COPPEAD/UFRJ

RELATÓRIO COPPEAD Nº 73

INFORMATION SYSTEMS CONTINGENCY THEORY: AN EMPIRICAL STUDY

Alberto Machado Bento *

October 1981

* Associate Professor of Information Systems - COPPEAD/UFRJ. This study was made possible through grants from CAPES - Coordenação do Aperfeiçoamento do Pessoal de Nível Superior and the Associates of Computers and Information Systems, Graduate School of Management, UCLA.

I. INTRODUCTION

The aim of this research is to test a contingency theory of information systems, relating societal decision-making with environment settings to the structure and content of an Information System in the public/not-for-profit sector. It is a contribution to the development and testing of IS theories.

Traditionally, the field of information systems has been concerned with problems of design, rather than with the development of a theory of information systems. Mason and Mitroff (1973, pp. 475-87), for the first time, have proposed a change in the focus of research from design considerations to the intrinsic elements of an information system:

> *... an information system consists of at least one PERSON of a certain PSYCHOLOGICAL TYPE who faces a PROBLEM within some ORGANIZATIONAL CONTEXT for which he needs EVIDENCE to arrive at a solution ... and that the evidence is made available to him through some MODE OF PRESENTATION...A program of research should seek to explore the differing characteristics of an MIS by manipulating these variables systematically (Mason and Mitroff, p. 475).*

Information Systems were treated, in the past, as a technological subject -- as the surface of the computer systems visible to the users -- and a "value-free" domain of the Science. In the late sixties this vision started to change as part of the moral and social revolution of the systems theory. This movement can be summarized in the following text:

> *No longer can we call upon the disinterested, competent observer to settle our issues. There is no "outside" which can observe the "inside" trying to depict reality ...We are not objective in the old-fashioned sense of "being apart", and "non-biased". Our bias is based on*

> *our conception (world view) of how social reality works and what "makes a difference"... (therefore) our measure should be based on a policy of moral universality -- everyone count as an end -- and not as a means only -- a deep analysis of how people are affected by the difference the measure will make (Churchman, 1970, p.10)*

Mason (1969, 1974) in different works emphasidez that in any organization/society measure expresses implicit underlying values and beliefs. When we are trying to be scientifically rational and unbiased in the measurements of our perceptions of reality, we are in fact conditioned by our Weltanschauung. Due to this kind of reasoning, authors such as Rittel, for example, were led to extreme ways of thinking and to define planning systems as "the same as... the planning information system."

> *First, given the characteristics of "wicked"problems, the planner must remain continuosly in touch with the surroundings of the problem being considered. Secondly, objectification in planning means exchanges of information among those concerned in order to reach mutual understanding. Learning from one another is based upon information. Thirdly, the subject of planning is only partially known and hence during the planning process there are changes in the criteria for considering the subject and in the knowledge of the subject of planning through information. From this we concluded that planning can be understood as the generation of ideas and of understanding of what is instead of that which ought to be and how to bring about what ought to be the case. This process of generating ideas is obviously an information process (Rittel, 1972, p.398).*

This research follows this new trend and contributes to the definition of the problematic of Information Systems as a theoretical discipline as well as to the understanding of the IS practice (see Bento (1980), pp. 115-131) for a detailed treatment of other IS traditions and research efforts).

A second departure from this same tradition is needed to study information systems for the public sector: the focus of research should move from organizational to societal decision-making and action. This implies the need to understand (a) what a social problem is, (b) what a solution (or resolution) for it is, and (c) how decisions and actions take place within society. This research contributes to this latter issue -- studying how public policies are established and the relation of society-at-large, with the public organizations supposedly acting in their name to solve social problems, specifically at the local level. The local level of government was selected given (a) the importance of urban problems in the present society, (b) its relative simplicity when compared to other levels of government, facilitating the transition from organization to societal decision-making, and (c) its closeness to the sources of demand and support for policies and services (see Bento (1980, pp. 11-34) for a detailed treatment of societal decision maling theories and research efforts).

Finally, a new treatment of Environment theories is needed to deal with public organizations. This implies the need to transfer the existing knowledge of environment taxonomy -- mainly based on causal texture factors -- to the public policies arena. (see Bento (1980, pp. 70-90) for a detailed treatment of environment theories and research efforts).

Given these assumptions the scope of this research can be defined as a formalization of a contingency theory of information systems, in general, and in public organizations, in particular, as well as, an empirical experiment relating the categories of environment, societal decision-making, and information systems in existence in local government, as a first attempt to test the contingency theory proposed, at the local governmental level.

The site of our experiments were 91 divisions/departments belonging to thirteen California cities chosen as a stratified random sample from cities with more than 50.000 inhabitants. Therefore the external validity of our results is limited to this same

population, although some of the results may challenge similar ones encountered in other levels of government and regions. These results show some methodological problems of previous researches in disconsidering a better evaluation of competing hypothesis, so that they might have assumed as valid correlations some spurious ones.

Nevertheless, a word of caution should be introduced here in regard to the nature and quality of the results of this research. This is an exploratory study, and as such, lacks some important controls for variables that might have a strong bearing on the results. For example, no controls were made for organization efficiency throughout the various experiments. It also lacks better surrogates, or actual measures, of some variables introduced as controls that have an important bearing in the results, as such, could not be omitted, but which were loosely defined and measured. For example, the cultural and historical background of the present environment was measured by the "region" where the environment category is taking place. Although some of the features of the cultural and historical heritage of the present environment can be captured by this variable (as our results show) much is left outside. In a larger scale experiment, probably, the region surrogate would be a poor approximation of this heritage. Finally, so many concepts were dealt with, so many traditions were synthesized and interpreted, that is hard to say where some misinterpretations may have been made, and some works overlooked, and so for these we apologize.

II. THE IS CONTINGENCY THEORY

The theory we are about to present is descriptive in nature, rather than prescriptive. We are concerned with ways we can understand and design information systems, without adhering to any given "ideal" type or way of doing things. Rather it is the ability to scan the concrete reality and, through practice and observation, to arrive at a holistic understanding of the apparent contradictions with which we are faced, that is the main trait of this theory. The contingency theory states that there is no such thing as the best method to solve any given problem. What was thought to be the best solution to a problem in a given society and time is in fact what in the given circumstances was so. As soon as the values of the variables that dictate that solution as the best change, new solutions will be proposed and, again, claims of another "best" solution to the problem will be made. A holistic and dialectical approach to the understanding of reality calls for the identification of the variables capable of constraining and allowing solutions to the problems, rather than for the apparently important search of a solution to a problem in a given time. If we are able to understand the logic behind the solutions and problems with which we are faced and to produce a synthesis that unravels the processes taking place, the problem of how to determine the appropriate action and solution for a given social formation or organization is rather trivial. Therefore the theory we are about to present is an attempt to describe the mechanisms at work in any given social formation or organization that allows/precludes a certain information system practice. In this sense it is both a theory for design and research into information systems. The practitioner can use the categories that are defined to determine what specific design is feasible in a given circumstance. The researcher can use the same categories to test hypotheses of information systems behavior under different circumstances.

In Figure 1 the main dimensions of the proposed IS contingency theory are presented as well as some of the main

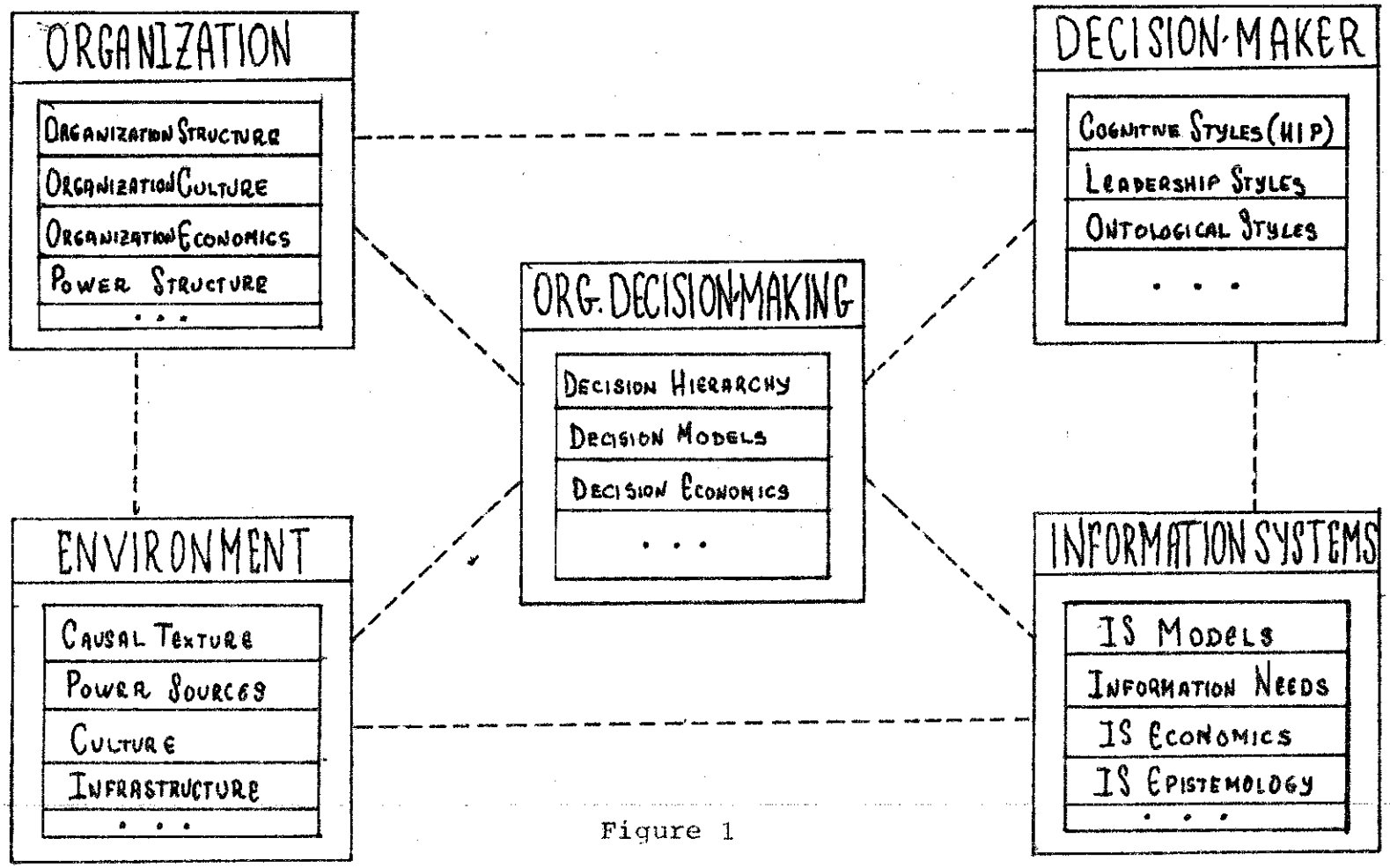


Figure 1

IS Contingency Theory

variables within each dimension.

An INFORMATION SYSTEM depends upon the DECISION-MAKER behavior within the ORGANIZATIONAL DECISION-MAKING process taking place in an ORGANIZATION that belongs to a certain ENVIRONMENT. Let's first examine each of these dimensions in turn, and later on, to discuss their relationships.

Environment is understood as "the totality of physical, socioeconomic, political, and cultural factors that in practice affect an organization". (Bento, 1980, p. 92). The causal texture of the environment is an important variable because it describes the complexity and rate of change of the environmental factors affecting an organization. The culture -- the social accumulation of history, beliefs, and values -- also has a pervasive importance on all other factors as well as over the organization. Hellriegel and Slocum (1974, pp. 17-22) discussed at lenght the role of culture and its implications for organizations. From their point of view it is culture which defines what social reality is, what is valuable, what the know-how and technologies available to pursue values are, and what the accepted rules of behavior in the environment are. The physical and socioeconomic factors are seen as the environment infra-structure, the material basis of society. Finally, the political factors -- the existing power structure in a given social formation -- are seen as a series of demands and supports imposed on organizations by interest groups, political parties, elites, labor, and other organizations. The relationship between environmental variables or factors has been the pursuit of much of the literature in fields such as sociology, political science, and economics. We are not going even to attempt to summarize the many competing hypotheses that exist in this literature to explain the relationship between the environment variables. From a contingency approach this is not required -- our search is for the variables and for the possible interrelations among them. The causal ordering assumed to be true in the present theory is shown in Figure 2. The relationships hypothesized in this figure are yet to be tested and "proved". Some of these

relationships will be assumptions we are going to use to test the hypothesis in this research; others will be tested as hypotheses.

An organization is "viewed as a set of interdependent parts which [are] dependent upon its environment for survival" (Hellriegel and Slocum, op. cit. p. 50). The way the organizations is differentiated and integrated to make exchanges with the environment defines not only the parts of the organizations but also the nature of their interdependence -- the organization structure. The organization culture, similar to culture at large,

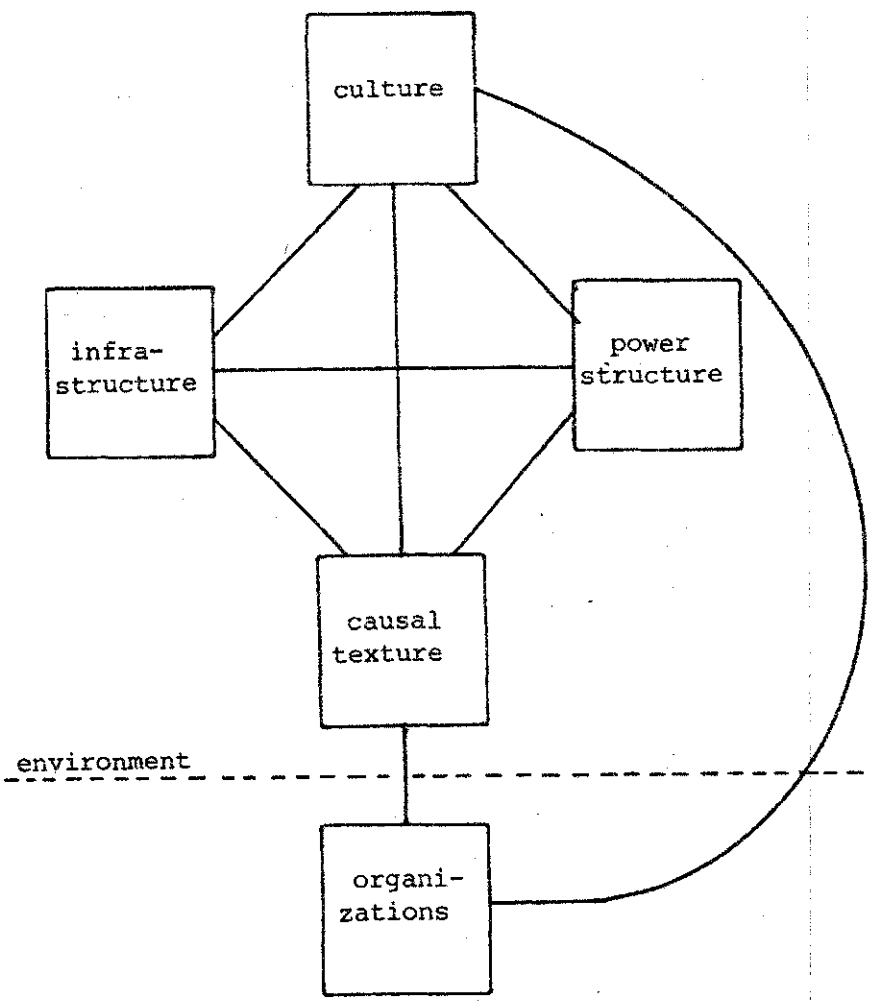


Figure 2

Environment Causal Ordering

defines the organization's social reality, values, know-how and technology, and accepted rules of behavior. The organization power structure gives legitimacy to actions and decisions pursued within the organization and represents the dynamic equilibrium of the various interests at stake in the organization. Finally, the organization economics defines the material basis of the organization -- its production function, performance and objectives. Again, many competing hypotheses exist in the literature to explain the relationship between these variables. The causal ordering assumed to be true in the present theory is shown is Figure 3. Again, the relationships hypothesized in this figure are yet to be tested, and are primarily assumptions to this research.

Organizational decision-making is seen as the process by which objectives, resources, and products of the organization come into being. Therefore no distinction between "decision" and "implementation" is made here; rather, the decision-making process is understood as a social process that only "makes decisions" when they are "implemented" -- the decisions only exist if they have a concrete existence in practice. Also, it is not seen as the isolated act of a given group of participants, but rather the complex product of social interaction of all the participants. An important variable in this process is the decision pattern used by the specific social formation or organization of which we presented three different models -- bureaucratic, ecological, and analytical (Bento, 1980, pp. 70-102). Another relevant variable is the decision hierarchy -- the level to which the organization commits its chances of survival in a given decision situation. Anthony (1965) devoted a lot of attention to this problem and classified the decisions as strategic, tactic, and operational -- along the continuum of time, resources, and system identity committed to a given decision situation. Finally, decision economics defines the material basis of the decision-making process -- the changes to the organization's production function, its own production function and performance. The causal ordering among the variables of the organizational decision-making os shown in Figure 4. Some of the relationships are taken as assumptions, while some are tested in this research.

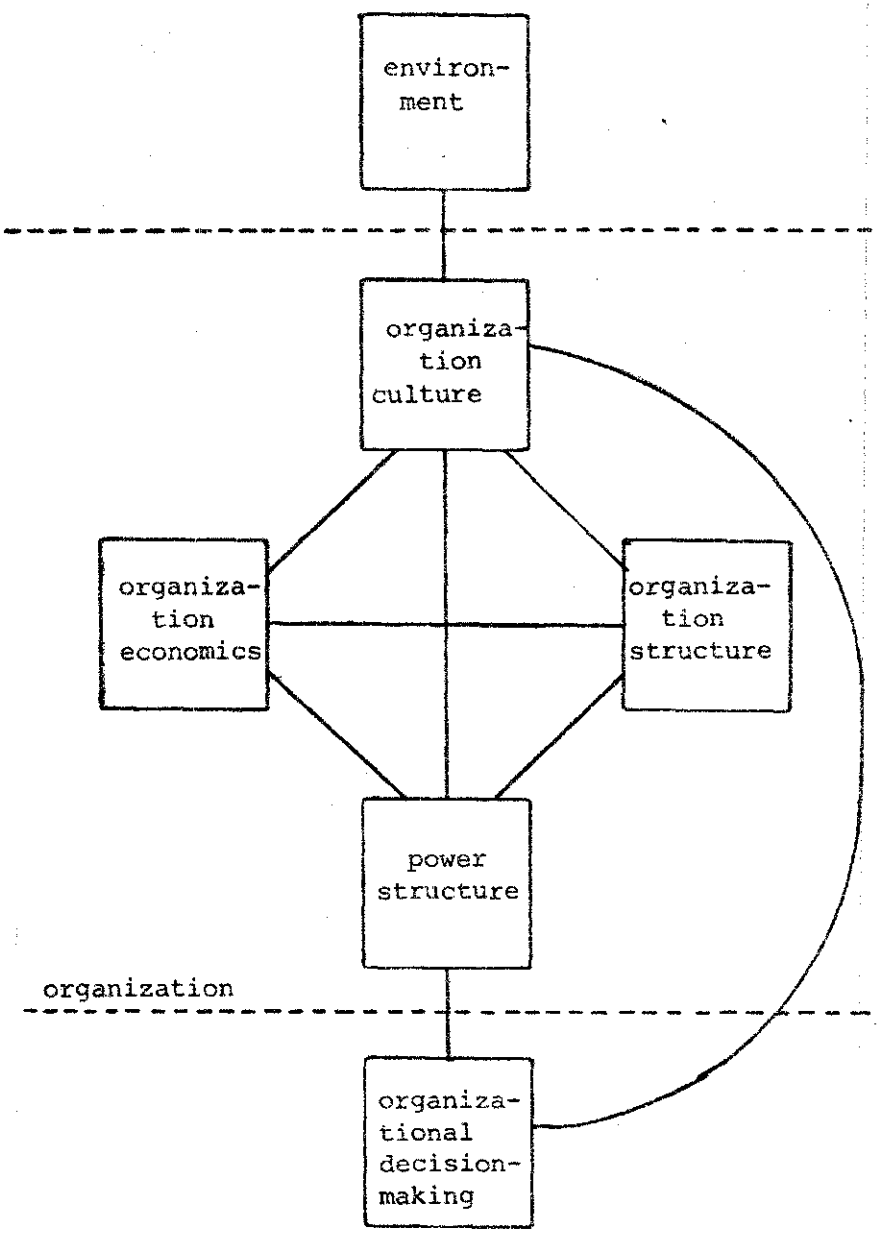


Figure 3

Organization Causal Ordering

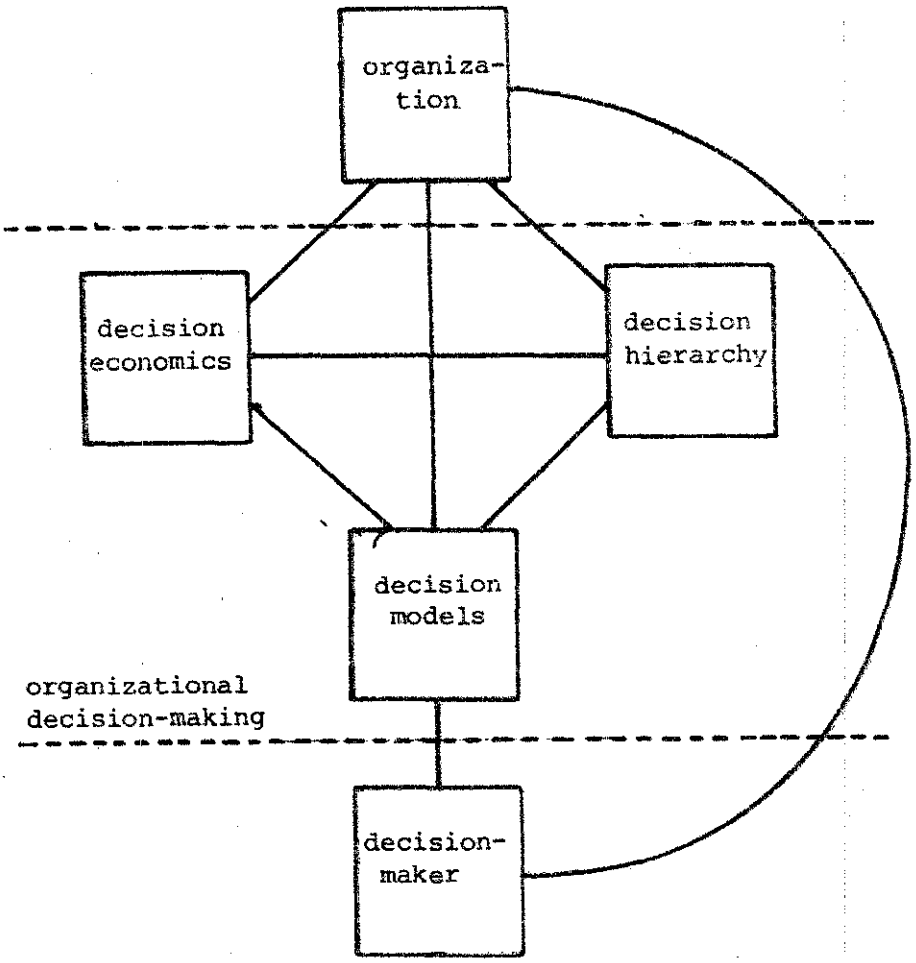


Figure 4

Organizational-decision-making

Causal Ordering

The decision-maker behavior -- the specific contribution of each individual participant to the organizational decision-making process -- is another important dimension in the IS contingency theory. Three main variables can be conceptualized as "styles" of decision-maker behavior -- cognitive styles, leadership styles, and ontological styles. Driver and Mock (1975) have studied the type and rate of comsumption of information by each cognitive style and which they classified as: decisive (low data use, one focus), flexible (low data use, multiple foci), hierarchic (high data use, one focus), integrative (high data use, multiple foci), and complex

(combination of hierarchic and integrative). Ontology is "a conception ... about what sort of things make up the world, how they are related, and how they act" (Diesing, 1971, p. 124). By ontological styles of decision-maker behavior, we mean both his epistemology and ideology when faced with any given set of data and decisions. To my knowledge there is no study describing ontological styles that can be drawn upon here. We can conceive the effects of such styles not only with regard to cognitive styles, but also with regard to information systems, as very important because they will define not only the type of data that is taken as true, but also the decision-maker logic-in-use when analyzing the data, decision, and action. Moreover, it will unravel the set of values the decision-maker will use to make judgments to measure the consequences of the actions being taken into consideration. Finally, the leadership styles in existence in a given organization, or parts of the organization, will determine the level of individual contribution of participants in the organizational decision-making process. An authoritarian leadership style will limit participation in the decision process to a few individuals; a participative leadership style will allow many individuals to influence the decision process which is channeled through a group of a few individuals (the leaders); and a transparent leadership style will make possible the participation of a large number of individuals, without a predominat group influencing the decision process. The consequences of the three leadership styles which have been described on the design of information systems, for example, are also very important. If we are to account for individual differences in a design, the importance of knowing the leadership style is paramount. If an authoritarian leadership exists, very few individual differences need be accounted for (the leaders). If the leadership is transparent, we will need to account for individual differences of a much larger number of individuals — the great majority of the participants. To my knowledge, no study has been made to try to measure and relate information systems to leadership styles and the bearing this has on IS design and type. Figure 5 presents

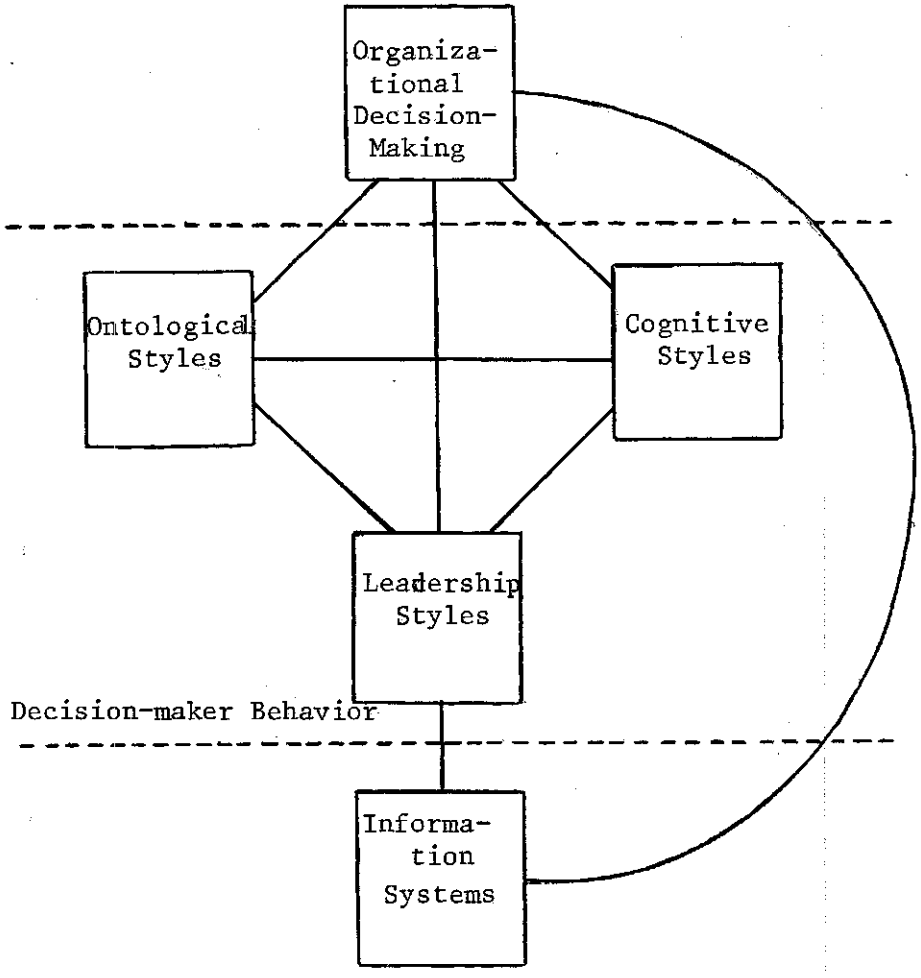


Figure 5

Decision-maker Behavior

Causal Ordering

the causal ordering assumed to be true with regard to decision-maker behavior in the proposed contingency theory. This ordering is part of the assumptions of the present research.

An Information System is seen as a socio-technical system with the objective of producing change in knowledge and practice. This definition, latu sensu, can be considered to comprise all dimensions previously discussed, except for the environment — the organization is seen as an "Information Processor" (see, for example, Galbraith (1972, pp. 49-73) for a discussion of organization in this perspective). In sensu stricto, as it will be used here, refers to the information processing function in a given organization as well as the designers and users of the information processing elements. This is presented in Figure 6 below and discussed elsewere (Bento, 1980,.pp. 132-134) as the IS model.

At least four variables are important in the study and design of information systems: the IS epistemology, the IS economics, the information needs, and the IS types or models. Mason and Mitroff (1973, p. 480-483) have defined five types of IS epistemologies: Lockean, Leibnitzian, Kantian, Hegelian, and Singerian-Churchmanian. I believe that at least one more epistemological type should be included to assure overall representativeness — the Marxist IS (be whatever the many conflicting authors in the subject may consider as such).

The information needs, refer to the demand for information and the constraints associated with it. The literature is full of methods to determine "information requirements," or information needs (See for example the excellent literature review article by Swanson and Cooper (1978), as well as their attempt to provide a synthesis of the subject). Unfortunately, no precise definition and measurement of such important variable exists in the same literature. The attempt made in a previous research (Bento, 1980, pp. 136-142) to define information needs, and to

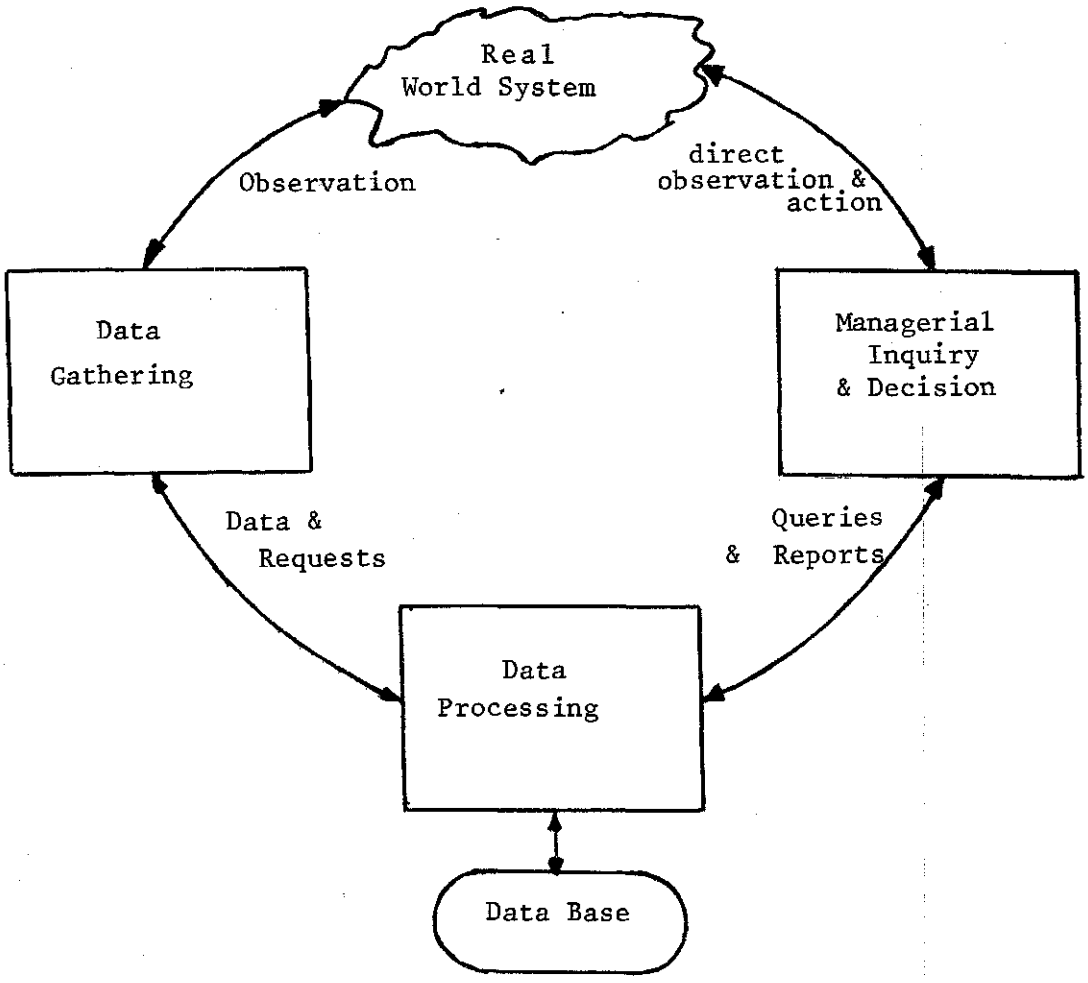


Figure 6

IS Model

provide an operationalization to this definition, is a very simplified view of the problem.

IS economics refers to the material basis of the information system — its production function and performance. In general, the literature deals with the subject from either the point of view of the value of information (Marshak, op. cit.) or from the point of view of resource allocation (McFarlan, Nolan and Norton, 1973, specially pp. 14-31, and 199-252). Furthermore, others deal with the productivity and performance of the IS (Mason, 1977). But, unfortunately, no synthesis exists to explain the IS production function in all of its components, together with the measurement of the IS performance.

Finally, the IS types or models, as discussed in Bento (1980, pp. 132-134), are seen to comprise at least three cases: Data Analysis, Decision Analysis, and Inquiring Systems. The causal ordering of these four IS main variables is depicted in Figure 7.

The contingency theory, as presented here, is still in a developmental stage — many of the hypothesized variables are yet to be operationalized and tested. Moreover, it was implicit in our presentation of the theory that no feed-back occurs from the information system to the environment and the remaining organizational dimensions. This is an oversimplification of the problem, because there is evidence in the literature that information systems are a source of power, that has a bearing in the organization structure, affects the organizational decision-making process, and influences the decision-maker behavior, among many other possible feed-backs. But, from a Singerian-Churmanian inquiring system point of view, we need to tame a problem to a certain level of knowledge of the situation, provide a solution to it, and then untame the problem, pursue more knowledge, and repeat the cycle. In the present situation we have tamed the problem far beyond our present possibilities to solve it. In the

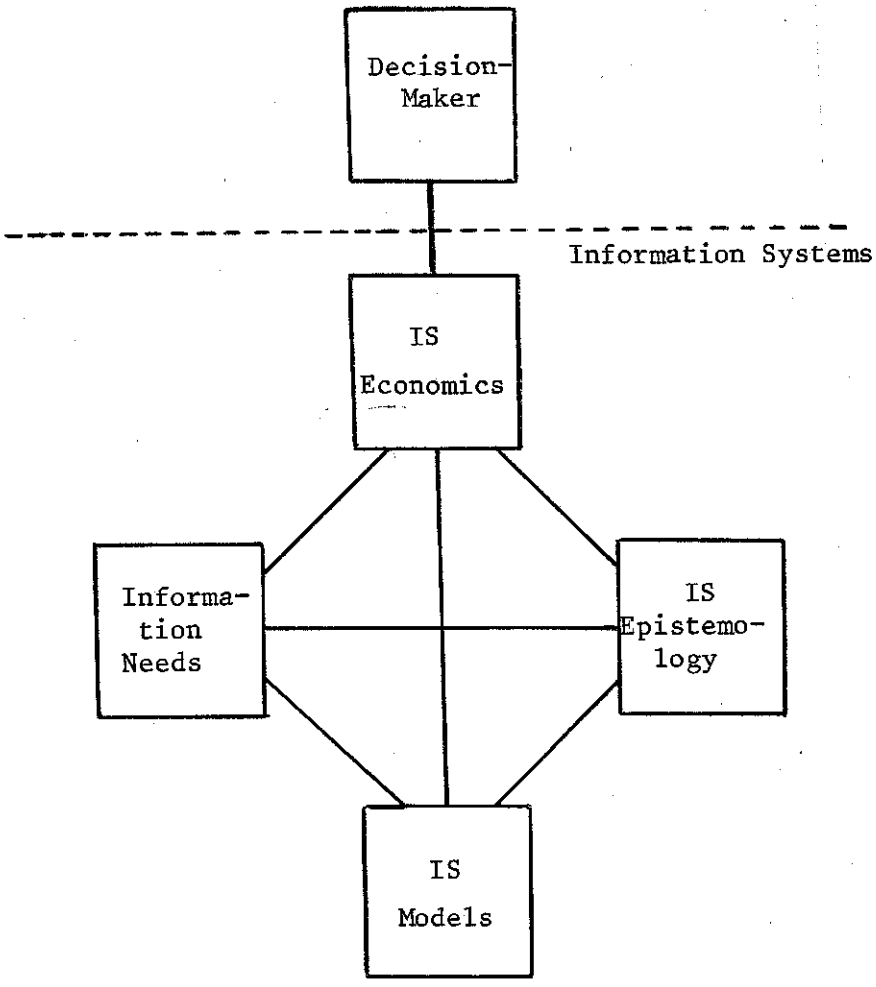


Figure 7

Information Systems

Causal Ordering

next section of this work we will simplify the problem even more, in order to tame it to a level suitable to perform a first exploraty study, using the results obtained by Bento (1980, pp. 53-69, 108-114, 195-200).

III. RESEARCH HYPOTHESIS

In the proposed contingency theory of this research at least eighteen variables were seen which allow us to explain the information system model in existence in a given organization. Given the exploratory character of this research, six of these variables were chosen to conduct a first experiment in order to test the proposed contingency theory partially. All dimensions, except decision-maker behavior, are represented by these six variables. The selected variables are: (a) culture, (b) environment causal texture, (c) organization economics, (d) societal decision-making models, (e) information needs, and (f) IS model.

The treatment of three of these variables (causal texture, societal decision-models, and IS models) was extensive in Bento (1980, pp. 11-200), and the measurement process of these variables allows us to say that reliable operational categories were established. The remaining three variables are included with much less refinement — and in some cases as crude measures — than the former three. Culture was operationalized through the region where the organizations were located — in Northern or Southern California. Organization economics was measured by the organizations' average budget size for the last twenty-two years, classified on a scale of 1 to 3, from small to large size. Finally, information needs were measured by means of the results to the survey instrument described in Bento (1980, pp. 143-155)

The hypotheses to be tested are the existence and the strength of the relationship between the above variables, as follows:

(a) Causal texture of the environment is strongly dependent of the culture.

(b) Organization economics is dependent upon the environment causal texture and on the culture the organization is in.

(c) Societal decision-making is dependent upon organization economics, the environment causal texture, and the culture the organization is in.

(d) Information needs are dependent upon societal decision-making, organization economics, the environment causal texture, and

(e) The information systems model is dependent upon organization economics, societal decision-making, and information needs.

IV. RESEARCH METHODOLOGY

The same sample used in Bento (1980, pp. 11-200) will be used here, that is, 91 departments of thirteen California cities. The data used in this research cames from the same source and is shown in Appendix A. Lets discuss the sample external validity.

The first problem that needs to be solved before we can select a sample is to identify the population to be studied. Unfortunately, there is no such thing as a list of all departments of all cities in California. Therefore, a first qualification is needed As previously stated, we do have a list of departments for cities with more than 50.000 inhabitants. These departments were identified by the following source: the U.S. Dept. of Commerce, Bureau of the Census City Government Finances in 1974-75, October 1976, Table 5 - Finances of Individual Cities and Selected Urban Towns and Townships Over 50,000: 1974-75.

From this Table, 476 departments, or expenditures that correspond to departments, were identified for the 68 cities with more than 50,000 inhabitants. This cannot be said to be the total population of departments, but rather the most significant in terms of participation in the total budget. This is so, because Table 5 of the publication referred to summarizes the expenditures of less important departments and activities under an overall title of "all other." Therefore, a second minor qualification should be made in this regard — the sample is representative of the main departments of the California cities with more than 50.000 inhabitants. For all practical purposes, I believe that this qualification is unnecessary because the remaining and omitted departments are so small that they do not, in fact, constitute a department in the sense we are been using throughout this research — an autonomous organization.

The following is the distribution of the 476 departments by size:

Table I

Departments' Size Distribution

Size (values in 000's)		Absolute (n)	Relative (%)
Small	(100-1,250)	151	31.7
Average	(1,251-15,000)	280	58.8
Large	(15,000-200,000)	45	9.5

Note: Each class interval was computed as having an upper limit approximately equal to 12.5 the lower limit, given the range of the distribution.

To obtain a stratified proportional random sample, departments of each size were supposed to be drawn at random from the 68 cities. But, since we could not afford the cost of studying one or two departments per city, as would be the case of a pure random sample, this constraint was introduced. The random sampling was continued until we reached a minimum of five departments per city, for a total of 13 cities. Then, we randomly chose two others to complete a total of 7 departments per city. Although the procedure we followed selected a random sample, the sample cannot be said to be an independent random sample. The main implication of this fact is that the assumption made by the staticians in devising the various parametric and non-parametric tests that "there is independence between events and that therefore conditional probabilities do not have to be used when multiplying probabilities" (Blalock, 1972, p. 142) is violated. But, again, in the words of Blalock (op. cit., p. 145) "especially in a discipline (social sciences) characterized by exploratory studies and relatively imprecise scientific techniques, it is necessary to make compromisses with reality". Therefore, a practical criterium would be to compromise, as I have done above, and measure the possible distortions introduced due to this compromise. If no significant distortion can be found, then we can assume that the sample has the desired property of being a proportional stratified random sample.

The following is the distribution of the 91 departments comprising the sample:

Table II

Distribution of the Size of the

Departments in the Sample

Size	Sample		Population	Deviation
	Absolute (n)	Relative (%)	Relative (%)	%
Small	25	27.5	31.7	-4.2
Average	52	57.1	58.8	-1.7
Large	14	15.4	9.5	5.9
μ ($\bar{x}$)	11,241.89		4,934.88	
σ (s)	24,736.17		15,288.58	

Note: The mean and standard deviations were computed using a non-aggregated statistical procedure.

At first glance, and assuming normality of the population, it seems that the sample is a little biased toward larger size departments. The result of a t test for one sample (Blalock, op. cit., pp. 188-193) indicates that we can only accept that the sample belongs to the population at .01; at .05 we would reject the hypothesis that this is a proportional strafified random sample — t= 2.411887, while $t_{.05,90} = 2.374$ and $t_{.01,90} = 2.6385$.

On the other hand, it seems that the normality assumption does not hold in the department's size population — the mode and the median are equal to 1,750 thousand dollars, while the mean is 4,935 thousands. Figure 8 presents the distribution function for the department's size. As can be seen the distribution has two peaks in the extremes and is skewed to the left of the mean — it resembles much more the sine function than the bell-shaped normal. Therefore the non-parametric χ^2 and Smirnov-Kolmogorov tests were also performed.

Using the χ^2 test (= 3.348) we cannot reject the idea that the sample is a proportional stratified sample at .15. Also, using the Smirnov-Kolmogorov test (D= .0593083) the same conclusion can be reached at .2. Based on these results one could say that the distortions introduced are not significant.

Summarizing, if we assume normality — which does not seem to be the case — the sample may be somewhat biased towards higher sized departments. Otherwise, using non-parametric measures, the sample seems to be representative of the population, and the deviations found are non-significant, at least at .15. Therefore, it seems that the sample possesses external validity.

The methodology used to test the hypothesis is based on the path analysis reasoning as described in Blalock (1971) and Asher (1976). Given the simplifying assumption made previously that no feed-back exists between the variables, our hypothesis can be seen as composing a recursive system, as shown in Figure 9.

In ooo's $

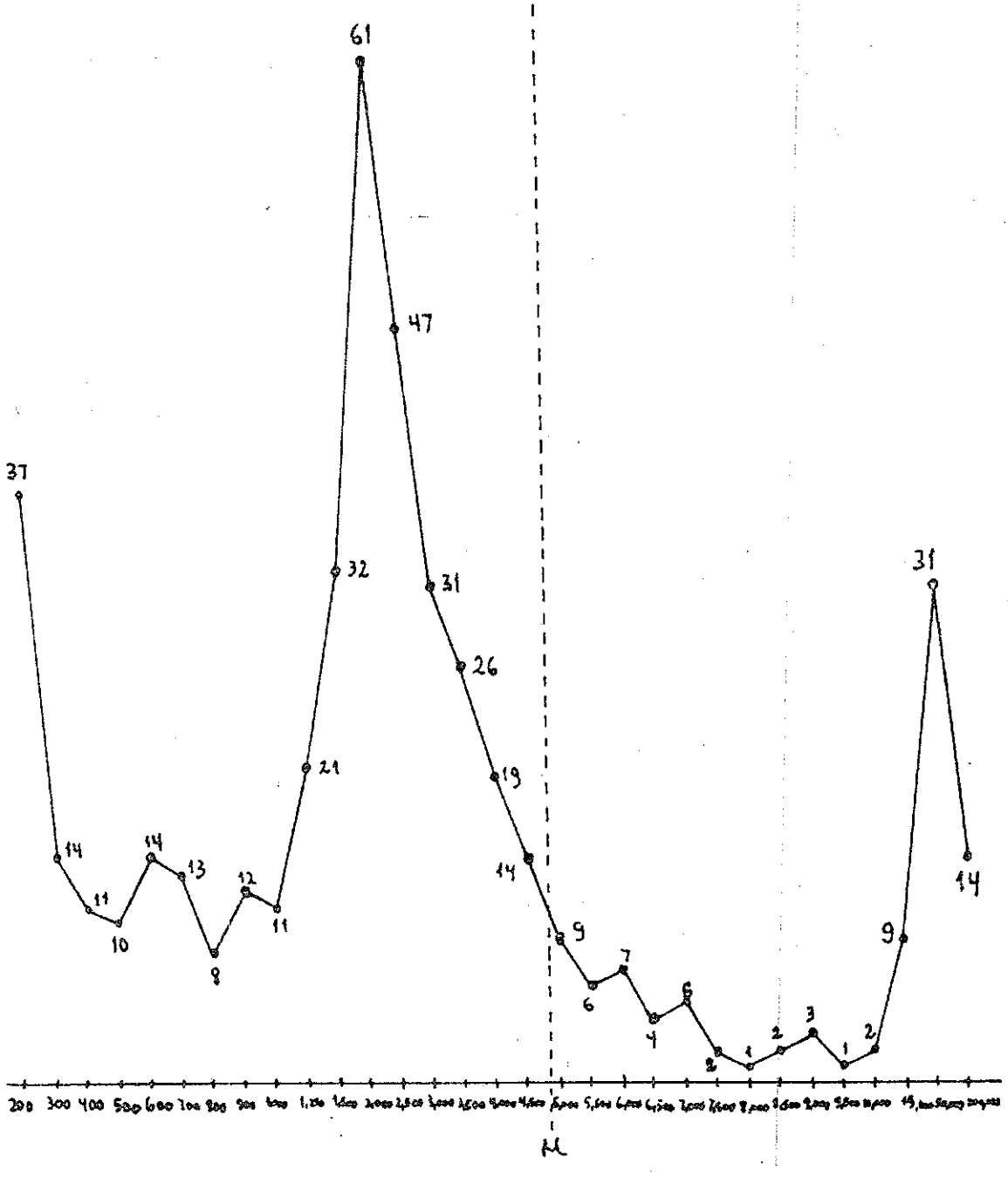
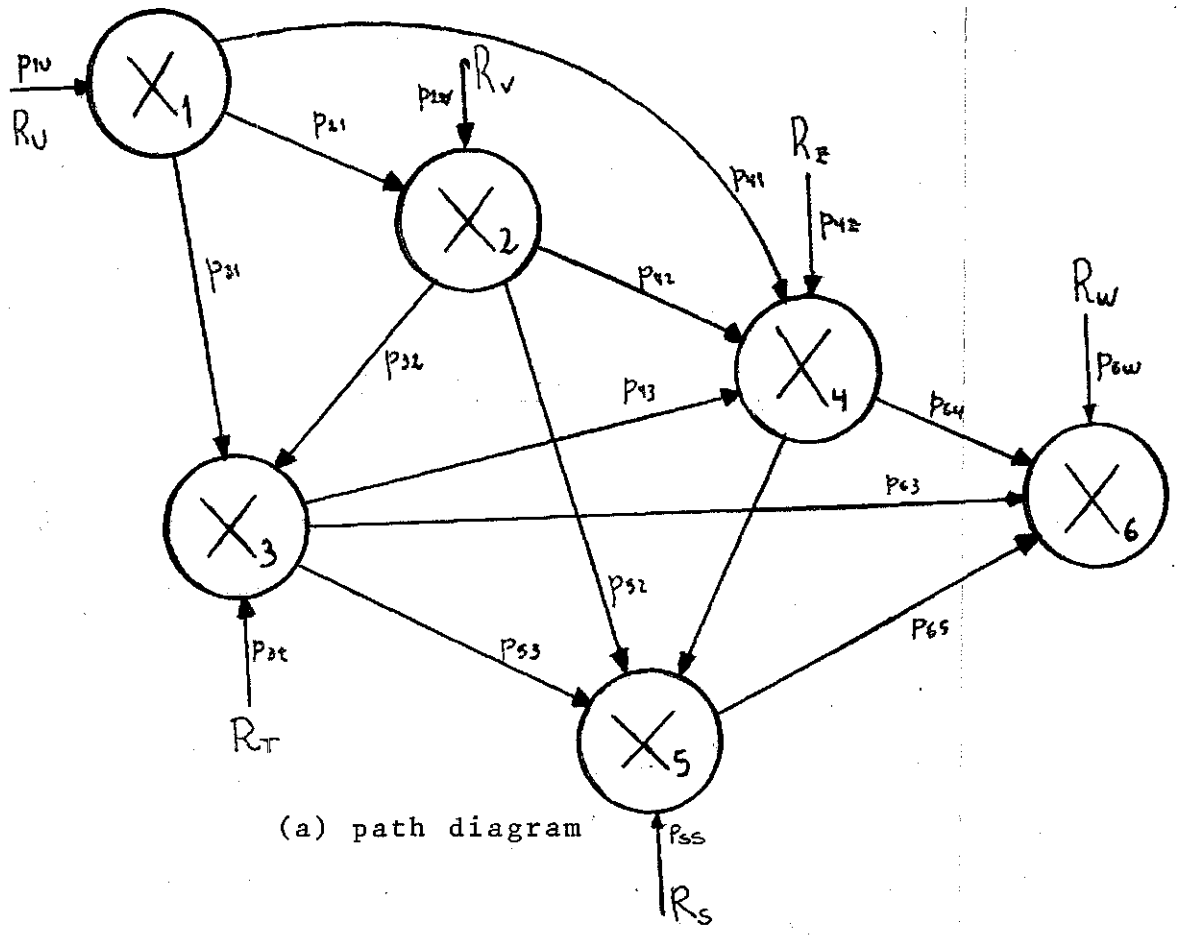


Figure 8
Department's Size Function



(a) path diagram

$$x_1 = p_{1u} \cdot R_u$$

$$x_2 = p_{21} \cdot x_1 + p_{2v} \cdot R_v$$

$$x_3 = p_{31} \cdot x_1 + p_{32} \cdot x_2 + p_{3t} \cdot R_t$$

$$x_4 = p_{41} \cdot x_1 + p_{42} \cdot x_2 + p_{43} \cdot x_3 + p_{4z} \cdot R_z$$

$$x_5 = p_{51} \cdot x_2 + p_{53} \cdot x_3 + p_{54} \cdot x_4 + p_{5s} \cdot R_s$$

$$x_6 = p_{63} \cdot x_3 + p_{64} \cdot x_4 + p_{65} \cdot x_5 + p_{6w} \cdot R_w$$

where: x_1 = culture; x_2 = Environment; x_3 = Organization economics; x_4 = societal decision-making; x_5 = information needs; x_6 = IS model

(b) path equations

Figure 9
Hypothesis Path Analysis

Unfortunately, path analysis requires the assumptions of normality and interval level of measurement. In our case none of the variables can be assumed to be so — the variables are in the ordinal level of measurement, but culture is in the nominal level. Therefore we will use Kendall's tau simple and partial order correlation coefficient to estimate the values of the path coefficientes. The procedure to be followed is:

1. Simple Rank Order Correlations: we will estimate the simple Kendall's tau rank order correlation between the dependent variables in the equations shown in Figure 9 and each independent variables.

2. Partial Rank Order Correlations: using the formula below, which was described in Bento (1980, p.157) research, we will compute the partial correlations between the dependent variables and the independent variables, controlled for the effects of the remaining variables, in the same equations shown in Figure 9. Unfortunately, there is no method to compute multiple rank order correlations and derive from them the partials (see Hildebrand, Laing and Rosenthal (1977, pp. 63-76) for a discussion of the problem) standard in the literature. The Kendall's tau partial order correlation will be computed by:

$$\tau_{xyz} = \frac{\tau_{xy} - \tau_{zy} \cdot \tau_{xy}}{\sqrt{1 - \tau_{zy}^2)\ (1 - \tau_{zx}^2)}} \quad \text{(first order correlation)}$$

$$\tau_{xy.zw} = \frac{\tau_{xy.z} - \tau_{xw.z} \cdot \tau_{yw.z}}{\sqrt{1 - \tau_{xw.z}^2} \cdot \sqrt{1 - \tau_{yw.z}^2}} \quad \text{(second order correlation)}$$

These partial correlation coefficientes are the estimates of the path coefficientes to be used to test the hypothesis.

3. Regression Beta Weights: to corroborate the results obtained, a hierarchical inclusion regression analysis will be conducted of the same equations shown in Figure 9. The results obtained will allow us to compare the simple correlations with the simple rank order correlations, and the beta weights — the standardized beta coefficients — with the partial rank order correlations. If they are close we may say that no pathological numerical values were assigned to the ordinal variables and that the method used is a good approximation of the estimate of the path coefficients using path analysis.

If the path coefficients are significant, approximately, at .05, then the relationship found in the sample can be inferred to exist in the population. Given the many simplifications and the variables omitted in this research, we cannot expect to find high values for the path coefficients. In cases where much more complete models were used, path coefficients of .4 were considered to represent strong relationships, and coefficients of .2 to express moderate relationships between the variables (see, for example, Cnudde and McCrone, op. cit.). Therefore, we can expect to have path coefficients of much lower order expressing strong relationships because the indirect effects of the variables used and hidden in the omitted variables will not be considered.

V. RESULTS

The overall results of this research confirm, in general, that the hypothesis of the IS contingency holds in the population. Figure 10 summarizes the relations found significant and the values estimated for the path coefficients. As can be seen no variables in the model explain information needs and organizations economics. Probably, the main variables related to them, as for example, in the case of information needs, the decision-maker behavior and information economics, and, in the case or organization economics, infrastructure, power sources and organization culture, had been omitted and the remaining variables do not carry enough power to explain their behavior per se. Societal decision-making was found to depend upon the culture and causal texture the organizations are in. The environment causal texture was found to be positively related to the culture, measured through the region, the departments are in. Organization economics, at least as measured by the resources budget size, was found not to be significant at .15. This is a surprising result because one would expect that the larger the organization, the more complex the organizational decision-making process would be. This seems not to be the case in the population studied.

The information system model was found to be dependent upon all the variables hypothesized. Information needs is the single more important factor, as expected, to explain the IS model used, But, it is a little surprising to see that the IS model is inversely proportional to the size of the organization. It seems that the larger the organization the more difficult it is to develop more complex information systems. Finally, societal decision-making has almost the same influence as organization size but in the opposite direction — the more complex the decision model, the more complex the information system, as we would have expected.

Therefore hypotheses (a), (c), (e) were found to hold

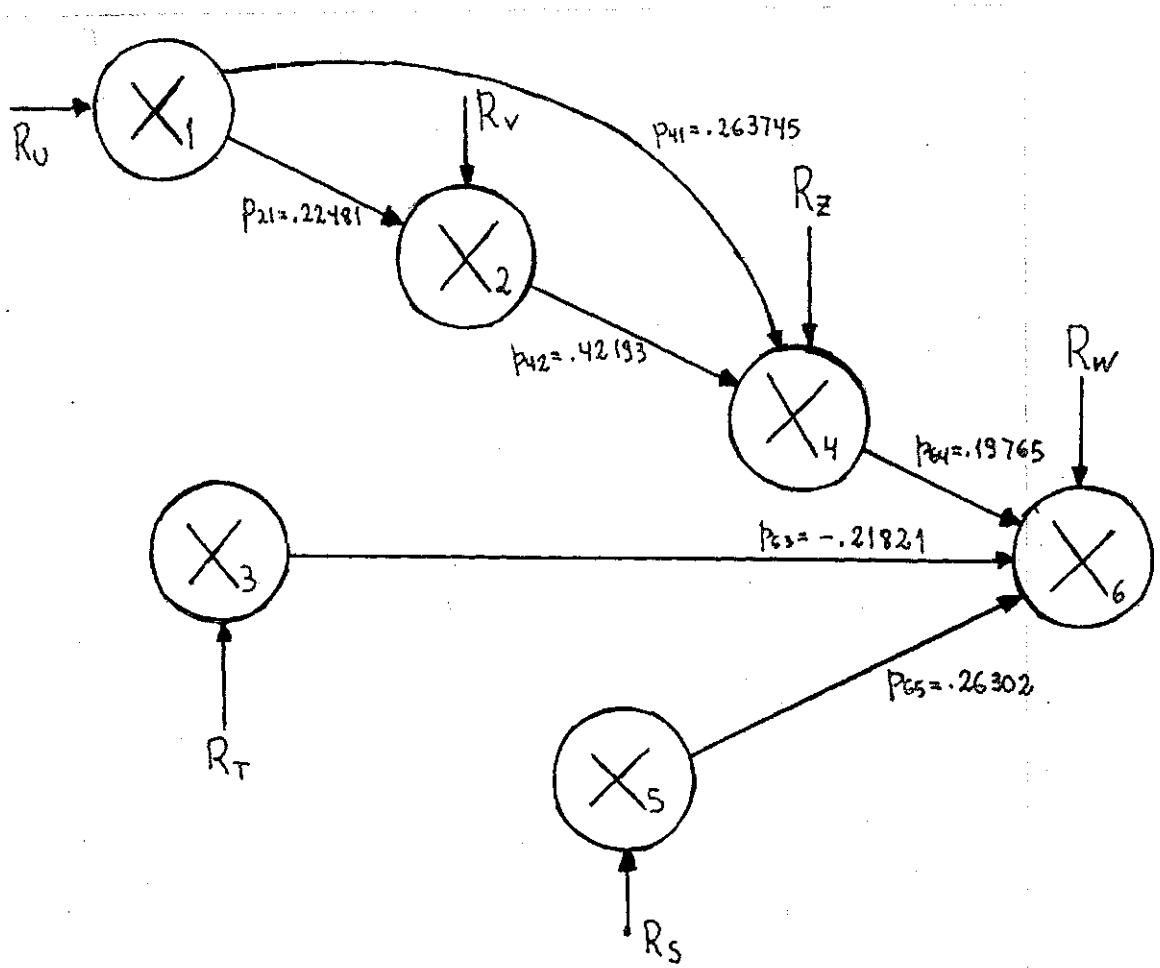


Figure 10

Path Analysis Results

in the population, while hypotheses (b) and (d) did not. In general, the results corroborate the proposed contingency theory, not only because the main relationships hypothesized did exist, but also because the strength of the relationships found are in line with what we would expect if the variables used were not able, per se, to explain the total variation of the dependent variables. If we had found either that no significant relationship did exist, or that some of the variables considered were the sole explanation of the dependent variables, then what we had proposed as the full set of variables composing the contingency theory could not be true. In the first case because the relationship between environment, the societal decision-making, and information systems — the core of our proposed theory — would have been denied. In the second case because if some variables were found as the sole explanation of any of the variables considered, then the other variables, hypothesized in the proposed theory as having a bearing in the variables considered, would not have.

The results obtained in the simple and partial rank order correlations between the dependent and independent variables in the equations of Figure 9 are shown in Table III. The partial rank order correlations were used as path coefficients estimators, as previously discussed.

Table IV shows the results obtained in the hierarchical inclusion regressions for the dependent and independent variables in the same equation. The beta weights are the parametric equivalent of the path coefficients estimated using non-parametric, ordinal measures.

As can be seen, there are no major differences, in this case, between the results obtained using parametric and non-parametric correlations and estimates of the path coefficients. Therefore the numbers attached to the ordinal categories did not introduce any abnormality with regard to the parametric statistics used. Moreover, given the absence of abnormalities, the parametric results corroborate the results we estimated of the path coefficients using the partial rank correlations.

Table III

Rank Order Correlations

Simple and Partial

Variables		X_1	X_2	X_3	X_4	X_5
X_2	simple	.22481				
	partial	.22481				
X_3	simple	ns .4	ns .7			
	partial	-	-			
X_4	simple	.30080	.43198	ns .15		
	partial	.26375	.42193	-		
X_5	simple		ns .35	ns .75	ns .35	
	partial		-	-	-	
X_6	simple			-.21821	.19765	.26302
	partial			-.21821	.19765	.26302

Table IV

Simple Correlations and Beta Weights

Variables		X_1	X_2	X_3	X_4	X_5
X_2	r	.23899				
	B	.23899				
X_3	r	ns .35	ns .7			
	B	-	-			
X_4	r	.29750	.45722	ns .2		
	B	.21175	.40202	-		
X_5	r		ns .3	ns .75	ns .25	
	B		-	-	-	
X_6	r			.24824	.20727	.29205
	B			.25578	.19723	.25237

VI. CONCLUSION

The main conclusions of this research, therefore, are that (a) the proposed contingency theory is reasonably supported by the results obtained, (b) future research using the contingency theory as a hypothesis would be a fruitful endeavor, (c) practical applications of the contingency theory to design information systems should be encouraged, and that (d) the methodology used should be standardized and made available for practitioners and researchers. Let us now discuss each of these conclusions in turn.

Although only six of the eighteen variables presented as composing the IS contingency theory were used in this research, the results for not denying, falsifying, the proposed theory, lends support to its existence in practice. Besides, the results have shown that the major hypothesized relationships do hold in practice. Therefore, the contingency theory has passed the "critical" experiment to evaluate its feasibility and power to explain practical phenomena. If omitting a major intervening dimension between societal decision-making and information systems — the decision-maker behavior — we still found that a reasonable relationship did exist between these two variables, then by including this dimension, the power of explanation of the theory would have been much better. Likewise, in the other dimensions, the great majority of the variables were omitted, and still we were able to find reasonably strong relations between dependent variables.

Therefore I claim that inquiry into information systems along the lines opened by the contingency theory is a fruitful aim; not only because it has been reasonably supported by the results of this research, but also because results of past inquiries can be integrated towards a unified theory of information systems. The efforts of Human Information Processing can be seen as studying the relationships between information systems and decision-maker

behavior. Research in Decision-Support Systems can be seen as studying the relationships between organization decision-making, organization economics, and information systems. Research in Inquiring Systems can be seen as studying the major elements and variables of information systems, and relating them, at large, with the organization variables as well as, to some extent, with environment variables. The contributions of other research such as economics of information, non-intended consequences of IS — psychologically and sociologically — communications theory in dissemination of information, information as the source of power, organization as information processing, etc., can be fit into the overall dimensions and variables of the contingency theory, thus providing a binding paradigm to interpret each of these separate pieces of knowledge, and unravelling their relationships. Moreover, this is a fruitful endeavor because it immediately poses all sort of questions with regard to the existence or non-existence of the proposed relationships in light of the bits of information we have from all the above (apparently) different approaches to research in information systems. Socrates' statement that the one who knows, knows that he does not know, has defined for all times what the characteristic of a good theory or paradigm to knowledge is: the answers that the theory offers, and the research derived from it, although casting light on our previous ignorance, show us how much more we still have to know. A good theory helps us to know what questions we should ask next in the endless pursuit of knowledge. I do believe that the theory proposed and tested initially in this research, is a modest contribution toward an information systems theory with the above Socratic property of knowledge.

The practitioner has in the proposed theory a guideline through which, he can not only see the relationships between the variables he is exposed to, and integrate the bits of knowledge he has acquired of these variables, but he can also design information systems. The contingency theory causal ordering of the variables can be seen as the steps he must follow in order to define an information system. Even though some parts of the theory do not

have tested categories and determined strength of the relationship between these categories, the practitioner can replace the lack of specific guidelines with the bits of knowledge he has accumulated, and with judgment. What the contingency theory provides, in this case, is the awareness and relative importance of the variables to be studied. The focus of the system design will be moved away from each particular component of the organizational system, and centered to select "ends" and "means" simultaneously with the understanding of the whole and the relationship of each part to this whole — the organizational system. The complexity of the system design process is apparently raised if one compares the contingency theory with the existing "frameworks." In practice the contingency theory, as proposed, is still an approximation of the real variables the practitioner has to deal with in order to design and implement an information systems. What happens is that, although apparently using the more simple frameworks. The practitioner is forced to take into consideration, be it through many changes in the design and in the system or through political and social pressure, the variables omitted from the simplified frameworks and contemplated in the contingency theory, many times unfortunately in an asystematic, expensive, and painful way. The contingency theory can avoid many problems of "implementation," "user misunderstanding," "usefulness of the system," etc., with which the practitioner is confronted because he omits so many important dimensions and variables in the system design process. I agree that it would be ideal if we "guarantee" that the contingency theory "works," that is if we could have tested all the possible hypotheses before recommending it to the practitioners. But since no theory can be fully proved, and the hypothesizing process is endless, it seems to me that the contingency theory, having passed the crucial experiment conducted in this research, is an alternative with high potential to solve the design problems we face with regard to, primarily, management control and strategic planning. As such it should be considered as a more systematic approach to the design of information system than ones available.

I recognize that one of the major problems associated with the usage of the present theory, as measured in this research, by practitioners and researchers alike is the effort necessary to replicate the methodology used in this research. Also, the practitioner will probably be more interested in studying an isolated organization rather than a large number of them as I have done in this research. Therefore, it is necessary that standardized instruments to measure each of the variables be developed or adapted, and probably that a full software package be prepared to assemble and integrate all these instruments. The practitioner version of this package should contain measures from other organizations to which he can compare the isolated results he will obtain for his organization. However, the present limitation is similar to that existing with available frameworks for the design of information systems. Therefore, both practitioners and researchers are also called upon to contribute toward the development of the necessary methodology. The difference of the present case to existing frameworks is that this research contains a full and detailed example of the methodology that needs to be standardized, at least for some of the variables of the proposed contingency theory.

Finally, this research has presented me with more questions and doubts than I am, or was, prepared even to understand the full meaning of let alone to give any definitive answer or solution to (if one ever "solves" a problem). I became aware of a series of sideline issues, more over, substantive ones. Some of these issues I have discussed, or, at least, pointed out, throughout this research. Others have directed my efforts to areas that I took for granted before, as for example, the development of a statistical method of identifying shift-points, and which I have included as an appendix. Still others, that I do consider of vital importance to this inquiry, I could not even touch the surface of. Therefore, I would like to finish this study by posing a problem and/or qualification to the overall inquiry conducted with regard to a basic issue I was unable to address in this research — the ontology of inquiring systems.

The ontological problem has a bearing on the way the information systems were defined, as well as on all data used in this research. From my point of view, ontology is a synthesis of ideology and epistemology. Unfortunately, with the knowledge I have I was unable to synthesize from the epistemologies I know (even with help from Mason and Mitroff or Churchman in their seminal works related to information systems) and the ideologies I think I know, any ontological categories through which I could have better depicted the information systems models. Moreover, I do believe I have utilized logical constructs to test hypotheses, consistency, validity, etc., that came from a different ontological basis, and possibly, even different from where the hypotheses came from. In fact, I have tried to map all possible interpretations of methods, concepts, etc., to their ontological basis. I discovered my enormous ignorance of the subject and became convinced that many years will pass before I will be able to solve the puzzle posed to me by Churchman (1971, p. 277) in his concluding remarks in the "Design of Inquiring Systems":

> *"Man expresses himself in his own individual way, to be sure, and his concept of the guarantor [of truth, reality,] comes out of his own individuality; yet his own individuality is a reality, and not relative to this or that inquirer's view of the world."*

After, and if, I am able to find a minimum satisfactory solution to the above question, then, I think, I can attempt to do the mapping I initially proposed doing. For now, I have used the best of my "intuition" to design the inquiry system that allowed this research to be done.

./sspm.

APPENDIX A

DATA FOR IS CONTINGENCY THEORY TESTING

City/Department	CULT	ENV	ORGSZ	SDM	INFNE	ISMOD
Alameda						
Police	2	1	1	1	1	2
Fire	2	2	1	1	1	2
Golf Course	2	3	1	3	1	2
Library	2	2	1	3	1	1
Streets	2	3	1	3	1	1
Parks & Recreation	2	3	1	3	1	2
Buildings & Inspections	2	1	1	3	0	0
Alhambra						
Police	1	1	1	1	0	0
Fire	1	3	1	1	0	0
Buildings & Planning	1	1	1	3	0	0
Street	1	1	2	3	0	0
Sanitation	1	1	1	3	0	0
Library	1	1	1	1	0	0
Parks & Recreation	1	1	1	2	0	0
Berkeley						
Police	2	2	2	1	0	0
Fire	2	3	2	3	0	0
Health	2	1	1	2	0	0
Public Works	2	1	2	3	0	0
Recreation & Parks	2	3	2	3	0	0
Library	2	2	1	3	0	0
City Manager	2	3	1	3	0	0
Compton						
Police	1	1	2	2	2	1
Fire	1	2	1	2	3	3
City Attorney	1	1	1	1	1	1
Public Works	1	1	2	3	1	1
Parks & Recreation	1	1	1	1	2	3
City Manager	1	1	1	1	3	1
Building & Safety	1	3	1	3	3	2
Long Beach						
Police	1	3	3	3	3	3
Fire	1	3	3	3	3	2
Health	1	1	1	3	3	3
Public Service	1	3	3	3	3	1
Park & Recreation	1	2	2	3	3	3
Planning & Building	1	1	1	1	3	1
Library	1	1	2	1	0	1

DATA FOR IS CONTINGENCY THEORY TESTING

City/Department	CULT	ENV	ORGSZ	SDM	INFNE	ISMOD
Los Angeles						
Fire	1	3	3	3	1	1
Police	1	1	3	3	0	1
Public Works	1	1	3	1	0	1
Building & Safety	1	2	3	2	3	1
Recreation & Parks	1	2	3	2	2	1
Public Util. & Transp.	1	1	3	1	0	1
Personnel	1	2	3	3	1	1
Oakland						
Police	2	1	3	3	1	1
Fire	2	1	3	1	1	3
Public Buildings	2	3	2	3	1	2
Public Works	2	3	3	3	3	1
Parks & Recreation	2	2	2	3	3	3
Library	2	1	2	3	3	3
Finance	2	1	1	1	1	1
Sacramento						
Police	2	3	3	3	2	2
Fire	2	3	2	3	0	2
Building Inspections	2	3	1	3	0	2
Public Works	2	3	2	3	2	3
Recreation & Parks	2	3	2	3	3	3
Library	2	2	1	3	1	3
City Manager	2	3	1	3	3	3
San Diego						
Police	1	2	3	1	2	1
Fire	1	2	3	2	1	3
Building Inspections	1	1	1	3	1	3
Public Works	1	3	3	3	2	1
Recreation & Parks	1	3	3	3	3	3
Library	1	3	2	3	3	2
City Manager	1	2	2	1	1	3
San Francisco						
Police	2	1	3	3	0	0
Fire	2	3	3	3	1	2
Health	2	1	3	1	1	1
Public Works	2	3	3	3	1	1
Recreation & Parks	2	1	3	1	1	1
Library	2	1	2	3	1	1
City Attorney	2	1	1	1	2	3

DATA FOR IS CONTINGENCY THEORY TESTING

City/Department	CULT	ENV	ORGSZ	SDM	INFNE	ISMOD
San Jose						
Police	2	1	3	3	1	3
Fire	2	3	2	3	1	3
City Manager	2	3	1	3	3	3
Public Works	2	1	3	3	3	3
Parks & Recreation	2	3	2	3	1	1
Library	2	3	1	3	3	3
Building Safety	2	3	1	3	1	3
Santa Ana						
Police	1	1	2	1	0	0
Fire	1	1	2	1	0	0
Finance	1	1	1	1	0	0
Public Works	1	1	2	3	0	0
Recreation & Parks	1	2	1	2	0	0
Library	1	3	1	1	0	0
Building Safety	1	2	1	2	0	0
Whittier						
Police	2	2	2	1	3	3
Fire	2	1	1	2	3	2
City Manager	2	3	1	3	1	2
Public Works	2	1	1	3	3	1
Parks & Recreation	2	3	1	3	3	3
Library	2	2	1	2	1	1
Building & Safety	2	3	1	3	3	3

BIBLIOGRAPHY

ASHER, Herbert B., Causal Modeling, Beverly Hills: Sage, 1976.

BENTO, Alberto M. The Information Systems Contingency Theory: A Proposal and Test in California Cities, Los Angeles, University of California, Los Angeles, 1980, Ph. D. dissertation.

BLALOCK, Jr., H. M., Causal Models in the Social Sciences, Chicago: Aldine, 1971.

CHURCHMAN, C. West. On the Facility, Felicity, and Morality of Measuring Social Change, Berkeley: U.C. Berkeley, August 1970.

————., The Design of Inquiring Systems, New York: Basic Books, 1971.

CNUDDE, Charles F. and Donald J. McCrone, "Party Competition and Welfare Policies in the American States," American Political Science Review, 63 (1969), pp. 856-866.

DIESING, Paul, Patterns of Discovery in the Social Sciences, Chicago: Aldine-Atherton, Inc., 1971.

DRIVER, Michael J. and Mock, Theodore J., "Human Information Processing, Decision Style Theory, and Accounting Information Systems," The Accounting Review, 1975.

GALBRAITH, J. R. "Organization Design: An Information Processing View," in Lorsch, J. W. and Lawrence (eds.), Organization Planning: Cases and Concepts, Homewood, Illinois: Richard D. Irwin, 1972).

HILDEBRAND, D., Laing, J. D., and Rosenthal, H., Analysis of Ordinal Data, Beverly Hills: Sage Publications, 1977.

KUHN, T. S. The Structure of Scientific Revolutions, Chicago: The University of Chicago Press, 1970.

MARSHAK, Jacob, Economics of Inquiring, Communicating, Deciding, Richard T. Ely Lecture, American Economics Association, Washington, D. C., 1967.

————, Information Economics Reconsidered, Los Angeles: Western Management Science Institute, UCLA, 1969.

MASON, Richard O. and Mitroff, Ian I., "A Program for Research on Management. Information Systems," Management Science, 1973.

————., Measures of Information Output, Los Angeles: Public Services Management and Policy, UCLA, 1977. Working Paper #3.

MCFARLAN, F. W., Nolan, R. L. and Norton, D.P. Information Systems Administration, New York: Holt, Rinehart and Winston, Inc., 1973.

MERTON, R. K. The Sociology of Science, Chicago: The University of Chicago Press, 1973.

POPPER, Karl R., Objective Knowledge, Oxford, England: Oxford University Press, 1972.

RITTEL, H., "On the Planning Crisis: Systems Analysis of the 'First and Second Generations,'" BEDRIFTSØKONOMEN, 1972.

WEBB, E. J., D. T. Campbell, R. D. Schwartz, and L. Sechrest, Unobstrusive Measures, Chicago: Rand McNally, 1966.

HELLRIEGEL, D. and Slocum, Jr., J. W. Management: A Contingency Approach, Reading, Massachusetts: Addison-Wesley, 1974.