Size, Technology, Environment and the Structure of Organizations

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Size, Technology, Environment and the Structure of Organizations[1]

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Literature pertaining to the structural influence of size, technology, and environment is reviewed. Results indicate similar structural predictions are offered by each of the three contingency variables. The roles of measurement, unit and level of analysis, variable and effect independence, and variable dominance in research inconsistencies and future research directions are considered.

Within recent years, organization theorists have realized that there is no universal best way to organize and that not all organization structures are equally effective (8, 44, 80). Rather, organizations have come to be viewed as open systems that must be designed so as to handle best their respective contingencies (73). As a consequence of this perspective, considerable research has been directed toward isolating factors upon which an organization's structure may be contingent. Although a number of such variables have been identified (62), the vast majority of research has focused on the respective roles of size, technology, and environment.

This article reviews the literature concerning the relationships of size, technology and environment to organization structure, points out

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areas of agreement and disagreement, and offers directions for future research. Brief consideration is first given to structural dimensions.

Dimensions of Structure

Researchers have used a large variety of measures in an attempt to understand the structural characteristics of organizations. Some measures reflect subtle differences in the concepts themselves, whereas others may be attributable to the vagueness or lack of consensus which surrounds the phenomenon in question. There is some disagreement as to whether control strategies (e.g., centralization and formalization) are part of one structure type or are separate, independent dimensions (11, 47, 61). There seems to be some agreement that three main dimensions of structure are complexity, formalization, and centralization (30, 61). Administrative intensity, as evidenced by the research that has focused on it, has also been considered an important element of organizational structure. Therefore, complexity, formalization, centralization and administrative intensity will be the major elements of structure considered here.

Complexity refers to the degree or extent of differentiation within a given system (60), where differentiation may be horizontal, vertical, spatial, or personal in nature (30). Thus complexity includes the number of hierarchical levels (vertical); the number of functions, departments or jobs (horizontal); the number of operating sites (spatial); and the degree of personal expertise (personal) (5, 27, 28, 31, 32, 33, 61, 66, 78).

Formalization may be defined as the degree to which rules and procedures within a system are specified and/or adhered to (11, 28, 31, 32, 60, 61, 78). As a strategy of control, it encompasses both the existence of rules or procedures, whether or not they are codified, and the degree of variation allowed therein.

As a second strategy of control, *centralization* is defined as the locus of formal control or power within a system (60). It includes such factors as the locus of decision-making authority, the hierarchy of authority, autonomy, and participative decision making (11, 15, 28, 31, 32, 53, 61).

Administrative intensity, also referred to as the supportive or administrative component, is a measure of the number of administrative personnel within a system. It has been expressed as a ratio of administrative personnel (indirect labor) to total or production personnel (direct labor) or as simple counts of administrative personnel.

Technology and Structure

Contemporary interest in technology as a determinant of structure began with Woodward's (80) studies. When no relationship was found between the use of classical management principles and firm success, she allocated the 100 varied English organizations to categories along a scale of technical complexity. Using this scale, she found a linear relationship between technical complexity and various measures of administrative intensity and vertical differentiation, but a curvilinear relationship to others, such as span of control of first line supervisors. In general, firms at the extremes of technological complexity (unit and continuous process) had organic management system structures, whereas those at the center were more mechanistic. Firms closer to the median scores for structure in their technological grouping were economically more successful than firms above or below the median. Thus, she concluded that success depended on the appropriateness of an organization's structure for a particular operations technology — the "technological imperative". Subsequent research by Zwerman (81) and Blau et al. (7) supported Woodward's findings.

Since Woodward's initial studies, there has been some controversy over the dimensions of her scale and its underlying theoretical construct. Starbuck (70) suggests that it measures the smoothness of production, whereas Hickson et al. (33) conceive of it as measuring the degree of throughput continuity and Hunt (39) implies that the scale taps a dimension of problem solving. That is, unit production (least technically complex) firms, facing numerous exceptions, are structured to solve subsequent problems, whereas continuous process firms (most technically complex), although facing relatively fewer problems, place major emphasis on solving potential problems. By adopting this perspective, Hunt offers one explanation for the structural similarities observed between Woodward's unit and continuous process technologies.

Harvey (32) suggests that the continuum underlying Woodward's scale is one of technical specificity. This perspective is based on the assumption that more specific technologies present fewer problems that require new or innovative solutions than do more diffuse (complex) technologies (39). In this respect, Harvey made a parallel between Woodward's unit production and his "technically diffuse" category (e.g., made to order products), her mass production and his "technically intermediate" category (e.g., the automobile industry has model changes only once a year and then the same product is produced), and her continuous process firms and his "technically specific" category (e.g., oil refinery). But in addition to technological form, he argued that the amount of change within that technology should also be taken into account. Considering specific technologies as those having few product changes and diffuse technologies as those with many, Harvey found in a study of 43 industrial firms that organizations with specific technologies had more specialized subunits, more authority levels, greater program specificity, and higher ratios of manager and supervisor to total personnel than those with diffuse technologies.

Ignoring the form aspects of technology stressed by Woodward and Harvey, while at the same time encompassing the change dimension considered important by Harvey, Perrow (57) offers a conceptual framework for the comparative analysis of organizations that considers technology to be the major structural determinant. Defining technology as the actions an individual takes upon an object so as to bring about a change in that object, Perrow proposes two dimensions in technology: the number of exceptions encountered and the degree to which search procedures are analyzable. Together, these dimensions determine four technology types: craft, routine, engineering, and nonroutine. Considering routine and nonroutine technologies to be the extremes, Perrow maintains that control and coordination methods will vary with technology type. Routine technologies allow for greater bureaucratization of an organization's structure, whereas nonroutine technologies require greater structural flexibility.

Numerous studies offer support for Perrow's technology construct and his contention that control and coordination methods will be influenced by technology. Lynch (46) and Van de Ven and Delbecq (77) demonstrate the validity of Perrow's construct in studies on library departments and employment-security agency work groups respectively. Grimes et al. (26) present evidence supporting their Matrix Model which is similar to Perrow's. Hage and Aiken (27) and Hall (28), although not explicitly using the two dimensions of technology presented by Perrow, found that organizations and organizational subunits with routine technologies tended to have greater formalization and centralization than their corresponding counterparts with nonroutine technologies.

Finally, in a direct test of Perrow's model, Van de Ven et al. (78) found their measures of complexity, formalization and centralization to be *differentially* related to the two dimensions of technology proposed by Perrow. Complexity (personal) was positively related to task difficulty, but not related to task variability. Formalization was negatively related to task variability, but not related to task difficulty, and centralization was a function of both dimensions. The Van de Ven et al. results suggest that measures of overall routineness may "hide" the source of their relationship to dimensions of structure.

Although the preceding studies seem to offer strong support for the technological imperative, there is an equally impressive volume of research which questions technology's importance. For example, Hickson et al. (33), in a sample of 46 diverse English organizations, found a lack of association between their measure of operations technology (workflow integration) and their measures of formalization, centralization and complexity. Even with only 31 manufacturing organizations in the sample, and a measure of technology (production continuity) which was conceptually similar to Woodward's technical complexity scale, there was a general lack of association between it and structure. Rather, size (log total number of employees) had a more dominant influence on organization structure.

Pugh et al. (62) also found size to have a stronger and more specific relationship to structure than technology, and Child and Mansfield, in a replication of Hickson et al.'s work, concluded that "size has a much closer relationship to the aspects of structure measured than does technology" (15, p. 383). Mohr (53) similarly found no relationship between technology and structure, and others (37, 43) found no or only modest relationships between technology and structure.

Blau et al. (7) question the conclusions of Hickson et al., Pugh et al. and Child and Mansfield and, by implication, those of other researchers. In their study of 110 New Jersey manufacturing organizations, they found that, although their measure of operations technology (mechanization) was not linearly related to structural differentiation and span of control, it was *curvilinearly related* when types of technical systems similar to those of Woodward were employed. Moreover, the curvilinear relationship held even when size was controlled. They point out that since Hickson et al. and Child and Mansfield used only indicators of linear association, they were not aware of the pervasiveness of the curvilinear relationships that they did observe. Even if technological complexity does not have a linear relation to structure, it may have a curvilinear one.

Summary

This brief review of the technology literature points up several issues. First, there is no unanimity that technology affects organizational structure. Although some studies found strong relationships, others did not. This inconsistency may stem partly from the types of technology considered. Many studies that found weak relationships between technology and structure focused exclusively on operations technology (15, 33), even though these same writers argued that organizations may employ more than one type of technology. Although the impact of operations technology may be slight in some organizations, this is not to say that other technologies or combinations of technologies could not explain the remaining variance in an organization's structure as well as or better than size.

Second, there is little consistency in how technology is measured and few (46) have offered validation of their measure(s). This problem may stem from the lack of consensus as to what technology is. Third, the impact of technology is likely to be selective, affecting some structural dimensions more than others. Fourth, as Blau et al. indicate, the assumption that there is a linear relationship between technology and structure may be invalid. Finally, most researchers suggest that technology per se determines structure — although Thompson (73) and Reeves and Woodward (64) suggest that it is not the technology per se, but the nature of the interdependency created by a technology that is important in determining an organization's structure.

Size and Structure

In addition to research focusing on the relative importance of size versus technology as determinants of an organization's structure, considerable work has been concerned exclusively with the influence of size alone, particularly as it relates to structural components of complexity and administrative intensity. Most research on size has centered on this latter relationship.

The basic assumption that underlies research on administrative intensity is that increases in size (number of people) lead to increases in control and coordination requirements. Based implicitly on administrative management theory, the argument is advanced that increases in the number of personnel at lower levels will result in disproportionate increases in the number of administrative personnel (70). This is due to the need to maintain optimal spans of control and the belief that only administrative personnel perform control and coordination functions. Therefore, in what is referred to as Parkinson's Law, the proportion of the containing organization given over to the administrative component will increase disproportionately with increases in organization size.

In a study of California school districts, Terrien and Mills (72) found that the administrative component increased with size regardless of school type (elementary, high, and unified). Caplow (9) noted that the proportion of workers not directly engaged in production tasks increased with organizational size. Tsouderos (76), in a study of interest groups, and Raphael (63), in a study of labor organizations, also found support for Parkinson's proposition.

Anderson and Warkov (4) presented contradictory evidence. Using a sample of 49 Veterans Administration hospitals, they found that the administrative component decreased with increased size. This same inverse relationship between size and the administrative component has been observed in studies of school systems (45), hospitals (10, 74), employment security agencies (5), occupational associations (1), church systems (34), manufacturing industries (59, 66), and various other business or voluntary organizations (40, 49). Thus the overwhelming weight of evidence indicates that larger organizations have smaller administrative intensities than do smaller organizations. But the relationship between size and adminstrative intensity may not be entirely a direct one.

In an attempt to reconcile their findings with Terrien and Mills (72), Anderson and Warkov (4) hypothesized that administrative intensity would increase as either the number of operating sites or the number of persons performing different tasks increased, but decrease as the number of persons performing similar tasks increased. Although their hypotheses imply that the effects of size and complexity are independent, they do not suggest which is dominant. As a result of their study of 50 hospitals, Champion and Betterton (10) concluded that complexity, rather than size, was the better predictor of administrative intensity.

Blau and Schoenherr (5), based on their analysis of employment security agencies, argued that size influences both complexity and administrative intensity, but that the effect of size on administrative intensity is greater. Since administrative intensity decreased with size, even though it increased with structural differentiation, they concluded that the direct effect of size to reduce administrative intensity must be greater than the indirect effects of size, through structural differentiation, to increase it. Rushing (66), observing a weaker relationship between complexity and administrative intensity in smaller than in larger industries, and between size and administrative intensity when complexity was high rather than low, argued that administrative intensity was the result of an interaction between size and complexity. Accordingly, the effects of size or complexity would vary depending on the level of the other.

With respect to structural complexity alone, Meyer (50) presented support for Blau and Schoenherr's contention that size increases lead to structural differentiation. Using path analysis on data collected from 194 government finance departments in 1966 and 1971, he found that size was more likely to be a determinant of complexity than vice versa. When size was controlled, there was no significant relationship between the various structure measures.

Although the results of the previous research seem to support the importance of size as a determinant of structure, the evidence is not unequivocal. With respect to studies focusing on administrative intensity, Rushing (65, 66) shows that although the overall administrative intensity decreased with size, its components (managerial, clerical, and professional) did not necessarily decrease, or not to the same degree. In fact, the number of both clerical and professional personnel increased, relative to production personnel, at a greater rate than managerial personnel. Others (42) have found similar results. Most researchers seem to accept the implicit assumption that only the number of personnel is responsible for administrative intensity. But Freeman (25), basing his arguments on the conceptual writings of Thompson (73), presents evidence that the complexity of the environment and the degree of automation in technology influence administrative intensity.

Aldrich (3) also questions the notion that size is the dominant determinant of structure. Using path analysis in a reanalysis of Hickson et al.'s data, he found several alternative and equally plausible models relating size, technology and structure. One showed technology to determine structure, which in turn determined size. Ironically, further doubt is shed on the Hickson et al. conclusions by a replication study. In the process of their abbreviated replication, Inkson et al. (41) used 14 organizations that had previously been included in the Hickson et al. study. Since the replication was conducted some time after the original study, the time difference provided for a partial longitudinal test of the Hickson et al. conclusions. Data showed that although size generally decreased, the measure of structure dimension increased. At the same time, the degree of work-flow integration increased.

Similarly, Mayhew et al. (48) questioned Blau and Schoenherr's contention that size causes structural differentiation. Using a computer program that determined the degrees of differentiation possible for each level of size, they demonstrated that the relationship between size and complexity (increasing at decreasing rate) found by Blau and Schoenherr could be derived from a process that assumed random structuring. Other negative evidence is presented by Hall et al. (31) who concluded from their study of 45 varied organizations that size was not a significant factor in the determination of either complexity or formalization and by Harvey (32) and Rushing (66) who found no significant relationship between size and structure.

Summary

This review points out several issues. First, although larger organizations generally have smaller administrative intensities than smaller organizations, recent findings (e.g., 25) raise serious questions as to why. Size may not be the only factor that influences administrative intensity. Moreover, since administrative intensity is not a homogeneous construct (65), the relationship between its various dimensions and the contingency variables identified here are not clear. Nor is the relationship of administrative intensity to the structural dimensions of formalization, centralization and complexity. Second, there is no consensus as to how size should be measured. Although most researchers have used some count of system members, others have not (4, 43). Finally, the relationship between size and structure is not clear. Although some have found strong relationship and argue for its causal nature (5, 33, 50), others have found no such relationship or have argued for its being a consequence rather than a cause (3, 31, 48).

Environment and Structure

One of the most widely discussed and least understood concepts in the field of organizational analysis today is the relationship between the organization and its environment. To date, much of the theoretical and empirical work on this issue has focused on the uncertainty element

(16, 23, 52, 55). Most researchers and theorists emphasize that organizations must adapt to their environment if they are to maintain and/or increase their effectiveness (8, 44, 73).

The problem has been how "best" to describe the environment. Dill (17) found the characteristics of an organization's task environment to be important in determining managers' decision-making autonomy. Characterizing the task environment of two Norwegian firms as heterogeneous or homogeneous, and stable or shifting, he found managers perceived greater decision-making autonomy in heterogeneous and shifting environments than in homogeneous and stable ones. Burns and Stalker (8) also suggested that the stability of an organization's environment is important in determining an organization's structure. They distinguished between two types of organizations—organic and mechanistic. The latter was found better suited to stable environments because of its greater centralization and formalization. The organic structure, with lower centralization and formalization, was found better suited to more dynamic environments. Child (14) also found environmental stability to be related to organizational structure and effectiveness.

In a different view, Thompson (73) suggests that it may not be the degree of heterogeneity or stability per se that is important, but rather the uncertainty that these two environmental factors create for the organization. He sees the organization's major problem as coping with uncertainty (technological and environmental) and argues that organizations will reduce uncertainty by creating requisite structures to deal with it. In the case of environmental uncertainty, boundary spanning units will be created in order to monitor the task environment. The complexity of an organization's structure is at least in part a reflection of the uncertainty in the task environment.

Lawrence and Lorsch (44), like Thompson, considered environmental uncertainty to be a key variable. Operationalizing uncertainty by measuring the clarity of information, the degree to which cause-effect relationships are known, and the time span of definitive feedback, they characterized an organization's environment as diverse if a wide range of uncertainty was perceived among its different parts, and homogeneous if the range was narrow. Using a sample of ten firms from three industries, they found that in successful organizations, each organization subunit met the demands of its subenvironment. In diverse environments, subunits were more differentiated than those in homogeneous environments. In this case, differentiation refers not only to differences in formal structure, but also to differences in the cognitive and emotional orientation of subunit members.

In a model of the environment similar to Thompson's (73), Duncan (23) proposed that environmental uncertainty, as it related to decision making, was determined by two dimensions: simple-complex (number of factors considered in decision making and their degree of similarity) and static-dynamic (degree to which factors change). From a study of managers in 22 decision units, he concluded that the static dynamic dimension was a more important determinant of perceived environmental uncertainty than the simple-complex dimension. But a replication (21) of Duncan's model obtained contrary results.

Using data from interviews with executives in 30 manufacturing plants in India, Negandhi and Reimann (54) found that organizations with a greater concern for task environment agents had fewer hierarchical levels and used more consultative decision-making than organizations with less concern. Decentralized firms were more effective in both behavioral and economic terms than centralized firms. Since one would have expected centralized organizations to be more effective in the stable environment of India, they concluded that the decision-maker's perceptions of the environment were crucial.

In an attempt to understand how individual differences might affect a manager's perception of uncertainty, Downey et al. (22) found that cognitive processes of managers were more consistently related to perceived environmental uncertainty than were the uncertainty constructs advanced by Duncan (23) and Lawrence and Lorsch (44). Downey and Slocum (20) also found that neither cognitive complexity nor perceived environmental uncertainty had a main effect on performance, but that the interaction effect was significant. Managers who were cognitively complex and perceived a great deal of uncertainty performed the poorest, whereas managers who were cognitively complex but operated in relatively certain environments were the most effective.

Summary

This brief review of the environmental literature points up several issues. First, in few studies has the term environment been thoroughly discussed or made explicit. Second, most researchers, in treating the environment as the "cause" of organization uncertainty, preclude the possibility of viewing particular environmental characteristics as dependent variables and thus subject to manipulation by the organization. Third, the impact of environmental uncertainty on internal operations of the organization is likely to be confined to managers at the institutional level or in boundary spanning positions (73). Fourth, there remains the problem of how environments become known to managers. Weick (79), Downey and Slocum (19), Downey, Hellriegel and Slocum (21), Darren, Snow and Miles (16), and others argue that the important organizational environments are those that are created through a process of attention. Managers respond to what they perceive. Although the "objective" environment (2) may be different to each manager, objective data have largely failed to predict perceived environmental uncertainty (75).

Discussion

In attempting to "pull together" various results to ascertain the overall relationship between the dimensions of structure and the variables of technology, size, and environment, key problem areas will be identified and discussed. Particular attention will focus on issues of measurement, unit and level of analysis, variable and effect independence, dominance, and future research needs.

Measurement

Of the four basic variables considered here (technology, size, environment, and structure in terms of complexity, formalization, centralization and administrative intensity), none are free from measurement problems. In the case of structure, some have measured the various dimensions objectively (5, 32, 33, 80) whereas others have relied on perceptions (27, 28). The problem is twofold. First, where only perceptual measures are collected from the same individuals, the results may be artifactual for psychological reasons. Second, since the two types of measures appear to lack convergent validity (56, 67) there are problems of generalizability, additivity, and integration. But rather than considering the two types of measures as rivals for the "true" structure of an organization, they can better be viewed as providing important information about *different* aspects of structure. Sathe (67) suggests that objective measures should be viewed as indicators of designed structure, and perceptual measures as indicators of emergent structure. One research issue emerging from this perspective is why these two differ, how they interact, and how each is important to different aspects of organizational behavior.

Although there is a growing consensus among organizational researchers that perceptual measures of the environment are more closely related to how managers relate to their environments than objective measures, there are some measurement problems. The two most commonly used instruments for measuring uncertainty (23, 44) are psychometrically inadequate

(21, 75). If these instruments are designed to measure a similar construct — total environmental uncertainty — there should be a significant relationship between them. According to Downey et al. (21) a correlation of .14 was found between these two instruments, clearly indicating that the core dimensions in them are dissimilar.

Research is needed on relevant dimensions of the environment. Thompson (73) suggests that the complexity (number and type) of the task environment will influence the complexity of the organization's structure. Similarly, Schmidt and Cummings (68) found that environmental dimensions of size (population base and percentage of minorities) influenced the total size of the organization (employment service districts), which positively impacted on the organization's internal structure (differentiation). Pfeffer and Leblebici (58), Hirsch (36), and Staw and Szwajkowski (71) found other environmental dimensions (e.g., competitiveness, control over gatekeepers in the task environment, scarcity/munificence respectively) related to an organization's structure. Attention should be given to dimensions of the environment other than the degree of perceived environmental uncertainty. Environmental complexity may influence structural complexity, but perceived environmental uncertainty may influence decision making structures and/or the strategies of control exercised by management.

There is also controversy as to how size should be measured. Although many researchers have defined size as the number of members in an organization, there is disagreement as to which members should be included. Others have suggested using output factors or total assets as measures of size (3, 43, 62). Although these differences may not be critical, the measures should be considered carefully, because of evidence that they are highly related (13, 30, 62).

It appears that many researchers believe all measures of size are measures of organization size, but this may not be the case. Rather, it seems beneficial to distinguish between two types of size — size of the organization and size of the domain and/or its task environment. From this perspective, it may be postulated that one form of size (domain) will influence an organization's size in that the domain determines the volume of work required (68). Thus, sales, market share, or other output factors can be viewed as a measure of the organization's domain size, whereas the number of organization members is better seen as a measure of organization size.

Another issue is personnel mix. Some current approaches treat size as a homogeneous variable, ignoring the qualitative differences in its composition. But Hrebiniak (38) demonstrated that such qualitative differences as staff professionalization may be an important factor in explaining some research inconsistencies on administrative intensity. Hall (29) and Blau et al. (6) also found member professionalization to influence organization structure. Thus, two organizations of identical size, but one comprised of many professionals and the other not, would exhibit different structures. This suggests that greater attention needs to be given to the qualitative aspects of size.

Technology poses conceptual and operational problems. Some writers view it as a multidimensional construct (26, 33, 57, 77), whereas others see it as unidimensional (27, 28, 32). In addition, operationalizations derived from these two conceptualizations have been at both the individual and organizational levels with measures being taken from managers (44), department heads (61), or system members (46). In spite of these differences, a common dimension seems to underlie the various approaches and measures — task predictability (routineness or programmability). Woodward saw her scale as encompassing the degree of control or predictability, as did Harvey, Hall, Hage and Aiken, and Van de Ven et al., who considered routineness in their measures. Finally, Hickson et al.'s workflow integration measure implicitly assumes predictability, a requisite condition for automation.

Unit and Level of Analysis

One problem in integrating the research reviewed is that units and levels of analysis vary. Studies of environment and technology have focused at both the organization and subunit levels, whereas researchers examining size have looked exclusively at the organization level. For example, Kasarda (42) failed to support Blau and Schoenherr (5) in a study of higher social systems. He found that although the managerial component of administrative intensity decreased with increased size in organizations, it increased in societies and had a curvilinear relationship in communities; he concluded that the "negative effect of size on the managerial structure of institutions may not be generalizable to larger and more diffuse social systems" (42, p. 10).

Child (11) similarly suggested that differences in units of anlysis may cause differences in research results. Observing discrepancies between his results and those of Pugh et al. (61) and Hinings and Lee (35), Child attempted to attribute those differences to the heterogeneity in organizational status of the Aston sample. Organizational status refers to whether the unit of study is a branch, department, subsidiary, or whole organization. Recent attempts at resolving this issue have been inconclusive (18).

The influence of unit of analysis differences is perhaps most evident in research focusing on the role of technology. Most studies on technology at the organization level (11, 15, 33, 62) 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 the technological imperative.

Related closely to this issue is the problem of measurement. If the unit of analysis is at one level, but measures are taken at another, the expected relationship may not obtain, not because the relationship does not exist but because the measures are at different levels. An example of this problem is found in the Hickson et al. (33) study. Their measure of technology was confined to one level (operations) of the organization, but their measures of size and structure were not. Consequently, structural variables at the same level as size were more strongly related to it than to technology, which was at another level. This phenomenon may, in part, account for the divergence in findings observed between studies on technology at the organization and subunit levels. By failing to consider "overall" technology, studies at the organizational level may "average" over several technologies, or ignore others. Relationships between technology and structure may be lost or reduced in significance. In this respect, even though studies at the subunit level collect perceptions from subunit members, they overcome the limitation confronting studies at the organizational level.

Care must be taken to assure that measures are consistent with the level or unit they are supposed to measure. Although it might be argued that measurement and unit problems could potentially account for all variation in previous research results, these may be only part of the explanation.

Independence

The construct of independence has two aspects — variable and effect. The first is concerned with the relationship between contingency variables of size, technology, and environment. The latter considers whether the relationship between a given contingency variable and a dimension of structure is "pure" or attributable to one of the other contingency variables. Variable independence will be considered first.

Although most researchers have conceptualized technology, size, and environment as independent factors, little research has examined their empirical interrelationship. Hall (30) suggested that routine tasks may be subdivided among large numbers of lesser skilled people but that nonroutine tasks are better handled by experts who have more parts of the task under

TABLE 1. Summary of Contingency-Structure Relationships

	Administrative Intensity	Complexity: Horizontal	Complexity: Vertical	Complexity: Spatial	Complexity: Personal	Formalization	Centralization
Technology (Task Routineness)	+	+	+		—	+	+
Size (Number of Members)	—	+	+	+		+	—
Environment (Perceived Uncertainty)	+	+				—	—

their control. Thus, one would expect to find a positive relationship between routineness of technology and size. Accordingly, Hickson et al. (33) found a significant positive relationship between size and production continuity and Hage and Aiken (27) found organizations with routine technologies to have staffs with lower professionalization. Similarly, Ford (24) found a significant positive relationship between size and task routineness and a significant negative relationship between the level of employee education and both size and task routineness. Labor intensive technologies that have been automated have reported reductions in the number of people employed (size), or, where absolute size has not changed, the personnel mix has. As Lawrence and Lorsch indicate, environmental uncertainty is likely to be related to task routineness. To the extent that stability is a factor in environmental uncertainty (23) and the number of exceptions is a dimension in task routineness (57), one would expect such a relationship. Ford (24) found a significant negative relationship between task routineness and environmental uncertainty. In view of these interrelationships, greater attention must be given to how these three variables relate to each other, and the subsequent effect of their interrelationships on research findings.

Aside from the issue of variable independence, effect independence must be examined. Notwithstanding the limitations with respect to measurement and unit and level of analyses, Table 1 summarizes the relationship between the structure and contingency variables reviewed in this article. In this table, a plus sign (+) indicates a positive relationship between the contingency and structure variables, whereas a minus sign (-) indicates a negative relationship. For example, as task routineness, size, and environmental uncertainty increase, the degree of horizontal differentiation also increases. Blanks indicate that the relationship has not been the subject of empirical test or is not known sufficiently.

As shown in Table 1, similar predictions of structure can be made by each of the three contingency variables. But few studies have considered two of the three contingency variables together, other than size and technology (25), and still fewer have considered some form of all three simultaneously (13). Thus the relationships observed in studies where only one contingency variable was considered (4, 28, 44, 78) may have been attributable to one of the contingency variables not considered. In this respect, Hickson et al. (33) found that when size was controlled, the relationship between technology and structure all but disappeared. Because of the failure to consider the three contingency variables simultaneously, the locus of causality is far from clear.

Dominance

With size, technology and environment all related to various aspects of structure, which is the more dominant variable affecting structure? Although dominance is an assumption implicit in much research in this area (62), the question of dominance itself assumes that the preceding issues of variable and effect independence, measurement and unit and level of analyses are either easily solved or trivial.

In addition, dominance assumes no interactions between the three contingency variables in how they relate to various structure variables. The relationship between size and structure, for example, must be assumed to be the same regardless of technology or environment. Child (12) questions such an assumption by noting that decision makers must consider all three contingency variables when designing structures and that the constraint imposed by any single contingency variable is likely to vary. There is growing evidence that the relationship between a given contingency variable and the various dimensions of structure is likely to be moderated by the other contingency variables.

In a study of voluntary organizations, Simpson and Gulley (69) found that large organizations facing heterogeneous environments had higher internal communications, had higher member involvement, and were more decentralized than organizations facing homogeneous environments. They did not find this same relationship in small organizations. This suggests a possible interaction between size and environment. Freeman (25) also found significant interactions between automation in technology and environmental complexity on administrative intensity. Although Blau et al. (7) failed to find empirical support, Hickson et al. (33), in an attempt to reconcile their findings with those of Woodward, suggested an interaction between size and technology: in a small organization, technology would dominate structure, but size would dominate in a large organization. Finally, in a study of organizational subunits, Ford (24) found that the relationship of size, technology, and environmental uncertainty to various dimensions of structure varied, depending on each of the other contingency variables. Moreover, the nature of the relationship varied depending on whether the other contingency variables were considered singularly or in combination. Considering this evidence, the issue of dominance itself may be trivial.

Future Research Directions

This review has shown that although there are some areas of commonality or convergence, there is also considerable room for improvement. Additional research might be directed toward better understanding the relationship between contingency variables and structure, and toward understanding the interrelationships among the contingency variables themselves. That these variables are significantly interrelated and appear to influence each other's relationship to structure (24) indicates that the current "single variable" approach may be misleading. More consideration also should be given to the interrelationships among elements of structure. Although current approaches to structure emphasize the importance of contingency variables, the influence of one structural element on other such elements should be explored. For example, does administrative intensity decrease with size because of greater formalization, or for other reasons?

Attention should focus also on other factors which are likely to influence structure. Meyer (51) shows that leader stability moderates the relationship between environment and structure. Similarly, Child (12) suggests that managers will create structures they feel are necessary to bring about the realization of some goal. Accordingly, management may be proactive rather than reactive, and thus may not *respond* to the "imperatives" of size, technology and environment. Such a possibility would help to account for the differences observed by Woodward (80), Lawrence and Lorsch (44), and Burns and Stalker (8). Thus, greater consideration should be given to the process by which contingencies are translated into structure. It is at this point that the attributes, behaviors, and philosophies of managers will become important (22).

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