	.0305	.0015	95.0	.039	.178	.045	.0492	.104 to .252	.08 to .27
.164	.0167	-.0102	100+	0	.188	0	.0548	.188	.08 to .30
.128	.0728	.0372	48.9	.193	.147	.221	.1397	-.216 to .510	-.13 to .42
.148	.0368	.0069	51.3	.093	.170	.095	.0588	.014 to .326	.05 to .28
.172	n.a.				.209	n.a.	.4277		-.63 to 1.00
.190	n.a.				.231	n.a.	.0967		.04 to .42
.156	.0305	.0015	95.0	.039	.178	.045	.0492	.104 to .252	.08 to .27
.221	.0468	.0221	52.7	.149	.324	.218	.0538	-.034 to .682	.22 to .43
.149	.0286	.0088	69.4	.094	.219	.138	.0573	-.008 to .446	.11 to .33
.397	.0450	.0071	84.1	.084	.567	.121	.0681	.368 to .765	.43 to .70
.010					.016	n.a.	.1960		-.37 to .40
.230	.0417	.0136	67.3	.117	.356	.180	.0639	.059 to .652	.23 to .48
.129	.0159	-.0132	100+	0	.207	0	.0999	.207	.01 to .40
.112	.0370	.0199	46.2	.141	.166	.208	.1272	-.177 to .509	-.08 to .42
.221	.0468	.0221	52.7	.149	.324	.218	.0538	-.034 to .682	.22 to .43
.048	.0759	.0526	30.6	.229	.059	.278	.0806	-.399 to .517	-.10 to .22
-.044	.1134	.0904	20.2	.301	-.053	.365	.1474	-.653 to .547	-.34 to .24
.115	.0566	.0276	51.2	.166	.140	.202	.1048	-.192 to .472	-.06 to .34
.120	.0016	-.0129	100+	0	.146	0	.1007	.146	-.05 to .34
.127	.0916	.0571	37.6	.239	.152	.288	.1074	-.320 to .626	-.06 to .36
-.015	.0385	.0163	57.7	.128	-.020	.173	.0912	-.304 to .264	-.20 to .16
.051	.0845	.0603	28.7	.245	.062	.298	.0875	-.428 to .552	-.11 to .23
.023					.034	n.a.	.1194		-.20 to .27
.406	.0204	.0122	40.3	.110	.473	.129	.0427	.261 to .684	.39 to .56
.399	.0182	.0114	37.5	.107	.465	.124	.0494	.261 to .669	.37 to .56
.435	.0291	.0147	49.2	.121	.507	.142	.0874	.274 to .740	.34 to .68
.544	.0090	-.0014	100+	0	.634	0	.0357	.634	.56 to .70
.322	.0122	.0062	49.4	.079	.375	.092	.0624	.224 to .525	.25 to .50
.321	.0108	-.0027	100+	0	.374	0	.0766	.374	.22 to .52
.406	.0204	.0122	40.3	.110	.473	.129	.0427	.261 to .684	.39 to .56

Table H-2--continued

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Mean
Size of Organization with Type of Organization, and Type of Measure:								
Small	27	1733	.224	.0372	.0187	49.8	.137	.317
Manufacturing	15	670	.293	.0404	.0140	65.3	.118	.419
Service	7	713	.192	.0366	.0238	34.9	.154	.280
Mixed	5	350	.159	.0171	.0012	93.0	.034	.226
Institutional	26	1662	.233	.0370	.0181	51.0	.135	.329
Questionnaire	1	71	.023					.034
Large	15	502	.324	.0350	.0023	93.5	.048	.454
Manufacturing	12	330	.350	.0383	-.0012	100+	0	.496
Service	5	148	.127	.0218	-.0123	100+	0	.189
Mixed	1	31	.480					.716
Institutional	15	502	.324	.0350	.0023	93.5	.048	.454
Unknown Size: Service and Institutional	2	143	.118	.0021	-.0134	100+	0	.168
Type of Organization with Type of Measure:								
Manufacturing	27	1000	.312	.0404	.0097	75.9	.099	.445
Institutional	27	1000	.312	.0404	.0097	75.9	.099	.445
Service	14	1004	.172	.0305	.0143	53.1	.120	.252
Institutional	13	933	.184	.0310	.0145	53.2	.120	.268
Questionnaire	1	71	.023					.034
Mixed: Institutional	6	381	.185	.0234	.0061	73.9	.078	.263

Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
ion, and Type of Measure:									
.224	.0372	.0187	49.8	.137	.317	.193	.0494	.000 to .635	.22 to .41
.293	.0404	.0140	65.3	.118	.419	.169	.0672	.141 to .698	.29 to .55
.192	.0366	.0238	34.9	.154	.280	.225	.1002	-.090 to .651	.08 to .48
.159	.0171	.0012	93.0	.034	.226	.049	.0777	.145 to .307	.07 to .38
.233	.0370	.0181	51.0	.135	.329	.190	.0498	.016 to .642	.23 to .43
.023					.034	n.a.	.1194		-.20 to .27
.324	.0350	.0023	93.5	.048	.454	.067	.0592	.344 to .563	.34 to .57
.350	.0383	-.0012	100+	0	.496	0	.0698	.496	.36 to .63
.127	.0218	-.0123	100+	0	.189	0	.1206	.189	-.05 to .42
.480					.716	n.a.	.0890		.54 to .89
.324	.0350	.0023	93.5	.048	.454	.067	.0592	.344 to .563	.34 to .57
.118	.0021	-.0134	100+	0	.168	0	.1183	.168	-.06 to .40
.312	.0404	.0097	75.9	.099	.445	.141	.0494	.213 to .676	.35 to .54
.312	.0404	.0097	75.9	.099	.445	.141	.0494	.213 to .676	.35 to .54
.172	.0305	.0143	53.1	.120	.252	.175	.0649	-.036 to .539	.12 to .38
.184	.0310	.0145	53.2	.120	.265	.176	.0674	-.021 to .557	.14 to .40
.023					.034	n.a.	.1194		-.20 to .27
.185	.0234	.0061	73.9	.078	.263	.111	.0840	.080 to .445	.10 to .43

Table H-3. Multiple Moderators: Standardization

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected (Mean	s
Total	15	902	.227	.0287	.0057	80.1	.076	.332	.
Technology Concept with Organization Size, Organization Type, and Type of Measure:									
Workflow Continuity	6	147	.057	.0832	.0471	43.3	.217	.067	.
Small	3	67	.126	.0761	.0358	50.6	.194	.149	.
Large	3	80	-.001	.0817	.0466	42.9	.216	-.001	.
Manufacturing	5	141	.082	.0709	.0371	47.7	.192	.097	.
Service	1	6	-.540					-.652	n
Institutional	6	147	.057	.0832	.0471	43.3	.217	.067	.
Workflow Integration	12	528	.220	.0441	.0157	64.4	.125	.333	.
Small	7	333	.166	.0498	.0269	45.9	.164	.253	.
Large	4	168	.343	.0174	-.0232	100+	0	.512	
Unknown Size	1	27	.120					.203	n
Manufacturing	6	192	.152	.0278	-.0066	100+	0	.244	
Service	5	161	.186	.0271	-.0060	100+	0	.305	
Mixed	3	160	.193	.0843	.0627	25.6	.250	.294	.
Institutional	12	528	.220	.0441	.0157	64.4	.125	.333	.1
Task Routineness	7	342	.132	.0341	.0139	59.2	.118	.165	.1
Small	2	109	.319	.0076	-.0137	100+	0	.400	
Large	3	144	.080	.0267	.0057	78.4	.076	.101	.(
Unknown Size	2	89	-.014	.0099	-.0127	100+	0	-.018	
Manufacturing	4	130	.137	.0345	.0048	86.2	.069	.170	.(
Service	5	212	.098	.0234	-.0011	100+	0	.138	
Institutional	5	252	.146	.0225	.0018	92.2	.042	.184	.(
Questionnaire	2	90	.090	.0644	.0456	29.2	.213	.114	.2
Information Technology	5	537	.334	.0236	.0125	46.9	.112	.403	.1
Small	4	455	.336	.0278	.0174	37.5	.132	.405	.1
Large	1	82	.327					.394	n.
Manufacturing	2	82	.550	.0181	-.0055	100+	0	.663	
Service	2	326	.282	.0004	-.0086	100+	0	.339	
Mixed	2	129	.362	.0576	.0409	29.0	.202	.436	.2
Institutional	5	537	.334	.0236	.0125	46.9	.112	.403	.1

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an r served	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	s.d.	s.e.	90 % Credibility Interval	95 % Confidence Interval
.227	.0287	.0057	80.1	.076	.332	.111	.0546	.150 to .514	.22 to .44
ganization Type, and Type of Measure:									
.057	.0832	.0471	43.3	.217	.067	.257	.1445	-.355 to .490	-.22 to .35
.126	.0761	.0358	50.6	.194	.149	.229	.1969	-.228 to .527	-.24 to .54
.001	.0817	.0466	42.9	.216	-.001	.256	.1999	-.422 to .419	-.39 to .39
.082	.0709	.0371	47.7	.192	.097	.228	.1434	-.277 to .472	-.18 to .38
.540					-.652	n.a.	.2392		-1.00 to -.21
.057	.0832	.0471	43.3	.217	.067	.257	.1445	-.355 to .490	-.22 to .35
.220	.0441	.0157	64.4	.125	.333	.190	.0838	.021 to .645	.17 to .50
.166	.0498	.0269	45.9	.164	.253	.250	.1250	-.158 to .663	.01 to .50
.343	.0174	-.0232	100+	0	.512	0	.1027	.512	.31 to .71
.120					.203	n.a.	.1880		-.16 to .57
.152	.0278	-.0066	100+	0	.244	0	.1154	.244	.02 to .47
.186	.0271	-.0060	100+	0	.305	0	.1268	.305	.06 to .55
.193	.0843	.0627	25.6	.250	.294	.380	.2486	-.332 to .919	-.19 to .78
.220	.0441	.0157	64.4	.125	.333	.190	.0838	.021 to .645	.17 to .50
.132	.0341	.0139	59.2	.118	.165	.148	.0876	-.078 to .409	-.01 to .34
.319	.0076	-.0137	100+	0	.400	0	.1088	.400	.19 to .61
.080	.0267	.0057	78.4	.076	.101	.095	.1185	-.056 to .257	-.13 to .33
.014	.0099	-.0127	100+	0	-.018	0	.1345	-.018	-.28 to .24
.137	.0345	.0048	86.2	.069	.170	.086	.1169	.029 to .312	-.06 to .40
.098	.0234	-.0011	100+	0	.138	0	.0963	.138	-.05 to .33
.146	.0225	.0018	92.2	.042	.184	.053	.0816	.097 to .270	.02 to .34
.090	.0644	.0456	29.2	.213	.114	.268	.2312	-.327 to .554	-.34 to .57
.334	.0236	.0125	46.9	.112	.403	.135	.0761	.181 to .625	.25 to .55
.336	.0278	.0174	37.5	.132	.405	.159	.0940	.143 to .666	.22 to .59
.327					.394	n.a.	.0939		.21 to .58
.550	.0181	-.0055	100+	0	.663	0	.0939	.663	.48 to .85
.282	.0004	-.0086	100+	0	.339	0	.0616	.339	.22 to .46
.362	.0576	.0409	29.0	.202	.436	.244	.1957	.035 to .837	.05 to .82
.334	.0236	.0125	46.9	.112	.403	.135	.0761	.181 to .625	.25 to .55

Table H-3--continued

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Mean
Size of Organization with Organization Type, and Type of Measure:								
Small	9	658	.256	.0254	.0033	87.0	.057	.373
Manufacturing	4	140	.219	.0503	.0192	61.8	.139	.326
Service	3	389	.274	.0015	-.0169	100+	0	.410
Mixed	2	129	.242	.0676	.0460	31.9	.214	.353
Institutional	8	630	.246	.0244	.0035	85.6	.059	.360
Questionnaire	1	28	.468					.685
Large	4	155	.243	.0164	-.0162	100+	0	.354
Manufacturing	3	90	.132	.0008	-.0365	100+	0	.198
Service	2	42	.106	.0034	-.0467	100+	0	.161
Mixed	1	31	.490					.714
Institutional	4	155	.243	.0164	-.0162	100+	0	.354
Unknown Size	2	89	-.017	.0091	-.0135	100+	0	-.025
Service	2	89	-.017	.0091	-.0135	100+	0	-.025
Institutional	1	27	.128					.186
Questionnaire	1	62	-.080					-.120
Organization Type with Type of Measure:								
Manufacturing	7	230	.184	.0328	-.0005	100+	0	.276
Institutional	6	202	.145	.0246	-.0072	100+	0	.218
Questionnaire	1	28	.468					.702
Service	7	520	.211	.0157	-.0043	100+	0	.317
Institutional	6	458	.250	.0048	-.0174	100+	0	.375
Questionnaire	1	62	-.080					-.120
Mixed: Institutional	3	160	.290	.0641	.0375	41.5	.194	.422

Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	s.d.	s.e.	90 % Credibility Interval	95 % Confidence Interval
, and Type of Measure:									
.256	.0254	.0033	87.0	.057	.373	.084	.0603	.236 to .511	.25 to .49
.219	.0503	.0192	61.8	.139	.326	.207	.1598	-.014 to .667	.01 to .64
.274	.0015	-.0169	100+	0	.410	0	.0704	.410	.27 to .55
.242	.0676	.0460	31.9	.214	.353	.313	.2528	-.162 to .868	-.14 to .85
.246	.0244	.0035	85.6	.059	.360	.086	.0629	.218 to .502	.24 to .48
.468					.685	n.a.	.1021		.48 to .88
.243	.0164	-.0162	100+	0	.354	0	.1118	.354	.14 to .57
.132	.0008	-.0365	100+	0	.198	0	.1583	.198	-.11 to .51
.106	.0034	-.0467	100+	0	.161	0	.2373	.161	-.30 to .63
.490					.714	n.a.	.0895		.54 to .89
.243	.0164	-.0162	100+	0	.354	0	.1118	.354	.14 to .57
-.017	.0091	-.0135	100+	0	-.025	0	.1583	-.025	-.33 to .28
-.017	.0091	-.0135	100+	0	-.025	0	.1583	-.025	-.33 to .28
.128					.186	n.a.	.1893		-.18 to .56
-.080					-.120	n.a.	.1262		-.37 to .13
.184	.0328	-.0005	100+	0	.276	0	.0968	.276	.09 to .47
.145	.0246	-.0072	100+	0	.218	0	.1050	.218	.01 to .42
.468					.702	n.a.	.0976		.51 to .89
.211	.0157	-.0043	100+	0	.317	0	.0635	.317	.19 to .44
.250	.0048	-.0174	100+	0	.375	0	.0661	.375	.24 to .50
-.080					-.120	n.a.	.1262		-.37 to .13
.290	.0641	.0375	41.5	.194	.422	.281	.1940	-.041 to .884	.04 to .80

Table H-4. Multiple Moderators: Overall Formalization

Variable	Number of Corre-lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Correc Mean
Total	43	2853	.173	.0303	.0135	55.6	.116	.254
Technology Concept with Organization Size, Organization Type, Level of Analysis, and Type of Measure								
Workflow Continuity	16	628	.174	.0692	.0454	33.3	.213	.206
Small	10	331	.168	.0862	.0624	27.6	.250	.200
Large	4	115	.139	.1026	.0703	31.5	.265	.165
Unknown Size	2	182	.204	.0119	-.0030	100+	0	.242
Manufacturing	13	426	.217	.0626	.0333	46.8	.182	.257
Service	1	6	-.907					-.907
Mixed	2	196	.113	.0399	.0250	27.9	.167	.133
Organization and Institutional	16	628	.174	.0682	.0454	33.3	.213	.206
Workflow Integration	25	1604	.111	.0441	.0304	31.0	.174	.170
Small	17	1193	.091	.0529	.0398	24.7	.200	.140
Large	4	176	.115	.0077	-.0156	100+	0	.175
Unknown Size	4	435	.164	.0308	.0188	38.9	.137	.250
Manufacturing	10	388	.230	.0272	-.0027	100+	0	.368
Service	10	755	.051	.0450	.0332	26.3	.182	.085
Mixed	7	646	.096	.0430	.0318	26.0	.178	.146
Individual	2	329	.018	.0168	.0109	35.4	.104	.027
Subunit	5	539	-.032	.0402	.0314	21.9	.177	-.049
Organization	18	936	.227	.0277	.0046	83.2	.068	.343
Institutional	21	1291	.127	.0536	.0377	29.7	.194	.194
Questionnaire	2	184	.170	.0050	-.0097	100+	0	.259
Other Measure	2	329	.018	.0168	.0109	35.4	.104	.027
Task Routineness	23	1233	.173	.0640	.0460	28.0	.214	.217
Small	13	696	.240	.0899	.0722	19.6	.269	.302
Large	6	192	.009	.0164	-.0154	100+	0	.012
Unknown Size	4	345	.127	.0119	.0002	98.5	.014	.159
Manufacturing	9	226	-.078	.0256	-.0112	100+	0	-.098
Service	15	925	.192	.0448	.0278	37.8	.167	.268
Mixed	1	82	.611					.771
Individual	1	174	.025					.032
Subunit	7	341	.318	.0474	.0247	47.9	.157	.400
Organization	15	715	.139	.0708	.0517	27.0	.227	.175
Institutional	14	786	.173	.0706	.0537	24.0	.232	.218
Questionnaire	8	273	.265	.0630	.0338	46.4	.184	.333
Other Measure	1	174	.025					.032

erall Formalization

in r Served	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	s.d.	s.e.	90 % Credibility Interval	95 % Confidence Interval
.173	.0303	.0135	55.6	.116	.254	.171	.0374	-.027 to .535	.18 to .33
ganization Type, Level of Analysis, and Type of Measure:									
174	.0682	.0454	33.3	.213	.206	.253	.0784	-.210 to .621	.05 to .36
168	.0862	.0624	27.6	.250	.200	.296	.1136	-.287 to .687	-.02 to .42
139	.1026	.0703	31.5	.265	.165	.314	.1920	-.352 to .682	-.21 to .54
204	.0119	-.0030	100+	0	.242	0	.0847	.242	.08 to .41
217	.0626	.0333	46.8	.182	.257	.216	.0818	-.099 to .613	.10 to .42
907					-.907	n.a.	.0793		-1.00 to -.75
113	.0389	.0280	27.9	.167	.133	.198	.1635	-.193 to .460	-.19 to .45
174	.0682	.0454	33.3	.213	.206	.253	.0784	-.210 to .621	.05 to .36
111	.0441	.0304	31.0	.174	.170	.266	.0642	-.268 to .608	.04 to .30
091	.0529	.0398	24.7	.200	.140	.305	.0862	-.362 to .642	-.03 to .31
115	.0077	-.0156	100+	0	.175	0	.1150	.175	-.05 to .40
164	.0308	.0188	38.9	.137	.250	.209	.1266	-.094 to .594	.00 to .50
230	.0272	-.0027	100+	0	.368	0	.0779	.368	.21 to .52
051	.0450	.0332	26.3	.182	.085	.302	.1133	-.413 to .583	-.14 to .31
096	.0430	.0318	26.0	.178	.146	.273	.1193	-.302 to .595	-.09 to .38
018	.0168	.0109	35.4	.104	.027	.160	.1413	-.236 to .290	-.25 to .30
032	.0402	.0314	21.9	.177	-.049	.272	.1384	-.496 to .398	-.32 to .22
227	.0277	.0046	83.2	.068	.343	.103	.0533	.173 to .513	.24 to .45
127	.0536	.0377	29.7	.194	.194	.296	.0772	-.294 to .681	.04 to .34
170	.0050	-.0097	100+	0	.259	0	.1096	.259	.04 to .47
018	.0168	.0109	35.4	.104	.027	.160	.1413	-.236 to .290	-.25 to .30
173	.0640	.0460	28.0	.214	.217	.270	.0662	-.226 to .660	.09 to .35
240	.0899	.0722	19.6	.269	.302	.337	.1040	-.253 to .857	.10 to .51
009	.0164	-.0154	100+	0	.012	0	.0921	.012	-.17 to .19
127	.0119	.0002	98.5	.014	.159	.017	.0675	.131 to .187	.03 to .29
078	.0286	-.0112	100+	0	-.098	0	.0840	-.098	-.26 to .07
192	.0448	.0278	37.8	.167	.268	.233	.0748	-.115 to .651	.12 to .41
611					.771	n.a.	.0451		.68 to .86
025					.032	n.a.	.0760		-.12 to .18
318	.0474	.0247	47.9	.157	.400	.197	.0968	.075 to .724	.21 to .59
139	.0708	.0517	27.0	.227	.175	.286	.0872	-.295 to .645	.00 to .34
173	.0706	.0537	24.0	.232	.218	.291	.0893	-.261 to .696	.04 to .39
265	.0630	.0338	46.4	.184	.333	.231	.1086	-.047 to .713	.12 to .55
025					.032	n.a.	.0760		-.12 to .18

Table H-4--continued

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Mean
Information Technology	9	935	.339	.0140	.0057	59.4	.075	.410
Small	7	753	.306	.0100	.0020	80.4	.044	.368
Large	1	82	.387					.465
Unknown Size	1	103	.550					.661
Manufacturing	3	204	.405	.0196	.0090	54.2	.095	.489
Service	3	437	.301	.0033	-.0031	100+	0	.363
Mixed	4	297	.352	.0273	.0150	45.1	.122	.425
Subunit	1	400	.302					.364
Organization	8	538	.367	.0225	.0106	53.2	.103	.443
Institutional	9	935	.339	.0140	.0057	59.4	.075	.410
Organization Size with Organization Type, Level of Analysis, and Type of Measure:								
Small	28	1949	.185	.0321	.0158	50.8	.126	.272
Manufacturing	9	355	.269	.0257	-.0036	100+	0	.399
Service	13	1080	.207	.0203	.0056	72.2	.075	.312
Mixed	6	514	.082	.0450	.0337	25.1	.184	.121
Individual	1	155	-.120					-.176
Subunit	5	789	.228	.0081	-.0033	100+	0	.334
Organization	22	1005	.199	.0399	.0168	58.0	.129	.292
Institutional	23	1551	.205	.0270	.0095	64.8	.098	.301
Questionnaire	5	318	.294	.0403	.0184	54.4	.136	.427
Other Measure	1	155	-.120					-.176
Large	8	246	.124	.0297	-.0036	100+	0	.183
Manufacturing	7	173	.150	.0385	-.0032	100+	0	.225
Service	3	81	.015	.0001	-.0386	100+	0	.023
Subunit & Quest.	3	45	-.043	.0050	-.0610	100+	0	-.063
Organization & Inst.	5	198	.165	.0273	.0010	96.2	.032	.242
Unknown Size	7	658	.154	.0236	.0110	53.1	.105	.226
Manufacturing	1	79	.080					.120
Service	4	345	.163	.0069	-.0066	100+	0	.247
Mixed	2	234	.165	.0540	.0437	19.1	.209	.243
Individual	1	174	.082					.120
Subunit	2	158	.001	.0086	-.0037	100+	0	.002
Organization	4	326	.266	.0167	-.0016	100+	0	.388
Institutional	5	454	.176	.0313	.0178	43.1	.133	.259
Questionnaire	1	30	.225					.331
Other Measure	1	174	.082					.120

ean r bserved	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
.339	.0140	.0057	59.4	.075	.410	.091	.0463	.260 to .559	.32 to .50
.306	.0100	.0020	80.4	.044	.368	.053	.0448	.281 to .456	.28 to .46
.387					.465	n.a.	.0571		.29 to .64
.550					.661	n.a.	.0558		.55 to .77
.405	.0196	.0090	54.2	.095	.489	.114	.0971	.300 to .677	.30 to .68
.301	.0033	-.0031	100+	0	.363	0	.0527	.363	.26 to .46
.352	.0273	.0150	45.1	.122	.425	.148	.0962	.182 to .668	.24 to .61
.302					.364	n.a.	.0434		.28 to .45
.367	.0225	.0106	53.2	.103	.443	.124	.0630	.239 to .647	.32 to .57
.339	.0140	.0057	59.4	.075	.410	.091	.0463	.260 to .559	.32 to .50
vel of Analysis, and Type of Measure:									
.185	.0321	.0158	50.8	.126	.272	.185	.0476	-.031 to .576	.18 to .36
.269	.0257	-.0036	100+	0	.399	0	.0741	.399	.25 to .54
.207	.0203	.0056	72.2	.075	.312	.113	.0542	.126 to .498	.21 to .42
.082	.0450	.0337	25.1	.184	.121	.271	.1284	-.325 to .568	-.13 to .37
-.120					-.176	n.a.	.0781		-.33 to -.02
.228	.0081	-.0033	100+	0	.334	0	.0495	.334	.24 to .43
.199	.0399	.0168	58.0	.129	.292	.190	.0605	-.020 to .604	.17 to .41
.205	.0270	.0095	64.8	.098	.301	.143	.0467	.065 to .536	.21 to .39
.294	.0403	.0184	54.4	.136	.427	.197	.1157	.103 to .751	.20 to .65
-.120					-.176	n.a.	.0781		-.33 to -.02
.124	.0297	-.0036	100+	0	.183	0	.0941	.183	-.00 to .37
.150	.0355	-.0032	100+	0	.225	0	.1140	.225	.00 to .45
.015	.0001	-.0386	100+	0	.023	0	.1725	.023	-.32 to .36
-.043	.0050	-.0610	100+	0	-.063	0	.2200	-.063	-.49 to .37
.165	.0273	.0010	96.2	.032	.242	.048	.1052	.164 to .321	.04 to .45
.154	.0236	.0110	53.1	.105	.226	.155	.0812	-.028 to .481	.07 to .38
.080					.120	n.a.	.1116		-.10 to .34
.163	.0069	-.0066	100+	0	.247	0	.0798	.247	.09 to .40
.165	.0540	.0437	19.1	.209	.243	.307	.2367	-.263 to .748	-.22 to .71
.082					.120	n.a.	.0749		-.03 to .27
.001	.0086	-.0037	100+	0	.002	0	.1184	.002	-.23 to .23
.266	.0167	-.0016	100+	0	.388	0	.0755	.388	.24 to .54
.176	.0313	.0178	43.1	.133	.259	.196	.1105	-.063 to .582	.04 to .48
.225					.331	n.a.	.1654		.01 to .65
.082					.120	n.a.	.0749		-.03 to .27

Table H-4--continued

Variable	Number of Corre-lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Mean
Type of Organization with Level of Analysis and Type of Measure:								
Manufacturing	17	607	.210	.0312	.0009	97.0	.030	.314
Subunit & Quest.	3	48	-.043	.0050	-.0610	100+	0	-.064
Organization & Inst.	14	559	.232	.0275	-.0003	100+	0	.346
Service	20	1506	.187	.0181	.0026	85.5	.051	.282
Individual	1	174	.082					.120
Subunit	6	816	.228	.0078	-.0037	100+	0	.342
Organization	13	516	.158	.0334	.0080	76.1	.089	.239
Institutional	14	1066	.204	.0219	.0060	72.4	.078	.307
Questionnaire	5	266	.155	.0065	-.0142	100+	0	.284
Other Measure	1	174	.082					.120
Mixed	8	748	.108	.0493	.0385	22.0	.196	.160
Individual	1	155	-.120					-.176
Subunit	1	131	-.041					-.061
Organization	6	462	.227	.0419	.0252	40.0	.159	.332
Institutional	7	586	.138	.0368	.0238	35.4	.154	.203
Questionnaire	1	82	.611					.771
Other Measure	1	155	-.120					-.176
Level of Analysis with Type of Measure:								
Individual and Other Measure	2	321	-.013	.0102	.0042	59.1	.064	-.019
Subunit	10	995	.179	.0173	.0041	76.2	.064	.263
Institutional	5	763	.193	.0181	.0081	55.4	.090	.284
Questionnaire	5	232	.132	.0118	-.0120	100+	0	.195
Organization	31	1529	.209	.0344	.0119	65.4	.109	.306
Institutional	28	1440	.197	.0334	.0121	63.9	.110	.288
Questionnaire	4	164	.411	.0462	.0112	75.8	.106	.588

ean r bserved	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	s.d.	s.e.	90 % Credibility Interval	95 % Confidence Interval
nd Type of Measure:									
.210	.0312	.0009	97.0	.030	.314	.045	.0598	.240 to .389	.20 to .43
-.043	.0050	-.0610	100+	0	-.064	0	.2247	-.064	-.50 to .38
.232	.0275	-.0003	100+	0	.346	0	.0605	.346	.23 to .46
.187	.0181	.0026	85.5	.051	.282	.077	.0416	.155 to .409	.20 to .36
.082					.120	n.a.	.0749		-.03 to .27
.228	.0078	-.0037	100+	0	.342	0	.0501	.342	.24 to .44
.158	.0334	.0080	76.1	.089	.239	.135	.0758	.016 to .461	.09 to .39
.204	.0219	.0060	72.4	.078	.307	.117	.0545	.114 to .500	.20 to .41
.155	.0065	-.0142	100+	0	.254	0	.0902	.254	.11 to .46
.082					.120	n.a.	.0749		-.03 to .27
.108	.0493	.0385	22.0	.196	.160	.289	.1155	-.316 to .636	-.07 to .38
-.120					-.176	n.a.	.0781		-.33 to -.02
-.041					-.061	n.a.	.0874		-.23 to .11
.227	.0419	.0252	40.0	.159	.332	.232	.1149	-.050 to .714	.11 to .56
.138	.0368	.0238	35.4	.154	.203	.227	.1047	-.171 to .576	-.00 to .41
.611					.771	n.a.	.0451		.68 to .86
-.120					-.176	n.a.	.0781		-.33 to -.02
.013	.0102	.0042	59.1	.064	-.019	.095	.1060	-.176 to .137	-.23 to .19
.179	.0173	.0041	76.2	.064	.263	.094	.0543	.108 to .418	.16 to .37
.193	.0181	.0081	55.4	.090	.284	.132	.0782	.067 to .501	.13 to .44
.132	.0118	-.0120	100+	0	.195	0	.0961	.195	.01 to .38
.209	.0344	.0119	65.4	.109	.306	.160	.0462	.043 to .569	.22 to .40
.197	.0334	.0121	63.9	.110	.288	.161	.0484	.023 to .554	.19 to .38
.411	.0462	.0112	75.8	.106	.588	.151	.1206	.339 to .837	.35 to .82

Table H-5. Multiple Moderators: Formalization of Roles

Variable	Number of Corre-lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Correct Mean
Total	25	1013	.218	.0372	.0106	71.5	.103	.334
Technology Concept with Type of Organization:								
Workflow Continuity	3	52	.209	.0475	-.0102	100+	0	.254
Manufacturing	3	52	.209	.0475	-.0102	100+	0	.254
Workflow Integration	20	719	.230	.0343	.0035	89.7	.059	.403
Manufacturing	15	463	.184	.0290	-.0050	100+	0	.310
Service	5	74	.261	.0595	.0010	95.4	.031	.443
Mixed	3	181	.350	.0176	-.0130	100+	0	.547
Task Routineness	16	601	.122	.0710	.0484	31.8	.220	.161
Manufacturing	14	385	.164	.0904	.0588	34.9	.242	.214
Service	5	216	.035	.0279	.0066	76.1	.082	.051
Information Technology	2	71	.328	.0000	-.0253	100+	0	.414
Manufacturing	1	20	.320					.469
Service	1	51	.331					.485

Table H-6. Multiple Moderators: Vertical Span

Variable	Number of Corre-lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Correct Mean
Total	29	2964	.268	.0292	.0146	49.8	.121	.342
Type of Measure with Size of Organization:								
Institutional	28	2893	.274	.0283	.0137	51.7	.117	.349
Small	21	2637	.278	.0275	.0143	48.0	.120	.354
Large	7	256	.236	.0356	.0061	82.8	.078	.303
Questionnaire	1	71	.019					.024
Small	1	71	.019					.024

ormalization of Roles

Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
.218	.0372	.0106	71.5	.103	.334	.158	.0562	.074 to .594	.22 to .44
n:									
.209	.0475	-.0102	100+	0	.254	0	.1655	.254	-.07 to .58
.209	.0475	-.0102	100+	0	.254	0	.1655	.254	-.07 to .58
.230	.0343	.0035	89.7	.059	.403	.104	.0606	.209 to .519	.24 to .48
.184	.0290	-.0050	100+	0	.310	0	.0768	.310	.16 to .46
.261	.0595	.0010	95.4	.031	.443	.053	.1921	.356 to .530	.07 to .82
.350	.0176	-.0130	100+	0	.547	0	.1026	.547	.34 to .75
.122	.0710	.0484	31.8	.220	.161	.289	.0900	-.315 to .637	-.02 to .34
.164	.0904	.0588	34.9	.242	.214	.316	.1072	-.306 to .734	.00 to .42
.035	.0279	.0066	76.1	.082	.051	.120	.1142	-.146 to .248	-.17 to .27
.328	.0000	-.0253	100+	0	.414	0	.1357	.414	.15 to .68
.320					.469	n.a.	.1790		.12 to .82
.331					.485	n.a.	.1082		.27 to .70

ertical Span

ean r bserved	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
.268	.0292	.0146	49.8	.121	.342	.154	.0361	.088 to .596	.27 to .41
.274	.0283	.0137	51.7	.117	.349	.149	.0358	.104 to .595	.28 to .42
.278	.0275	.0143	48.0	.120	.354	.152	.0404	.103 to .605	.27 to .43
.236	.0356	.0061	62.8	.078	.303	.100	.0855	.138 to .468	.14 to .47
.019					.024	n.a.	.1184		-.21 to .26
.019					.024	n.a.	.1184		-.21 to .26

Table H-7. Multiple Moderators: Centralization

Variable	Number of Corre-lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Mean
Total	56	3423	.025	.0496	.0342	31.0	.185	.036
Technology Concept with Size of Organization, Type of Organization, Level of Analysis, and Type of Meas								
Workflow Continuity	19	785	.049	.0328	.0091	72.1	.096	.056
Small	11	439	.098	.0222	-.0035	100+	0	.113
Large	6	164	.157	.0250	-.0122	100+	0	.181
Unknown Size	2	182	-.166	.0024	-.0112	100+	0	-.192
Manufacturing	16	583	.105	.0283	.0008	97.1	.029	.120
Service	1	6	.166					.236
Mixed	2	196	-.120	.0090	-.0025	100+	0	-.135
Organization and Institutional	19	785	.049	.0328	.0091	72.1	.096	.056
Workflow Integration	33	2222	-.060	.0402	.0258	35.8	.161	-.069
Small	19	1283	-.039	.0376	.0227	38.4	.152	-.058
Large	9	360	-.094	.0536	.0302	43.6	.174	-.140
Unknown Size	5	579	-.085	.0354	.0264	25.4	.162	-.127
Manufacturing	15	701	-.010	.0142	-.0068	100+	0	-.016
Service	11	836	-.011	.0365	.0237	35.2	.154	-.018
Mixed	9	670	-.177	.0522	.0368	29.5	.192	-.262
Individual	2	329	-.114	.0417	.0344	17.4	.186	-.169
Subunit	6	524	-.023	.0514	.0409	20.6	.202	-.034
Organization	25	1369	-.061	.0344	.0166	51.5	.129	-.091
Institutional	26	1546	-.051	.0332	.0158	52.5	.126	-.076
Questionnaire	3	347	-.050	.0670	.0590	12.0	.243	-.074
Other Measure	2	329	-.114	.0417	.0344	17.4	.186	-.169
Task Routineness	27	1705	.167	.0323	.0165	48.9	.128	.204
Small	13	575	.084	.0559	.0351	37.2	.187	.103
Large	6	192	.195	.0061	-.0258	100+	0	.238
Unknown Size	5	938	.211	.0168	.0072	57.3	.085	.258
Manufacturing	9	226	.071	.0125	-.0280	100+	0	.086
Service	19	1397	.161	.0342	.0205	40.0	.143	.219
Mixed	1	82	.473					.679
Individual	2	511	.298	.0075	.0011	85.3	.033	.364
Subunit	11	656	.030	.0209	.0043	79.6	.065	.037
Organization	14	538	.209	.0289	.0039	86.6	.062	.255
Institutional	12	405	.117	.0138	-.0157	100+	0	.143
Questionnaire	13	789	.107	.0419	.0265	36.6	.163	.131
Other Measure	2	511	.298	.0075	.0011	85.3	.033	.364

ntralization

ean r bserved	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	s.d.	s.e.	90 % Credibility Interval	95 % Confidence Interval
.025	.0496	.0342	31.0	.185	.036	.266	.0433	-.401 to .474	-.05 to .12

Type of Organization, Level of Analysis, and Type of Measure:

ean r bserved	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	s.d.	s.e.	90 % Credibility Interval	95 % Confidence Interval
.049	.0328	.0091	72.1	.096	.056	.110	.0486	-.125 to .238	-.04 to .15
.095	.0222	-.0035	100+	0	.113	0	.0552	.113	.00 to .22
.157	.0250	-.0122	100+	0	.181	0	.0895	.181	.01 to .36
.166	.0024	-.0112	100+	0	-.192	0	.0836	-.192	-.36 to -.03
.105	.0263	.0008	97.1	.029	.120	.033	.0486	.066 to .175	.02 to .22
.166					.236	n.a.	.4226		-.59 to 1.00
.120	.0090	-.0025	100+	0	-.135	0	.0816	-.135	-.30 to .02
.049	.0328	.0091	72.1	.096	.056	.110	.0486	-.125 to .238	-.04 to .15
.060	.0402	.0258	35.8	.161	-.089	.240	.0524	-.483 to .305	-.19 to .01
.039	.0376	.0227	38.4	.152	-.058	.227	.0668	-.432 to .315	-.19 to .07
.094	.0536	.0302	43.6	.174	-.140	.258	.1167	-.566 to .285	-.37 to .09
.085	.0354	.0264	25.4	.162	-.127	.242	.1245	-.524 to .271	-.37 to .12
.010	.0142	-.0068	100+	0	-.016	0	.0604	-.016	-.13 to .10
.011	.0365	.0237	35.2	.154	-.018	.249	.0938	-.428 to .391	-.20 to .16
.177	.0522	.0368	29.5	.192	-.262	.284	.1099	-.729 to .205	-.48 to -.05
.114	.0417	.0344	17.4	.186	-.169	.276	.2112	-.623 to .285	-.58 to .24
.023	.0514	.0409	20.6	.202	-.034	.301	.1394	-.530 to .461	-.31 to .24
.061	.0344	.0166	51.5	.129	-.091	.192	.0558	-.407 to .225	-.20 to .02
.051	.0332	.0158	52.5	.126	-.076	.187	.0520	-.384 to .232	-.18 to .03
.050	.0670	.0590	12.0	.243	-.074	.362	.2238	-.669 to .521	-.51 to .36
.114	.0417	.0344	17.4	.186	-.169	.276	.2112	-.623 to .285	-.58 to .24
.167	.0323	.0165	48.9	.128	.204	.157	.0418	-.054 to .462	.12 to .28
.084	.0559	.0351	37.2	.187	.103	.229	.0816	-.274 to .480	-.06 to .26
.195	.0061	-.0258	100+	0	.238	0	.0862	.238	.07 to .41
.211	.0168	.0072	57.3	.085	.258	.104	.0530	.088 to .428	.15 to .36
.071	.0125	-.0280	100+	0	.086	0	.0818	.086	-.07 to .25
.161	.0342	.0205	40.0	.143	.219	.195	.0572	-.101 to .540	.11 to .33
.473					.679	n.a.	.0599		.56 to .80
.295	.0075	.0011	85.3	.033	.364	.041	.0571	.297 to .430	.25 to .48
.030	.0209	.0043	79.6	.065	.037	.080	.0538	-.094 to .168	-.07 to .14
.209	.0289	.0039	86.6	.062	.255	.076	.0549	.130 to .380	.15 to .36
.117	.0138	-.0157	100+	0	.143	0	.0608	.143	.02 to .26
.107	.0419	.0265	36.6	.163	.131	.199	.0702	-.196 to .458	-.01 to .27
.298	.0075	.0011	85.3	.033	.364	.041	.0571	.297 to .430	.25 to .48

Table H-7--continued

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corre ----- Mean
Information Technology	12	842	-.150	.0466	.0336	27.8	.183	-.176
Small	6	494	-.100	.0447	.0336	24.7	.183	-.118
Large	5	245	-.144	.0388	.0198	49.0	.141	-.169
Unknown Size	1	103	-.400					-.469
Manufacturing	6	353	-.081	.0139	-.0028	100+	0	-.095
Service	3	195	-.246	.0605	.0480	20.5	.219	-.289
Mixed	4	294	-.146	.0905	.0791	12.5	.281	-.172
Organization and Institutional	12	842	-.150	.0466	.0336	27.8	.183	-.176
Organization Type with Size of Organization, Type of Measure, and Level of Analysis:								
Manufacturing	24	973	.020	.0154	-.0092	100+	0	.029
Small	12	579	.015	.0115	-.0092	100+	0	.022
Large	11	315	.062	.0203	-.0147	100+	0	.091
Unknown Size	1	79	-.110					-.160
Institutional and Organization	21	925	.011	.0144	-.0083	100+	0	.016
Questionnaire and Subunit	3	48	.196	.0025	-.0631	100+	0	.286
Service	23	1613	.095	.0436	.0296	32.1	.172	.141
Small	11	541	.018	.0323	.0133	58.9	.115	.026
Large	4	134	-.097	.1093	.0836	23.6	.289	-.144
Unknown Size	8	938	.167	.0268	.0160	40.1	.127	.247
Institutional	12	443	-.045	.0542	.0287	47.0	.169	-.066
Questionnaire	9	659	.045	.0186	.0058	65.7	.076	.067
Other Measure	2	511	.281	.0121	.0018	85.2	.042	.409
Individual	2	511	.281	.0121	.0018	85.2	.042	.409
Subunit	8	608	.011	.0076	-.0056	100+	0	.016
Organization	13	494	.007	.0654	.0452	33.9	.213	.010
Mixed	11	845	-.097	.0805	.0688	14.6	.262	-.139
Small	7	540	-.043	.0946	.0835	11.8	.289	-.061
Large	2	71	-.447	.0042	-.0313	100+	0	-.618
Unknown Size	2	234	-.115	.0268	.0175	34.8	.132	-.165
Institutional	9	608	-.114	.0540	.0400	25.9	.200	-.164
Questionnaire	1	82	.473					.679
Other Measure	1	155	-.330					-.473
Individual	1	155	-.330					-.473
Subunit	2	150	-.009	.0104	-.0024	100+	0	-.013
Organization	8	540	-.054	.1035	.0915	11.6	.302	-.078

Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
-.150	.0466	.0336	27.8	.183	-.176	.215	.0738	-.530 to .178	-.32 to -.03
-.100	.0447	.0336	24.7	.183	-.118	.215	.1024	-.472 to .236	-.31 to .08
-.144	.0388	.0198	49.0	.141	-.169	.165	.1046	-.440 to .102	-.37 to .04
-.400					-.469	n.a.	.0772		-.62 to -.32
-.081	.0139	-.0028	100+	0	-.095	0	.0626	-.095	-.22 to .03
-.246	.0605	.0480	20.5	.219	-.289	.257	.1685	-.712 to .134	-.62 to .04
-.146	.0905	.0791	12.5	.281	-.172	.330	.1783	-.714 to .371	-.52 to .18
-.150	.0466	.0336	27.8	.183	-.176	.215	.0738	-.530 to .178	-.32 to -.03
, Type of Measure, and Level of Analysis:									
.020	.0154	-.0092	100+	0	.029	0	.0477	.029	-.06 to .12
.015	.0115	-.0092	100+	0	.022	0	.0617	.022	-.10 to .14
.062	.0203	-.0147	100+	0	.091	0	.0839	.091	-.07 to .26
-.110					-.160	n.a.	.1103		-.38 to .06
.011	.0144	-.0083	100+	0	.016	0	.0489	.016	-.08 to .11
.196	.0025	-.0631	100+	0	.286	0	.2087	.286	-.12 to .70
.095	.0436	.0296	32.1	.172	.141	.254	.0646	-.278 to .560	.01 to .27
.018	.0323	.0133	58.9	.115	.026	.171	.0824	-.255 to .307	-.14 to .19
-.097	.1093	.0836	23.6	.289	-.144	.427	.2494	-.847 to .559	-.63 to .34
.167	.0268	.0160	40.1	.127	.247	.186	.0809	-.060 to .554	.09 to .40
-.045	.0542	.0287	47.0	.169	-.066	.251	.1016	-.479 to .347	-.26 to .13
.045	.0186	.0058	65.7	.076	.067	.113	.0692	-.119 to .253	-.07 to .20
.281	.0121	.0018	85.2	.042	.409	.061	.0734	.308 to .510	.26 to .55
.281	.0121	.0018	85.2	.042	.409	.061	.0734	.308 to .510	.26 to .55
.011	.0076	-.0056	100+	0	.016	0	.0605	.016	-.10 to .14
.007	.0654	.0452	33.9	.213	.010	.315	.1105	-.509 to .528	-.21 to .23
-.097	.0805	.0698	14.6	.262	-.139	.376	.1238	-.758 to .480	-.38 to .10
-.043	.0946	.0835	11.8	.289	-.061	.416	.1689	-.745 to .622	-.39 to .27
-.447	.0042	-.0313	100+	0	-.618	0	.1333	-.618	-.88 to -.36
-.115	.0268	.0175	34.8	.132	-.165	.190	.1632	-.478 to .147	-.48 to .15
-.114	.0540	.0400	25.9	.200	-.164	.287	.1118	-.636 to .308	-.38 to .06
.473					.679	n.a.	.0599		.56 to .80
-.330					-.473	n.a.	.0626		-.60 to -.35
-.330					-.473	n.a.	.0626		-.60 to -.35
-.009	.0104	-.0024	100+	0	-.013	0	.1182	-.013	-.24 to .22
-.054	.1035	.0915	11.6	.302	-.078	.435	.1658	-.793 to .637	-.40 to .25

Table H-8. Multiple Moderators: Supervisor's Span of Control

Variable	Number of Corre-lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Mean
Total	22	2592	.078	.0132	.0043	67.7	.065	.101
Technology Concept with Size of Organization, Type of Organization, and Level of Analysis:								
Workflow Continuity	14	497	-.075	.0411	.0150	63.6	.122	-.078
Small	9	377	-.113	.0358	.0126	64.3	.113	-.118
Large	5	120	.045	.0384	.0005	98.6	.023	.047
Manufacturing	13	491	-.080	.0393	.0146	62.7	.121	-.083
Service	1	6	.354					.391
Subunit	1	20	.284					.313
Organization	13	477	-.090	.0372	.0116	68.9	.108	-.094
Workflow Integration	14	688	-.029	.0308	.0120	61.1	.110	-.039
Small	11	551	-.075	.0126	-.0078	100+	0	-.100
Large	3	137	.155	.0620	.0442	28.7	.210	.206
Manufacturing	11	496	-.068	.0207	-.0006	100+	0	-.097
Service	4	109	-.006	.0321	-.0032	100+	0	-.009
Mixed	1	68	-.177					-.261
Subunit	1	61	-.120					-.178
Organization	13	627	-.020	.0330	.0139	57.8	.118	-.027
Task Routineness	10	483	.070	.0388	.0190	50.9	.138	.077
Small	7	341	.110	.0365	.0170	53.3	.130	.120
Large	3	142	-.026	.0313	.0104	66.8	.102	-.029
Manufacturing	7	268	-.030	.0058	-.0212	100+	0	-.033
Service	4	133	.308	.0629	.0361	42.6	.190	.373
Mixed	1	82	-.029					-.035
Subunit	3	186	.225	.0363	.0222	38.9	.149	.246
Organization	7	297	-.027	.0159	-.0081	100+	0	-.030
Information Technology	8	2028	.095	.0102	.0064	37.4	.080	.100
Small	5	1875	.098	.0074	.0048	35.3	.069	.103
Large	3	153	.058	.0421	.0238	43.4	.154	.061
Manufacturing	5	334	-.061	.0199	.0053	73.2	.073	-.064
Service	4	1694	.129	.0018	-.0005	100+	0	.137
Subunit	2	1616	.123	.0009	-.0004	100+	0	.130
Organization	6	412	-.018	.0308	.0170	45.0	.130	-.019

Supervisor's Span of Control

Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
.078	.0132	.0043	67.7	.065	.101	.084	.0311	-.038 to .240	.04 to .16

n, Type of Organization, and Level of Analysis:

Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
-.075	.0411	.0150	63.6	.122	-.078	.127	.0579	-.267 to .131	-.19 to .04
-.113	.0355	.0125	64.3	.113	-.118	.117	.0662	-.311 to .075	-.25 to .01
.045	.0384	.0005	98.6	.023	.047	.024	.0972	.008 to .086	-.14 to .24
-.080	.0393	.0146	62.7	.121	-.083	.126	.0586	-.290 to .123	-.20 to .03
.354					.391	n.a.	.3788		-.35 to 1.00
.284					.313	n.a.	.2069		-.09 to .72
-.090	.0372	.0116	68.9	.108	-.094	.112	.0569	-.277 to .090	-.20 to .02
-.029	.0308	.0120	61.1	.110	-.039	.147	.0649	-.281 to .203	-.17 to .09
-.075	.0126	-.0078	100+	0	-.100	0	.0574	-.100	-.21 to .01
.155	.0620	.0442	28.7	.210	.206	.281	.1974	-.256 to .668	-.18 to .59
-.068	.0207	-.0006	100+	0	-.097	0	.0642	-.097	-.22 to .03
-.006	.0321	-.0032	100+	0	-.009	0	.1421	-.009	-.29 to .27
-.177					-.261	n.a.	.1138		-.48 to -.04
-.120					-.176	n.a.	.1250		-.42 to .07
-.020	.0330	.0139	57.8	.118	-.027	.158	.0697	-.288 to .233	-.16 to .11
.070	.0388	.0190	50.9	.138	.077	.152	.0696	-.173 to .326	-.06 to .21
.110	.0365	.0170	53.3	.130	.120	.143	.1104	-.115 to .356	-.04 to .28
-.026	.0313	.0104	66.8	.102	-.029	.112	.1132	-.213 to .155	-.25 to .19
-.030	.0058	-.0212	100+	0	-.033	0	.0672	-.033	-.16 to .10
.308	.0629	.0361	42.6	.190	.373	.230	.1499	-.005 to .751	.08 to .67
-.029					-.035	n.a.	.1110		-.25 to .18
.225	.0363	.0222	38.9	.149	.246	.163	.1217	-.022 to .515	.01 to .48
-.027	.0159	-.0081	100+	0	-.030	0	.0644	-.030	-.16 to .10
.095	.0102	.0064	37.4	.080	.100	.084	.0378	-.039 to .238	.03 to .17
.098	.0074	.0048	35.3	.069	.103	.073	.0408	-.018 to .224	.02 to .18
.058	.0421	.0238	43.4	.154	.061	.163	.1275	-.207 to .330	-.19 to .31
-.061	.0199	.0053	73.2	.073	-.064	.077	.0675	-.191 to .062	-.20 to .07
.129	.0018	-.0005	100+	0	.137	0	.0253	.137	.09 to .19
.123	.0009	-.0004	100+	0	.130	0	.0259	.130	.08 to .18
-.018	.0308	.0170	45.0	.130	-.019	.138	.0768	-.245 to .207	-.17 to .13

Table H-8--continued

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corre ------ Mean
Type of Organization with Size of Organization and Level of Analysis:								
Manufacturing	15	719	-.053	.0133	-.0079	100+	0	-.071
Small	10	589	-.062	.0117	-.0056	100+	0	-.082
Large	5	130	-.014	.0186	-.0205	100+	0	-.019
Subunit	2	115	.082	.0085	-.0086	100+	0	.109
Organization	13	604	-.079	.0100	-.0124	100+	0	-.105
Service	5	1807	.134	.0042	-.0014	100+	0	.179
Small	5	1713	.129	.0029	-.0012	100+	0	.172
Large	3	94	.218	.0205	-.0132	100+	0	.288
Subunit	4	1707	.130	.0029	-.0006	100+	0	.172
Organization	4	100	.205	.0219	-.0215	100+	0	.271
Mixed	1	75	-.096					-.136
Small and Organization	1	75	-.096					-.136
Level of Analysis with Size of Organization:								
Subunit	6	1822	.127	.0034	-.0012	100+	0	.164
Small	5	1802	.125	.0031	-.0009	100+	0	.161
Large	1	20	.284					.366
Organization	16	770	-.038	.0174	-.0038	100+	0	-.049
Small	11	575	-.083	.0100	-.0100	100+	0	-.107
Large	5	195	.095	.0155	-.0113	100+	0	.123

Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
tion and Level of Analysis:									
-.053	.0133	-.0079	100+	0	-.071	0	.0497	-.071	-.17 to .03
-.062	.0117	-.0056	100+	0	-.082	0	.0547	-.082	-.19 to .02
-.014	.0186	-.0205	100+	0	-.019	0	.1183	-.019	-.25 to .21
.082	.0085	-.0086	100+	0	.109	0	.1234	.109	-.13 to .35
-.079	.0100	-.0124	100+	0	-.105	0	.0540	-.105	-.21 to .00
.134	.0042	-.0014	100+	0	.178	0	.0308	.178	.12 to .24
.129	.0029	-.0012	100+	0	.172	0	.0316	.172	.11 to .23
.218	.0205	-.0132	100+	0	.288	0	.1317	.288	.03 to .55
.130	.0029	-.0006	100+	0	.172	0	.0317	.172	.11 to .23
.205	.0219	-.0215	100+	0	.271	0	.1291	.271	.02 to .52
-.096					-.136	n.a.	.1122		-.36 to .08
-.096					-.136	n.a.	.1122		-.36 to .08
:									
.127	.0034	-.0012	100+	0	.164	0	.0298	.164	.10 to .22
.125	.0031	-.0009	100+	0	.161	0	.0300	.161	.10 to .22
.284					.366	n.a.	.1987		-.02 to .76
-.038	.0174	-.0038	100+	0	-.049	0	.0471	-.049	-.14 to .04
-.083	.0100	-.0100	100+	0	-.107	0	.0541	-.107	-.21 to .00
.095	.0155	-.0113	100+	0	.123	0	.0929	.123	-.06 to .30

Table H-9. Multiple Moderators: % Direct Workers

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Correcte Mean
Total	12	497	-.207	.0654	.0390	40.4	.197	-.265
Technology Concept with Size of Organization, and Type of Organization:								
Workflow Continuity	12	453	-.257	.0929	.0665	28.5	.258	-.267
Small	9	372	-.312	.0896	.0636	29.0	.252	-.325
Large	3	81	-.002	.0291	-.0052	100+	0	-.002
Manufacturing	11	447	-.271	.0792	.0522	34.1	.225	-.282
Service	1	6	.791					.883
Workflow Integration	11	436	-.056	.0532	.0304	42.8	.174	-.076
Small	8	298	-.112	.0493	.0248	49.7	.157	-.150
Large	3	138	.064	.0404	.0188	53.4	.137	.086
Manufacturing	10	373	-.116	.0330	.0054	83.8	.073	-.165
Service	3	47	.161	.1546	.1107	28.4	.333	.232
Task Routineness	6	214	.015	.0239	-.0033	100+	0	.016
Small	3	71	.094	.0457	.0046	89.9	.068	.103
Large	3	143	-.024	.0085	-.0120	100+	0	-.027
Manufacturing	6	173	-.096	.0446	.0116	74.0	.108	-.105
Service	2	41	.189	.0082	-.0416	100+	0	.231
Information Technology	3	218	-.160	.0079	-.0055	100+	0	-.169
Small	2	137	-.111	.0061	-.0086	100+	0	-.111
Large	1	81	-.243					-.271
Manufacturing	3	192	-.166	.0117	-.0032	100+	0	-.175
Service	1	26	.105					.117
Size of Organization with Type of Organization:								
Small (< 1000)	9	373	-.262	.0737	.0460	37.6	.214	-.335
Manufacturing	8	367	-.266	.0737	.0485	34.2	.220	-.346
Service	1	6	.000					.000
Large (> 1000)	3	124	-.041	.0037	-.0216	100+	0	-.052
Manufacturing	3	91	-.167	.0027	-.0334	100+	0	-.220
Service	2	41	.195	.0076	-.0432	100+	0	.258

% Direct Workers

Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
-.207	.0654	.0390	40.4	.197	-.265	.254	.0920	-.683 to .152	-.44 to -.08
ion, and Type of Organization:									
-.257	.0929	.0665	28.5	.258	-.267	.268	.0901	-.708 to .174	-.44 to -.09
-.312	.0896	.0636	29.0	.252	-.325	.262	.1004	-.756 to .107	-.52 to -.13
-.002	.0291	-.0052	100+	0	-.002	0	.1175	-.002	-.23 to .23
-.271	.0792	.0522	34.1	.225	-.282	.238	.0852	-.672 to .109	-.45 to -.11
.791					.853	n.a.	.4796		-.06 to 1.00
-.056	.0532	.0304	42.8	.174	-.076	.234	.0959	-.461 to .309	-.26 to .11
-.112	.0493	.0248	49.7	.157	-.150	.211	.1076	-.497 to .196	-.36 to .06
.064	.0404	.0188	53.4	.137	.086	.184	.1566	-.217 to .388	-.22 to .39
-.116	.0330	.0054	83.8	.073	-.165	.104	.0804	-.335 to .006	-.32 to -.01
.161	.1546	.1107	28.4	.333	.232	.480	.3489	-.557 to 1.000	-.45 to .92
.015	.0239	-.0033	100+	0	.016	0	.0763	.016	-.13 to .16
.094	.0457	.0046	89.9	.068	.103	.075	.1391	-.020 to .226	-.17 to .38
-.024	.0055	-.0120	100+	0	-.027	0	.0929	-.027	-.21 to .16
-.096	.0446	.0116	74.0	.108	-.105	.118	.0964	-.295 to .086	-.29 to .08
.189	.0082	-.0416	100+	0	.231	0	.1887	.231	-.14 to .60
-.160	.0079	-.0055	100+	0	-.169	0	.0702	-.169	-.31 to -.03
-.111	.0061	-.0086	100+	0	-.111	0	.0898	-.111	-.29 to .06
-.243					-.271	n.a.	.1036		-.47 to -.07
-.166	.0117	-.0032	100+	0	-.175	0	.0747	-.175	-.32 to -.03
.105					.117	n.a.	.1973		.27 to .50
tion:									
-.262	.0737	.0460	37.6	.214	-.335	.274	.1106	-.785 to .116	-.55 to -.12
-.266	.0737	.0485	34.2	.220	-.346	.287	.1198	-.818 to .125	-.58 to -.11
.000					.000	n.a.	.4000		-.78 to .78
-.041	.0037	-.0216	100+	0	-.052	0	.1175	-.052	-.28 to .18
-.167	.0027	-.0334	100+	0	-.220	0	.1362	-.220	-.49 to .05
.195	.0076	-.0432	100+	0	.255	0	.2037	.258	-.14 to .66

Table H-10. Multiple Moderators: % Supervisors

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Mean
Total	10	1813	-.096	.0251	.0192	23.4	.139	-.124
Total w/o Harvey, 1968	9	1770	-.117	.0075	.0012	84.5	.034	-.151
Size of Organization with Organization Type:								
Small	8	1688	-.086	.0253	.0203	19.8	.142	-.112
Small w/o Harvey, 1968	7	1645	-.109	.0068	.0013	80.4	.036	-.140
Manufacturing	4	325	.121	.0733	.0622	15.2	.249	.159
Manufacturing w/o Harvey, 1968	3	282	.023	.0127	.0022	83.0	.046	.031
Service	2	1209	-.145	.0006	-.0028	100+	0	-.192
Mixed	2	154	-.065	.0000	-.0134	100+	0	-.084
Large	2	125	-.225	.0044	-.0147	100+	0	-.288
Manufacturing	1	55	-.042					-.055
Service	2	76	-.242	.0080	-.0209	100+	0	-.319

Supervisors

an r served	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	s.d.	s.e.	90 % Credibility Interval	95 % Confidence Interval
.096	.0251	.0192	23.4	.139	-.124	.179	.0642	-.419 to .171	-.25 to .00
.117	.0075	.0012	84.5	.034	-.151	.044	.0337	-.223 to -.079	-.22 to -.08
.086	.0253	.0203	19.8	.142	-.112	.185	.0723	-.415 to .191	-.25 to .03
.109	.0068	.0013	80.4	.036	-.140	.047	.0362	-.218 to -.063	-.21 to -.07
.121	.0733	.0622	15.2	.249	.159	.329	.1797	-.382 to .700	-.19 to .51
.023	.0127	.0022	83.0	.046	.031	.062	.0868	-.070 to .132	-.14 to .20
.145	.0006	-.0028	100+	0	-.192	0	.0374	-.192	-.26 to -.12
.065	.0000	-.0134	100+	0	-.084	0	.1045	-.084	-.29 to .12
.225	.0044	-.0147	100+	0	-.288	0	.1097	-.288	-.50 to -.07
.042					-.055	n.a.	.1357		-.32 to .21
.242	.0080	-.0209	100+	0	-.319	0	.1440	-.319	-.60 to -.04

Table H-11. Multiple Moderators: % Clerical Personnel

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Correc ------- Mean
Total	13	1996	.002	.0108	.0044	59.4	.066	.003
Type of Organization with Size of Organization, Level of Analysis, and Type of Measure:								
Manufacturing	8	444	.120	.0102	-.0086	100+	0	.158
Small	5	343	.134	.0124	-.0028	100+	0	.177
Large	3	101	.071	.0000	-.0316	100+	0	.094
Organization and Institutional	5	444	.120	.0102	-.0056	100+	0	.155
Service	7	1564	-.022	.0065	.0020	70.0	.044	-.029
Small	3	1322	-.006	.0026	.0002	93.0	.013	-.008
Large	3	94	.054	.0066	-.0258	100+	0	.072
Unknown Size	1	148	-.212					-.305
Subunit	2	1349	-.043	.0035	.0019	45.5	.044	-.055
Organization	5	215	.108	.0058	-.0192	100+	0	.144
Institutional	6	1416	-.002	.0031	-.0013	100+	0	-.003
Questionnaire	1	148	-.212					-.305
Level of Analysis with Size of Organization and Type of Measure:								
Subunit	2	1349	-.043	.0035	.0019	45.5	.044	-.055
Small and Institutional	1	1201	-.022					-.032
Unknown Size and Questionnaire	1	148	-.212					-.305
Organization	11	647	.097	.0127	-.0050	100+	0	.125
Small	7	464	.138	.0095	-.0069	100+	0	.179
Large	4	183	-.008	.0055	-.0171	100+	0	-.011
Institutional	11	647	.097	.0127	-.0050	100+	0	.125
Type of Measure with Size of Organization:								
Institutional	12	1848	.020	.0077	.0012	84.2	.035	.025
Small	8	1665	.023	.0078	.0031	60.1	.056	.029
Large	4	183	-.008	.0055	-.0171	100+	0	-.011
Questionnaire	1	148	-.212					-.305
Unknown Size	1	148	-.212					-.305

Clerical Personnel

an r served	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	Corrected Correlation s.d.	Corrected Correlation s.e.	90 % Credibility Interval	95 % Confidence Interval
.002	.0108	.0044	59.4	.066	.003	.086	.0376	-.138 to .144	-.07 to .08
n, Level of Analysis, and Type of Measure:									
.120	.0102	-.0086	100+	0	.158	0	.0622	.158	.04 to .28
.134	.0124	-.0028	100+	0	.177	0	.0704	.177	.04 to .31
.071	.0000	-.0316	100+	0	.094	0	.1328	.094	-.17 to .35
.120	.0102	-.0056	100+	0	.155	0	.0622	.158	.04 to .25
022	.0065	.0020	70.0	.044	-.029	.059	.0405	-.127 to .068	-.11 to .05
006	.0026	.0002	93.0	.013	-.008	.018	.0382	-.038 to .021	-.08 to .07
054	.0066	-.0258	100+	0	.072	0	.1394	.072	-.20 to .34
212					-.305	n.a.	.0748		-.45 to -.16
043	.0035	.0019	45.5	.044	-.055	.057	.0552	-.149 to .038	-.16 to .05
108	.0055	-.0192	100+	0	.144	0	.0908	.144	-.03 to .32
002	.0031	-.0013	100+	0	-.003	0	.0355	-.003	-.07 to .07
212					-.305	n.a.	.0748		-.45 to -.16
d Type of Measure:									
043	.0035	.0019	45.5	.044	-.055	.057	.0534	-.149 to .038	-.16 to .05
022					-.032	n.a.	.0288		-.09 to .02
212					-.305	n.a.	.0748		-.45 to -.16
097	.0127	-.0050	100+	0	.125	0	.0508	.125	.02 to .22
138	.0095	-.0069	100+	0	.179	0	.0592	.179	.06 to .29
008	.0055	-.0171	100+	0	-.011	0	.0968	-.011	-.20 to .18
097	.0127	-.0050	100+	0	.125	0	.0508	.125	.02 to .22
020	.0077	.0012	84.2	.035	.025	.045	.0329	-.049 to .100	-.04 to .09
023	.0078	.0031	60.1	.056	.029	.072	.0408	-.090 to .148	-.05 to .11
008	.0055	-.0171	100+	0	-.011	0	.0968	-.011	-.20 to .18
212					-.305	n.a.	.0748		-.45 to -.16
212					-.305	n.a.	.0748		-.45 to -.16

Table H-12. Multiple Moderators: % Administration

Variable	Number of Corre- lations	Total Sample	Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Mean	s
Total	12	753	.066	.0367	.0213	41.9	.146	.085	.
Technology Concept with Size of Organization, and Type of Organization:									
Workflow Continuity	7	355	.176	.0545	.0336	38.2	.183	.183	.
Small	4	246	.187	.0628	.0455	27.6	.213	.194	.
Large	3	109	.151	.0348	.0060	82.7	.078	.157	.
Manufacturing	7	355	.176	.0545	.0336	38.2	.183	.183	.
Workflow Integration	10	637	.007	.0083	-.0073	100+	0	.009	
Small	6	441	.023	.0070	-.0065	100+	0	.031	
Large	4	196	-.029	.0094	-.0112	100+	0	-.039	
Manufacturing	9	480	.046	.0063	-.0127	100+	0	.065	
Service	3	157	.036	.0143	-.0045	100+	0	.052	
Task Routineness	3	177	.028	.0094	-.0075	100+	0	.031	
Large	3	177	.028	.0094	-.0075	100+	0	.031	
Manufacturing	3	135	.034	.0297	.0081	72.6	.090	.037	.
Service	2	42	.150	.0028	-.0466	100+	0	.183	
Information Technology	7	527	.048	.0552	.0438	20.7	.209	.050	.
Small	4	374	.022	.0413	.0313	24.2	.177	.024	.
Large	3	153	.109	.0839	.0689	17.8	.262	.115	.
Manufacturing	5	333	.192	.0392	.0269	31.4	.164	.203	.
Service	3	194	-.191	.0073	-.0075	100+	0	-.202	
Size of Organization with Type of Organization:									
Small	7	516	.099	.0383	.0248	35.1	.158	.128	.
Manufacturing	6	401	.161	.0322	.0159	50.5	.126	.212	.
Service	1	115	-.116					-.154	n
Large	5	237	-.007	.0256	.0052	79.7	.072	-.010	.
Manufacturing	4	155	.103	.0184	-.0078	100+	0	.136	
Service	3	94	-.089	.0411	.0094	77.1	.097	-.119	.

% Administration

Mean r Observed	Observed Variance	Residual Variance	Percent Variance Explained	Residual s.d.	Corrected Correlation Mean	s.d.	s.e.	90 % Credibility Interval	95 % Confidence Interval
.066	.0367	.0213	41.9	.146	.085	.189	.0722	-.226 to .396	-.06 to .23
on, and Type of Organization:									
.176	.0545	.0336	38.2	.183	.183	.190	.0900	-.131 to .496	.01 to .36
.187	.0628	.0455	27.6	.213	.194	.221	.1281	-.170 to .558	-.06 to .44
.151	.0348	.0060	82.7	.078	.157	.080	.1090	.024 to .289	-.06 to .37
.176	.0545	.0336	38.2	.183	.183	.190	.0900	-.131 to .496	.01 to .36
.007	.0083	-.0073	100+	0	.009	0	.0536	.009	-.10 to .11
.023	.0070	-.0065	100+	0	.031	0	.0643	.031	-.10 to .16
-.029	.0094	-.0112	100+	0	-.039	0	.0968	-.039	-.23 to .15
.046	.0063	-.0127	100+	0	.065	0	.0654	.065	-.06 to .19
.036	.0143	-.0045	100+	0	.052	0	.1172	.052	-.18 to .28
.028	.0094	-.0075	100+	0	.031	0	.0833	.031	-.13 to .19
.028	.0094	-.0075	100+	0	.031	0	.0833	.031	-.13 to .19
.034	.0297	.0081	72.6	.090	.037	.098	.1106	-.125 to .199	-.18 to .25
.150	.0028	-.0466	100+	0	.183	0	.1893	.183	-.19 to .55
.048	.0552	.0438	20.7	.209	.050	.221	.0955	-.313 to .414	-.14 to .24
.022	.0413	.0313	24.2	.177	.024	.187	.1084	-.284 to .331	-.19 to .24
.109	.0839	.0689	17.8	.262	.115	.277	.1814	-.341 to .572	-.24 to .47
.192	.0392	.0269	31.4	.164	.203	.173	.0958	-.082 to .488	.01 to .39
-.191	.0073	-.0075	100+	0	-.202	0	.0737	-.202	-.35 to -.06
ion:									
.099	.0383	.0248	35.1	.158	.128	.204	.0956	-.207 to .463	-.06 to .32
.161	.0322	.0159	50.5	.126	.212	.166	.0935	-.061 to .484	.03 to .39
-.116					-.154	n.a.	.0914		-.33 to .03
-.007	.0256	.0052	79.7	.072	-.010	.093	.0947	-.163 to .144	-.20 to .18
.103	.0184	-.0078	100+	0	.136	0	.1062	.136	-.07 to .34
-.089	.0411	.0094	77.1	.097	-.119	.129	.1573	-.331 to .094	-.43 to .19

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