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# A contingency framework--The influence of computerized information systems on organizational performance

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## ABSTRACT

*Evaluation is a task most designers, builders, and supporters of information systems agree is significant. However, most information systems evaluations are performance evaluations focusing on the efficiency of the computer system. There is another dimension to the evaluation of the information system that must be considered if computerized information systems (CIS) are to be designed to "fit" an organization: impact evaluations. Impact evaluations are concerned with those effects on an organization which result from the development and use of an information system.*

*The actual task of performing an impact evaluation is hindered by the complexity of the task and by the apparent lack of methods. The complexity is characterized by the difficulties in choosing measures, by the multiplicity and interactions of factors influencing impacts, by the inability to control some of those factors, and by the varying criteria for judging impacts. The lack of methods is characterized by inexperience and insufficient documentation.*

## PROBLEM STATEMENT

### *Problem*

The need for research in the area of measurement of the impact of computerized information systems on the organizational structure is based on the following "problems" in previous research: (1) the majority of the research in system evaluation has focused on the evaluation of system performance, specifically system efficiency and cost reduction; (2) the major studies completed in the actual area of impact evaluation of computerized information systems are over twenty years old -- significant changes have occurred during the last three decades in system design and implementation; (3) the major impact evaluation studies have primarily investigated large firms in the insurance industry -- the results may not be generalized to other industries or to smaller organizations; and (4) the impact evaluations completed so far show inconsistent results.

## *Scope*

As will be shown by the review of literature, much work has been done in the area of the impact of computer systems and/or computerized information systems on the structure of the organization. However, the research has tended to take two main streams of investigation: 1) general case studies conducted after the implementation of the system or 2) cross-sectional studies conducted after the implementation of the system. Both types of studies have relied on manager's perceptions of before-implementation conditions and after-implementation conditions.

In addition to the above problem, previous studies have not attempted to separate the changes in organizational structure due to the actual implementation process from those changes due to the implemented system itself. Nor have researchers attempted to narrow their investigation of structural changes to one specific area--generally, all organizational changes are observed and recorded and an attempt is later made to extract the actual structural changes.

This study will recommend investigating organizations from the systems planning stage through the implementation and post-implementation stages. At each stage the structure of the organization will be the primary target of investigation, while other changes will be noted only in order to check for their possible effect on the organizational structure, effects unrelated to the computerized information system implementation. Not only does the time span in this study differ from previous research, but the proportion of the organization actually studied also differs - the changes in the entire organization will be investigated rather than just one type of division or functional area.

## *Limitations*

By focusing on the structural changes related to implementation of computerized information systems, the objectives of the study centers on finding evidence in support of previous research concerning expected structural changes. Although only supportive evidence is sought (in order to help clear some of the confusion of results in this area), by focusing on a particular type of organizational structure in a simple, stable environment, the results should be easier to verify and duplicate by other researchers than previous studies have been.

Although case studies generally provide the most extensive information concerning organizations, two main limitations are inherent in this approach. First, the amount of time necessary to complete a thorough case study may become a burden to the organizations involved unless substantial groundwork for motivating organizational personnel is completed prior to the start of investigation. Although the amount of time involved in each case may limit the number of organizations willing to participate, a much greater problem exists in finding a sufficient number of organizations meeting the basic criteria set for organizations in this study, including type of organization and type of computerized information system being implemented.

### *Importance of the Study*

If the computerized information systems are to enhance decision making in an organization and increase the effectiveness of the organization, practitioners must be aware of the possible impact such systems may have on their organizations prior to the actual implementation process. *The results of this study will provide information in one area namely structural change necessary for information systems designers to fit the system to the organization.* Future research employing computerized information systems implementation as a manipulating factor will be better able to explore other areas of impact once the area of structural impact has been solidified.

The investigative methodology of combining structural analysis of previously published cases with actual current case studies should provide, not only supportive evidence for the current case studies, but also should demonstrate the effective use of another investigative technique rarely used in organizational research.

## METHODOLOGY

### *Background*

In most areas of organizational analysis there exists conceptual and methodological problems which clouds one's ability to interpret research findings. Most of these problems center on differences in definitions and research methods among the studies.

One of the issues concerns the distinction between functions of decision-making and control. Some studies mentioned earlier central control. Researchers such as Whisler have, in fact, been primarily concerned with the impact of computers on control. Ouchi (Ouchi, 1979) considered *output oriented control and behavioral oriented control*. Before any overall findings can emerge in the area of evaluation of the impact on organizational structure, a distinction of what is meant by decentralization and centralization must be made, as well as an enumeration of the specific components necessary to specify an organizational structure.

Related to the above issue is the use of abstract concepts. As soon as the researcher selects a variable that cannot be measured in the organization's own terms, he/she is reduced to using perceptual measures which can distort reality (Mintzberg, 1979). For example, concepts such as "decentralization" cannot be measured in terms of any single organizational activity - nothing happens in the organization to generate a single valid objective measure of such a concept. Data may be obtained in response to questions concerning the perceptions of managers but the researcher does not get any idea about the connection between the perception he/she has measured and the reality the managers purport to describe.

Another area of confusion in contingency analysis is the problem of multiple contingencies. Using Mintzberg's (Mintzberg, 1979; Mintzberg, 1973) terms, a technical system may call for a bureaucratic structure while the age of the organization may call for an organic one. The researcher may naively measure for either the age or the technical system (but not both) and not realize that he must correct for the other factor. This negligence may lead the researcher to find

statistically insignificant results inaccurately indicating that the contingency factor under study has no relationship with the structure variable.

The resulting conclusion from the above methodological and conceptual problems is that case studies appear to yield a more "accurate" or complete representation of the actual impact of CIS implementation on the structure of an organization than do cross-sectional studies. Case studies could certainly include investigation and evaluation of organizational effectiveness prior to computerized information systems implementation as well as after such implementation. Case studies done over a period of several months, beginning with a pre-implementation organizational study and continuing through a post-implementation evaluation, would be most likely to reveal any links between computerized information system implementation and organizational structure changes than would a cross-sectional study of the organization after computerized information systems implementation.

### ***Proposed Design***

This study will attempt to add clarification to the area of impact evaluations by seeking to identify the problem areas relating to the impact of CIS on the structure or organizations.

A preliminary study will be conducted using structural analysis of published cases to determine preliminary information concerning the impact of the implementation of computerized information systems on small machine bureaucracies.

Using the information found in the preliminary investigation, case studies involving small machine bureaucracies will be completed in order to determine the actual impact that the implementation of computerized information systems have on these organizations.

As a secondary consideration of this research, the feasibility of using structural analysis of cases as a preliminary investigative technique will be explored.

## **A CONTINGENCY FRAMEWORK INFLUENCING THE COMPUTERIZED INFORMATION SYSTEMS (CIS) -- ORGANIZATIONAL CHARACTERISTICS (OC) RELATIONSHIP**

### ***Overview***

The research has the following purposes and aims:

1. making a critical review of literature in the field with efforts to explain differences in findings
2. identifying crucial contingencies influencing the CIS - organizational structure relationship
3. making methodological conclusions upon this basis and
4. design an outline for a research project on the matter

There are some important characteristics for the focused relationship and differences among the studies performed that are mentioned more or less explicitly, and that could be emphasized in a more clear-cut manner.

Computerization could a) be of different kinds and b) be performed on different organizational levels and there are links between a) and b).

### *Computerization Characteristics*

One distinction has to do with the technical aspects: Is it a huge centralized computer ("mainframe"), a minicomputer with a large number of terminals or separate PCs (linked or not linked in a network) installed or is it a combination (Bordoli & Jenkins, 1990)? Obviously the alternative chosen can be linked to factors like organization size (Hunt & Newell, 1971; Robey, 1977; Zannetos & Serbel, 1976), information flow and departmental organization (Rockart, 1988) (many or few workstations, degree of discretion for individuals before implementation of the CIS, etc.). According to conventional wisdom (which of course can be put into question) large computers demanding expertise (sometimes even a department) for operation and support etc. tend to maintain or create a more centralized structure of information flow than PCs not connected in a network. Robey (1977) points out a system can be designed and used for many different functions. Several such functions could be identified. Distinctions could, for example, be made between CIS used as fast calculating devices (Vergin, 1967), for production control (including logistics), operational control, management control (e.g., a financial control system or management information system - cf. Reif, 1968) or strategic decisions (e.g., expert systems). I think Anthony (1965) is still going strong here. For strategic decisions CIS are still rarely used, however.

There is also a time dimension here. The findings referred to originate from studies in the 1960s and 70s in most cases. The fast development of technique and applications makes conclusions for today doubtful and calls for further research, which is exactly what is proposed here. One question is then if there are no more up-to-date studies on the subject than those referred to, can we identify crucial contingencies influencing CIS-organization structure relationship? One central issue may be the purpose of the implementation of the CIS. In the Schultz and Whisler study from 1960 the aim was to centralize, which was also accomplished. Macintosh (1985), Otley (1980), and Waterhouse & Tiessen (1978) refer to the links between information systems and organizational structure as it is a huge research area and looks important for this discussion.

### *Organizational Characteristics*

Another aspect with respect to organization size refers to the information processing capacity of the organization as outlined by Galbraith (1972). For the synchronizing of activities CIS can be used to realize and facilitate one or more of the coordinating mechanisms discussed by Galbraith, (e.g., rules and programs, planning, authority structuring, vertical information systems, and lateral relationships). All these mechanisms have impacts on the degree of (de)centralization. The choice can be administered when implementing a CIS. Taken as examples, rules and programs can be built in the CIS promoting more efficient behavioral control (Ouchi, 1979), while lateral relationships may promote decentralization.

Organization level is of importance (managerial levels). Strategic problems and activities are allocated to top management level, management control mostly to middle management and operational control to the execution of the "physical activities" supervised by foremen and bosses "on the floor of the workshop" (Anthony, 1965). It is reasonable to assume that this distinction is important for the kind of computerization implemented and its consequences for (de)centralization degree.

Though interlinked, the distinction between effects of the information system per se and the computer system ought to be addressed on the one hand, and the mutual connections between context (i.e., conditions in terms of decentralization degree, etc.) ex ante and the characteristics of CIS on the other. Accordingly the direction and magnitude of change (of the degree of [de]centralization) is of interest.

### *Technology Dimension*

The existing literature supports that technology is of significant importance and must be emphasized (Mintzberg, 1973, 1979; Ouchi, 1979; Pettigrew, 1973). However, to me it is not enough to classify technology according to Ouchi (1979). Rather I would use Perrow (1967) for this purpose. Of special interest in relation to the feasibility of designing management control systems and systems for operational control are the coordinating mechanisms used and the degree of discretion for actors on different levels, more specific "production" level ("supervisors") and product and process design level ("technicians"). A CIS can be assumed to reinforce the embedded tendency towards (de) centralization as the technical arrangements facilitate the desired outcome by increased information processing capacity. The coordinating mechanisms can be typified as feedback and planning, representing two main categories and frequently-used mechanisms. Planning corresponds more to behavioral oriented control (Ouchi) than does feedback. Feedback often goes together with large discretion and for those cases it is difficult to design CIS creating substantial degrees of centralization on the two organizational levels in question. Decentralization is a much more plausible outcome in these instances. Using planning as a coordinating device when discretion is small may on the other hand promote the creation of centralization when implementing a CIS.

A research technology is characterized by poor task analyzability and large task variability (i.e., many exceptions). This combination promotes use of feedback as a feasible coordinating tool and large discretion for "supervisors" as well as "technicians." Hence it is difficult to design a CIS creating massive centralization of the organization. Decentralization is more likely to occur.

In a craft technology company, the setting in terms of coordination devices and discretion is similar (to research technology) for "supervisors." Hence the conditions for decentralizations are promising there when implementing a CIS. For the technicians, planning is a feasible coordinating mechanism which together with low degree of discretion makes it likely that control will be exercised in a more centralized fashion.

Engineering technologies and routine technologies are of special interest as insurance companies and banks can be classified in either or both of the two groups depending upon the degree of standardization in their services offered. For the "supervisors," coordination tends to be ac-

completed by planning with constrained opportunities for discretion in both technologies. Consequently, a tendency towards centralization is enhanced as the outcome of a CIS implementation on this level. For the "technicians," the most feasible coordinating mechanism is feedback in an engineering technology, also providing a substantial degree of discretion. Thereby decentralization is promoted by the implementation of a CIS. The degree of discretion can vary from small to large for the "technicians" in a routine technology which can be considered equivalent to a machine bureaucracy in Mintzberg's terms. As planning tends to be the main coordinating device, the outcome is ambiguous here. This makes a case for additional investigations where contingencies can be specified further on a more detailed level.

The reasoning on CIS effects with reference to the Perrow model and the underlying theoretical base is discussed more thoroughly in Macintosh (1985).

The concept "decentralization" should be defined clearly. The understanding of the contingencies would benefit greatly if we could provide at least a provisional definition and specify the definitions used by the several authors referred to. That would improve the chances to judge the validity of explanations to differences in findings. For example, *decentralization* cannot be measured in terms of a single organizational activity. Nothing happens in the organization to generate a single valid objective measure of decentralization. Data may be obtained in response to the questions concerning the perceptions of managers (about decentralization). But the researcher does not get any idea about the connection between the perception he/she has measured and the reality the managers are describing.

For the reader to follow the arguments on existing result shortcomings and reasons for disparate findings, it would be possible to specify the important differences when discussing the reports referred to. Perhaps even a table could be made, specifying the dimensions of importance including assumed contingencies and presenting these categories for each of the studies referred to. Here is an example. (By reason of space I put the studies in the columns and the significant categories in the rows. It is perhaps more logical to transpose the axes.)

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### Computerization and Organizational Characteristics and Outcome Measures

Study 1 . . . . 2 . . . . 3 . . . . 4 . . . . 5 . . . .

#### Significant category or important characteristics

Kind of computerization

##### Technical aspects

Huge centralized computer ("mainframe")

Minicomputer

Number of terminals

PCs

Network

Combination

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Designed functions/Function in use

- Calculating devices
- Production control
- Operational control
- Management control
- Strategic decisions

Available technique and applications when study was made

**Purpose of the implementation of the CIS**

To centralize/decentralize

**Organizational characteristics**

- Organizational size
- Information flow and departmental organization
- Number of workstations
- Span of control
- Expertise (department) for operation and support of system

Mechanisms used for the synchronizing of activities

- Rules and programs
- Planning
- Authority structuring
- Vertical information systems
- Lateral relationships

Study 1 . . . . . 2 . . . . . 3 . . . . . 4 . . . . . 5 . . . . .

Organization levels influenced

- Top management level
- Middle management
- Operational level

Technology/industry

- Craft
- Research
- Engineering
- Routine

- Coordinating mechanisms (feedback and planning) used for "supervisors"
- Coordinating mechanisms (feedback and planning) used for "technicians"

Degree of discretion for "supervisors"  
 Degree of discretion for "technicians"

Behavioral oriented control (Ouchi)  
 Output oriented control (Ouchi)

### Environmental uncertainty

Context ex ante

### **Outcomes**

Operationalization of the concept "decentralization"

Effects of the information system per se  
 Effects of the computer system per se

Direction and magnitude of change (degree of (de) centralization)

Effectiveness measure  
 Effectiveness outcome

### ***Contingency Approach***

The study suggests a contingency approach in the present framework. Varying social settings make a significant difference, structure is "caused" by environmental uncertainty, technology, and size. The contingency theory can be used for explanation of differences in situations, context and outcomes. The reference is very illustrative of contingency theory applicability in AOS (1983).

In some of the literature research we can identify "span of control" used as an independent variable. Technology can be created as a contingency factor for span of control. In attempting the study, the influence of implementing Computerized Information Systems on organizational performance, case studies are suggested (several small case studies). In the literature review (Galbraith, 1972; Macintosh, 1985; Perrow, 1970) technology framework was discussed. The technological arguments can be used to make likely why insurance companies and banks (Whisler, 1970; Reif, 1968; Sollenberger, 1968; Vergin, 1967) have been in the lead on computerization.

Rosengren (1981) and Weber (1985) have described content analysis in the context of large, medium and small organizational performance. The present study attempted to use content analysis (structured) to conduct a pilot study to gain information from organizational case studies. The table describing "significant category or important characteristics of computerization, organization, and outcome measures" is a good attempt to capture the contingency relationships.

The project will be comprehensive in nature. The possibility of considering including ex post cases (where some companies have completed the implementation of CIS when data will be collected) would facilitate the choice of study subjects and broaden the "population" of prospective firms.

### ***Background on Research Methodology***

Another conceptual problem is the lack of effectiveness criteria for the organization studied. According to Robey (1977), it is insufficient to assume that, because an organization adopts a particular structure, such a structure is an effective one for that particular organization. Certainly, contingency theorists make a central issue of this point. To date, few researchers studying the impact of computerized information systems attempt to assess the effectiveness of the adopting organization's structure prior to the system implementation. Such evaluation is most often reserved for investigation after the implementation if the evaluation is completed at all.

Many studies indicate that it is "dangerous" to consider an overall impact of computerized information systems because of the many different functions a system performs (Robey, 1977). For this reason case study research appears to be a more valuable research strategy than survey methods. Case studies permit detailed elaboration of the type of application, the particular functions affected, and the structural effects felt in different areas. As Stewart (1967) observes:

Generalizations about the impact of the computer or management are likely to be misleading. The nature of the impact can vary because of differences in the type of problem that the computer application is designed to help with, because of differences in the organization of the computerized differences in the organization of computerized process and because of differences in the extent and nature of managerial involvement. More is to be gained by taking a particularistic orientation, where contingencies and conditions are specified, than to assert broad generalizations.

Finally, the relationship between contingency factors and structural variables (i.e., Mintzberg's design parameters) are often surrounded by a great deal of confusion. Cases exist where different researchers present diametrically opposed findings (e.g., Whisler versus Schutz), sometimes marshalling a half dozen or more competing arguments between them to explain their findings. According to Mintzberg, a large part of the confusion can be blamed on the research methods that have been relied upon, especially the cross-sectional studies based on perceptual measures. Such methods have generated a host of problems.

Confusion is introduced by the fact that structural change lags situational change. The structural changes resulting from computerized information system implementation will not be immediately observable. Using cross-sectional methods, the researcher cannot verify whether he is capturing the organizational structure that reflects the current situation, which it measures, or the past situation, which it measures, or the past situation, which it does not measure. As Kimberly (1976) notes in his review of the studies of organizational size as a contingency factor,

"cross-sectional measures and conceptualization have led to a static perspective." This problem is compounded in studies of information systems due to the highly dynamic nature of such systems.

Another area of confusion in contingency analysis is the problem of multiple contingencies. Using Mintzberg's terms, a technical system may call for a bureaucratic structure while the age of the organization may call for an organic one. The researcher may naively measure for either the age or the technical system (but not both) and not realize that he must correct for the other factor. This negligence may lead the researcher to find statistically insignificant results inaccurately indicating that the contingency factor under study has no relationship with the structure variable (Markus & Robey, 1988).

The resulting conclusion from the above methodological and conceptual problems is that case studies appear to yield a more "accurate" or complete representation of the actual impact of contingency analysis. An attempt will also be made to control the type of environment, particularly the amount of simplicity and stability of that environment, and the size and type of computerized information system to be implemented in that organization. Typically, machine bureaucracies tend to operate in simple, stable environments, thus allowing the researcher to concentrate on changes in organizational structure that might otherwise be overshadowed by environmental changes and complex contingency interrelationships.

## ***Design***

The research methodology is divided into two areas: 1) a preliminary investigation of computerized information system impact based on a structured analysis of cases and 2) case studies of a uniform group of small businesses based on the criteria developed during the preliminary analysis.

## ***Structured Analysis of Cases***

A structured analysis of cases uses a content analysis schedule to draw relevant information from published case materials. Information from such cases is coded on a content analysis schedule much as a respondent would complete a questionnaire. Only the specific information sought by the researcher is coded. Multiple readings of the cases and multiple case coders are used to develop a broad sample that can be partially checked for reliability and validity. Since the structured content analysis relies on a well-developed content analysis schedule, it is a substantial departure from the typical combination of narrative and enumerative accounts of specific cases.

The content analysis schedule is similar to a questionnaire in that the schedule is designed to estimate specific variables prespecified by the researcher. Information unrelated to the items in the schedule is ignored. When a case provides sufficient information, it is eliminated from consideration much like a blank questionnaire is considered a nonresponse.

The structural content analysis technique will be used to conduct a pilot study to gain information from published cases of organizations that have undergone the computerized information system implementation process. The information obtained will provide preliminary information on implementation such as information on the stability of the environment during the process, typical age and size of the organization, span of control of managers at the outset of the implementation process, and the extent of the centralization and decentralization in the organization during the process. Although relatively few such cases appear to exist (in comparison with other types of cases dealing with organizations), it is felt that enough cases do exist to provide the necessary information for the pilot study. The purpose of this preliminary investigation is to narrow the variability in the main study among the independent or contingency factors, thus making the results of the dependent variable measurements more specific.

### *Case Studies*

Using the preliminary information obtained in the structural analysis of cases, in depth case studies will be completed on small machine bureaucracies. All organizations will be matched as closely as possible for size, environmental stability, and organizational structure. The actual number of cases studied will be determined by the number of organizations meeting the specified criteria that are also willing to subject themselves to such in-depth analysis. The organizations must not only meet the structural criteria as stated above, but they must also be in the preliminary stages of designing a CIS for implementation in the near future.

The actual investigation of the organization will begin at the time of the preliminary design of the computerized information system. At that time the actual organizational structure will be evaluated specifically for *effectiveness*, span of managerial control, and extent of decentralization and centralization in the various organizational components. *Effectiveness* can be measured by profitability, market share, return on investment, etc. The study will continue through the actual implementation of the computerized information system and for a prespecified period of time after the actual implementation (this period of time to be determined from the pilot study as the minimum amount of time necessary to span the gap between computerized information system implementation and the actual observable impact on the organization).

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### APPENDIX 1 Ouchi (1979)

	Knowledge of cause and effect		
Good output measures		Clear	Unclear
	Yes	Both	Output-oriented control
	No	Behavioral oriented control	Ritual

### APPENDIX 2 Elaboration on Perrow (1967)

	Task variability	Small	Large
Task analyzibility		Few exceptions in the production process	Many exceptions
	Poor	Craft Technology	Research Technology
	Good	Routine Technology	Engineering Technology