Dynamic Patterns of Organizational Characteristics: An Exploratory Study

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This study delineates, based on previous works mostly undertaken in advanced countries, a set of new hypotheses on the not well known relationships between operations technology, environment, structure, innovation and size, and provides initial evidence from organizations in a developing country, Korea. These previous works include studies on (1) technology and structure, (2) innovation and structure, (3) environment and structure, and (4) environment, innovation and operations technology.

First, classical management theory such as works of Fayol and Urwick have striven to put forward principles which would apply irrespective of task and technology. However, technology had recently been suggested as a major determinant of an organization's structure and other variables within the organization. Early works on technology focused on the group and individual within the organization and found the close connection between technology adopted and interpersonal interaction, social norms, satisfaction and attitudes (e.g., Trist and Bamford, 1951, Waler and Guest, 1952, and Blauner, 1964). More recently, since Woodward (1965)'s seminal study on the relationship between technical complexity and various measures on structural characteristics, many studies supported, from their theoretical reasoning and empirical findings, the notion that technology is one of most important variables in determining an organizations' structure (e.g., Thompson, 1967; Perrow, 1967: 1970; Hickson, et al., 1969; Magnusen, 1970; Lynch, 1974). Thompson (1967) suggests that the nature of interdependency created by technology determines organization's structure. Perrow (1967:1970) proposes that simple polar contrast between bureaucratic and non-bureaucratic organizations is dependent upon the degree of routineness in technology. Hickson, et al. (1969) and its replication by Child and Mansfield (1972) concluded that size is more important than technology in determining an organization's structure. Studies on technology and structure are diverse and often inconsistent on the

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relationship between technology and structure, stemming largely from differences in the type of technology considered. Most studies, however, appear to suggest that technology is an important determinant of an organization's structure. Lynch (1974) and Slocum (1977) provide useful reviews of these studies.

Second, several studies have recently attempted to identify particular organizational characteristics that might be most compatible in dealing with innovation. There is no unanimity on the relationship between an organization's structure and innovation, inconsistency stemming largely from differences in the types of organization and innovation considered. Nevertheless, there seem to be some agreements among studies in two different perspectives. Studies in the first perspective conclude that an organic structure is more conducive to innovation than a mechanistic structure (e.g., Hage and Aiken, 1967; Miller, 1971; Kim, 1980a). Studies in the second perspective, mostly conceptual in nature, suggest the contingency notion that while an organic structure has a momentum to the initiation, a mechanistic structure facilitates the implementation of innovation(e.g., Wilson, 1966; Shephard, 1967; Zaltman, et al, 1973; Pierce and Delbecq, 1977). Zaltman, et al. (1973) and Pierce and Delbecq (1977) provide useful reviews of these studies.

Third, since the introduction of the "open system" concept in the 1940s, environment has received increased attention from the students of organization. However, a set of widely accepted, related concepts which effectively describe this subject has not been developed (Organ, 1971). Nevertheless, several studies have provided fragmented pieces of understanding on the relationship between an organization's environment and structure. Burns and Stalker (1961) suggest that an organic structure is more appropriate than a mechanistic structure in dealing with a changing environment. Along a similar line, Dill (1958) found that managers of organizations in a heterogeneous and shifting environment had more autonomy in decision making than in a homogeneous and stable environment. Child (1972) found that in a changing environment organizations with low formalization were found to be more successful than those with high formalization. Thompson (1967) and Galbraith(1977) suggest that an organization's structure is dependent upon the degree of uncertainty and its capability to process information about events that could not be anticipated in advance. Despite these and other studies on the subject, an understanding of the relationship between environment and structure is rudimentary and inconclusive problems stemming largely from the lack of conceptualization and operationalization of environmental variables. Ford and Slocum (1977) provide a brief review of the subject.

Fourth, recently several studies (e.g., Abernathy and Townsend, 1975; Utterback and Abernathy, 1975; Abernathy and Utterback, 1978) suggest that in manufacturing organizations operations technology is closely associated with the environment and technological innovation in products and processes. Abernathy and Utterback (1978), based on a large number of case studies, postulate that in an changing and uncertain market and technical environment organizations (they used a term "productive units") are expected to have frequent innovations in products and have highly flexible and adaptable operations technology in order to incorporate frequent product changes. In a more stable and certain market and technical environment organizations are expected to have infrequent, incremental changes in products and highly specific and rigid operations technology in order to increase productivity of producing more standardized products. They further propose that organizations in the more stable and certain environment were in the changing and uncertain environment at their time of origin and have gradually evolved in response to changes in the environment.

With the background of the above literature, Kim (1980 b) developed a conceptual model of organizational evolution in a developing country, Korea. He suggests that in a developing country a new industry is initially established in response to market opportunity created and protected by government import substitution policy. Production at this phase is merely an assembly operation of foreign components and parts with equipment purchased from overseas. Operations technology is inefficient due mainly to low wages and little cost pressure in low market competition. Few indigenous efforts are seen to undertake technological innovation in products and processes due to lack of technological capability and market incentives to bring about changes. Rather, infrequent changes in products and processes stem from parts, components and equipment supplied from overseas. For this reason, government policy on trade and foreign capital technology acquisition and government incentives for emerging industries affect significantly technological innovation. At the same time multinational firms play an important role as suppliers of technology, equipment and component parts. Under such a relatively certain environment, a mechanistic structure is the most compatible in dealing with implementation of production operation.

As product design and production techniques become assimilated the accumulation of production operations, such knowhows are quickly diffused within the country, resulting in increased number of firms competing in the same market. Product improvement and cost reduction become an important basis for competition not only in the domestic market but also in international markets which become increasingly important. Indigenous efforts for technological innovation become necessary, if not imperative, to improve products and to increase productivity, leading to relatively more efficient, integrated and larger production system. Sources of external influences shifts from those of government and suppliers to those of customer, competitor technology. Changing needs of domestic consumers, custom orders of overseas distributors, together with competitor behaviors, become important sources of stimuli for new product design and development. In such a changing environment, an organic structure is more compatible in dealing with changes than a mechanistic structure.

The central idea underlying the above concept is that operations technology, innovation and organization structure evolve with a common pattern in response to a changing competitive environment. Thus, it requires a longitudinal analysis to test such a model. However, it also provides a useful basis for formulating a set of hypotheses that can be tested by onetime observations. That is, organizations with highly adaptable operations technology are expected to be young, small and to have fabrication or small batch operations. The market is expected to be relatively certain and consequently organizations are expected to have infrequent technological innovation in products. Thus, structure is expected to be mechanistic. Important components of the task environment may be government and suppliers. In contrast, organizations with rigid operations technology are expected to be relatively old, large and to have large batch or process operations. The market is expected to be more competitive, in response to which organizations have frequent techological innovation in products and processes. Thus, structure is expected to be more organic. Important components of the task environment may be customer, competitor and changes in technology. Organic and mechanistic structures, may be operationally measured in terms of complexity, formalization, centralization and integration.

These relationships between operations technology and other variables may be stated in the form of a set of tetsable hypotheses:

Hypothesis 1 : Operations technology adaptability is positively related to the influence of the supplier and government components of the task environment; and inversely related to the influence of the customer, competitor and technological components of the task environment.

Hypothesis 2 : Operations technology adaptability is positively related to formalization and centralization; and inversely related to complexity and integration.

Hypothesis 3 : Operations technology adaptability is inversely related to technological innovation.

Hypothesis 4 : Operations technology adaptability is inversely related to size, age and indigenous technological capability.

METHOD

Sample

The data for this study were collected from 31 consumer and industrial electronic equipment (end products) manufacturing firms or electronic equipment divisions of firms producing several product lines in Korea.

The 31 organizations were selected on the basis of "chunk" sampling methods so as to have as much variability as possible in terms of product lines, size and age of the organization. "Chunk" sampling refers to a procedure used to select representative samplings on an *a priori* basis through multi-stages (Kish, 1965). Table 1 shows the distribution the sampling.

The data for structural variables were obtained from 306 individual respondents in the 31 organizations. These respondents include department heads, section heads and randomly selected workers but do not include those in finance, personnel or purchasing departments, nor clerical and assembly line workers as they have little bearing on innovation and production decision making.

Measures

This study used well known measures in order to maintain comparability with other works and to provide a basis for further comparative works by the author and others.

Operations Technology Variables

This study used operations technology, as workflow system and activities are easily identifiable in manufacturing organizations. Hickson, et al. (1969) suggest five indicators to measure operations technology: adaptability, continuity, automaticity, interdependence,

Table 1 Distribution of Samples by Size, Age and Product Line N=31

		TV	Audio[a]	Comm. equip[b]	Semicon. equip[c]	Preci. equip[d]	Multi-line[e]	Tõtal
Size	Below 99		3	1		2		6
	100~499		3	3	3		4	13
	500~1000		2	1	1		2	6
	Over 1000	1	1				4	6
Total		1	9	5	4	2	10	31
Age	15 or more	1	2	2			4	9
	10~14		2	1		1	2	6
	7~9		2	1	1	1		5
	4~6		1	1	1		1	4
	3 or less		2		2		3	7

a. Audio includes radio, tape recorder, stereo equipment, etc.
b. Communication equipment includes radio communication equipment as well as broadcasting equipment
c. Semiconductor equipment includes electronic calculator and electronic watch.
d. Precision equipment includes all testing instruments.
e. Multi-product lines refer to the organizations that produce all or most of products exhibited in this table.

and specificity of quality evaluation. The degree of automaticity in the industry under study was found negligible. And three-point scale of interdependence and specificity of quality evaluation measures used by Hickson, et al.(1969) did not differentiate organizations within the same industry in this study. For this reason, this study reports adaptability and continuity as they relate to other veriables measured.

Adaptability refers to the degree of flexibility or adaptability in operations technology and was measured by an eight-item workflow scale developed by Aston Group (Hickson, et al., 1969). Continuity refers to the degree of continuity in workflow and was measured by a ten-point scale which Aston group (Hickson, et al., 1969) developed on the basis of Woodward (1965).

Environment Variables

Environment appears to have been studied by students of organization in three different aspects: its characteristics (e.g., Burns and Stalker, 1961; March and Simon, 1958; Lawrence and Lorsch, 1967; Jurkovich, 1967; Jurkovich, 1974), (2) its components (e.g., Dill, 1958; Duncan, 1972), and (3) the organization's strategy towards its environment (e.g., Selznick, 1949; Chandler, 1962; Thompson, 1967; Perrow, 1970; Utterback and Abernathy, 1975). Of these three, this study is concerned with the components of the task environment.

The task environment refers to individuals, organizations, and other social systems external to the organization that affect directly the formulation and attainment of organizational objectives. Duncan (1972), based on Dill (1958), suggests that the task environment has five components: customer, supplier, competitor, socio-political, and technological. His five components have 13 subcomponents altogether. This study modified his typology and delineated 20 subcomponents as shown in Table 2 so as to make them more appropriate in the Korean Context. Each of these 20 subcomponents or variables was measured by five-point Likert scale.

Structural Variables

Structure refers to the pattern of the relationships among various activities or subsystems within an organization designed to attain organizational objectives. Most organization structure studies used Weber's basic model (see Gerth and Mills, 1916) of bureaucracy as a point of departure (e.g., Reimann, 1971; Pugh, et. al., 1968; Hage and Aiken, 1967; Zaltman, et al, 1973). These studies suggest, in general, four structural dimensions: complexity, formalization, centralization and integration. These four dimensions also reflect the concept of organic and mechanistic patterns. These structural variables were measured by the scales developed by Hage and Aiken (1967). Data for the structure variables were obtained from 306 individuals in the organizations under study through questionaires and were pooled to reflect the characteristics of the organization. To minimize methodological problems in aggregating individual data, the following method (formula) was used:

$$\text{Organizational score} = \frac{1}{n} \sum_{i=1}^{n} \left(\frac{1}{m_i} \sum_{j=1}^{m_i} X_{ij} \right)$$

where n = number of hierarchical levels covered in the study

m_i = number of respondents in hierarchical level i

X_{ij} = score from respondent j in hierarchical level i

The results of reliability test for four multi-item scales indicated that job codification, rule observation, hierarchy of authority and non-participation in decision making showed the alpha coefficients of .69, .71, .71, and .93, respectively.

Innovation

Knight (1967) categorizes innovation in the organization in terms of application as: (1) product or service innovation; (2) production process innovation; (3) structural innovation; and (4) people innovation. In this study innovation refers to the first two which are often called technological innovation, for two reasons; first, the other two innovations are not readily measurable, and second, in manufacturing, especially where technology changes rapidly as in the electronics industry, technological innovation may be the predominant innovation in the organization.

Innovation is defined in this study as the rate of technological change in products and processes and measured by the total number of technological changes that have occurred in products and processes in the previous five years. The measure appears to be most useful in the context in which this study was undertaken, and at the same time innovations encountered in this study are relatively homogenous in terms of the nature and quality of innovation. In other words, all innovations encountered in the study were involved in the development of new products that also changed the techniques and process of production to a certain degree.

$$I=\frac{\sum_{i=1}^{n}(D_i+S_i-C_i)}{n}$$

I =innovation index per year

D_i=product innovation in year i

S_i=process innovation in year i

C_i=cosmetic change in year i

n=number of years in operation

Other Variables

Size refers to the number of workers in the organization. Age refers to the number of years passed since the organization established production facilities for the product lines covered in the study. Indigenous technological capability refers to the degree of indigenous capability in developing new products. The variable is measured by a six-point scale. An organization which performs a simple assembly operation of 100% foreign parts for foreign designed products is scored 1, while an organization which produces products which are unique and entirely different from the existing products of the advanced economies is scored 6.

RESULTS

The purpose of the study is not to identify causal or independent relationship between operations technology and other variables, rather to identify variables that are associated with operatons technology.

The results of correlational analysis on the relationship of operations technology to environment variables are presented in Table 2. It shows that operations technology

Table 2. Correlation Between Operations Technology and Environment N=31

			Operations Technology	
			Workflow Adaptability	Continuity
ENVIRO—NMENT	Customers	Domestic Distibutors	−.55***	.41**
		Overseas Distributors	−.72***	.78***
		Domestic Consumers	−.06	.20
		Overseas Consumers	.25	.05
	Suppliers	Raw Material Suppliers	.43**	−.65***
		Equipment Suppliers	.63***	−.37**
		Technology Suppliers	−.30*	.29*
		Overseas Capital Suppliers	−.48**	.27*
		Domestic Fund Suppliers	.30*	−.34**
	Competitors	Overseas Competitors	−.62***	.59***
		Local Competitors	−.41**	.11
		Competitors for Supply	−.45**	.26*
	Government	Regulatory Control	−.30**	.23
		Incentive Programs	.43**	−.16
		Import/Export Policy	.21	.22
		Control on Foreign Technolgy	−.45	.48**
	Technology	Technical Requirements of the Industry	−.16	−.35**
		New Technology Development	−.03	.10
		Local Research Institutions	.43**	−.02
		Local Technical Information Centers	.14	.11

* Significance level<.1 ** Significance level<.05 *** Significance level<.001

adaptability is positively related, as hypothesized, to the influence of raw material suppliers ($r=.43$, $p<.05$), equipment suppliers ($r=.63$, $p<.001$), domestic fund suppliers ($r=.30$, $p<.1$) and government incentive programs ($r=.43$, $p<.05$). It is also inversely related, as hypothesized, to the influence of domestic distributors ($r=-.55$, $p<.001$), overseas distributors ($r=-.72$, $p<.001$), overseas competitors ($r=-.62$, $p<.001$), local competitors ($r=-.41$, $p<.05$), and competitors for supply ($r=-.45$, $p<.05$).

On the other hand, operations technology adaptability is significantly related but in the opposite direction of the hypothesis to the influence of local research institititions ($r=.43$, $p<.05$), technology suppliers ($r=-.30$, $p<.1$), overseas capital suppliers ($r=-.48$, $p<.05$), government regulatory control ($r=-.30$, $p<.1$) and control on foreign technology ($r=-.30$, $p<.1$) and control on foreign technology ($r=-.45$, $p<.05$). And the relationship of operations technology adaptability is not statistically significant to the influence of domestic consumers, overseas consumers, import policy, technical requirements, new technology development, and local technical information centers.

The above results indicate that operations technology adaptability is inversely related, as hypothesized in H(1), to the influence of the customers and competitors components, supporting the general belief that as market competition becomes more important, it is necessary to improve the production processes. The insignificant relationship found between operations technology and the influence of two consumers subcomponents may be explained by the fact that the distributors reflect the needs of the end users.

The suppliers and government components have both positively and inversely related subcomponents. An interesting point in this finding is that organizations which have adaptible production processes are more concerned with suppliers that affect the current production and government incentives, while organizations which have more rigid production processes are concerned with suppliers and government controls that affect technology and capital investments. On the other hand, the technological component, except the local research institutions, was found to be insignificant part of the task environment. This is not surprising, because it is generally known technologies that local organizations aim at implementing or imitating for the local or overseas markets.

Table 3 presents the correlation coefficients beween operations technology adaptability and structure variables. It shows that operations technology adaptability is positively related to job codification. ($r=.82$, $p<.001$) and hierarchy of authority($r=.63$, $p<.001$), and inversely related to professional training($r=-.27$, $p<.1$) and integration ($r=-.80$, $p<.001$), as hypothesized in H(2). On the other hand unlike the hypothesis, operations technology adaptability is negatively related to inverse participation in decision making ($r=-.31$, $p<.05$) and insignificantly related to professional activity and rule observation. It is not surprising to find that professional activity is not a significant variable. In a developing country like Korea, most professional organizations are still in the formative

Table 3. Correlation Between Operations Technology, Structure, Innovation, Size and Age

N=31

			Operations Technology: Workflow Adaptability	Operations Technology: Continuity
STRUCTURE	Complexity	Professional Training	−.27*	.48**
		Professional Activity	.09	−.05
	Formalization	Job Codification	.82**	−.54***
		Rule Observation	−.07	.32**
	Centralization	Hierarchy of Authority	.63***	−.59***
		Inverse Participation in Decision Making	−.31**	.05
	Integration		−.80***	.72***
OTHER VARIABLES	Innovation		−.48**	.64**
	Size		−.73***	.34*
	Age		−.31**	−.07
	Indigenous Technological Capability		−.36**	−.004

* significance level <.1 ** significance level<.05 *** significance level<.001

stage and their activites are rudimentary. The insignificance of rule observation may mean that since structure variables measured in this study are perceptual, job codification might reflect at the same time the degree of rule observation. In short, operations technology adaptability is positively related to formalization and inversely related to complexity and integration, as hypothesized in H(2). However, the adaptability is positively related, as hypothesized, to inverse participation in decision making about work (hierarchy of authority), and negatively related to inverse participation in decision making about resource allocation (inverse participation in decision making). Thus, the relationshp between operations technology adaptability and centralization is inconclusive.

Table 3 also presents the correlation coefficients between operations technology adaptability and other variables such as innovation, size, age, and indigenous technoloical capability. It shows that operations technology adaptability is inversely related, as hypothesized in H(3), to technological innovation ($r=-.48$, $p<.05$). Since technological innovation in this study refers only to product change, this finding is contradictory to the hypothesis of Abernathy and Utterback (1975) that the rigid production process makes it difficult to make frequent product changes. This discrepancy in product change between advanced and developing economies can be explained by the fact that the rigidity found in the production process in this study is only a relative term and still adaptable enough to incorporate imitative product changes.

Operations technology adaptability is also found inversely related, as hypothesized in H (4), to size ($r=-.73$, $p<.001$), age ($r=-.31$, $p<.05$) and indigenous technological capability ($r=-.36$, $p<.05$). This means that small and young organizations are mainly engaged in assembly operation of foreign components and parts with adaptable(inefficient) production technology.

In summary, the results show that Hypotheses 3 and 4 are supported, while Hypothesis 1 is partially and Hypothesis 2 is mostly supported.

SUMMARY AND DISCUSSION

In the past two decades, many organizational studies, undertaken mostly in advanced economies, have attempted to identify the relationships between operations technology, environment, structure, innovation and size. The vast majority of the studies has focused on the bivariate relationships among the variables. Recent attempts to synthesize a set of bivariate relationships are yet at the conceptual level (e.g., Kast and Rosenzweig, 1973; Ford and Slocum, 1977). All these studies are primarily concerned with identifying the static patterns of the organization. As a departure from the tradition, Abernathy and Utterback (1975) developed a conceptual model that identifies the evolutionary pattern of organization's characteristics in response to changing environment.

With this background in mind, Kim (1980b) developed a conceptual model of organizational evolution in a developing country, which provided a theoretical framework for this study. The study looked at 31 organizations in the rapidly changing electronics industry in a rapidly developing country, Korea. The findings of the study suggest that in a developing country organizations with adaptable operations technology are small and new, have mechanistic structure producing infrequent product changes, perform merely assembly operation of standardized products with low indigenous technological capability, and perceive that raw material, equipment and domestic fund suppliers, together with government incentive programs, are important components of the task environment. On the other hand, organizations with relatively more rigid operations technology are large and old, have relatively organic structure producing frequent product changes, and perceive that the customers, competitors and suppliers and government control that affect technical and capital investments are important components of the task environment.

This is not a longitudinal study. The findings of the study, however, lead to the formulation of a set of propositions that can be tested in a longitudinal analysis. Table 4 summarizes these propositions.

Table 4. Dynamic patterns of manufacturing organization's characteristics in a LDC

Variable	Early stage	Later stage
Size	small	relatively larger
Operations technology	adaptable	relatively more rigid
Indigenous technological capability	low	relatively higher
Frequency of technological change	low	relatively higher
Market competition	low	relatively higher
External environment	supplier on short term production	supplier on long term production; government regulation; customer, competitor
Organizational structure	mechanistic	organic

These propositions should be tested not only in Korea but also in other developing countries in order to examine their generalizability.

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