A METHOD FOR MEASURING SOME PROPERTIES OF INFORMATION SYSTEMS

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Abstract

An approach to measuring information systems properties is developed and tested with data from 38 systems in the same application area (mortgage loan servicing). The results provide support for the notion that general measures of system properties can be made operational and that these measures may be useful to other researchers.

As a complement to descriptive studies of information systems (e.g., Laudon, 1974; Markus, 1981) researchers also preform large scale field investigations of many systems. Examples are Kraemer, Dutton, and Northrop's (1980) study of six application systems in 42 local governments, Turner's (1980) study of one application area in 71 mutual savings banks, Ginzberg's (1975) investigation of 34 projects in 11 organizations, and Lucas' (1981) investigation of 19 application areas in 44 manufacturing plants.

These field studies attempt to relate patterns of system implementation or use among many systems to users reactions to these systems in order to identify underlying principles. For instance, a study may investigate how the level of organizational commitment to information systems in a particular application area is related to task performance in that area (Kraemer, et al., 1980). All of these studies must deal with a common problem; since information system properties can account for variation in dependent variables, such as use, performance, or satisfaction, some method must be found to make these properties operational.

This paper describes one scheme for representing system properties, illustrating some of the issues with which a researcher must contend when developing or selecting operational measures. The purpose of this paper is to introduce the general topic of information system parameter measurement and to promote dissemination and sharing of measures among researchers. First, general considerations in selecting measures are discussed. Then, as an example, a framework is constructed for a particular research setting. These measures are then tested with a sample of routine data processing systems from one application area.

It is not the intent of this paper to advocate a particular measurement framework. No framework will capture all of the aspects of information systems that are of interest to others; a framework should be considered open ended. Furthermore, one concept is not superior to another, except in the context of a particular research question. To the extent we are critical of other frameworks, it is to illustrate pitfalls in constructing measures rather than to promote a particular approach.

GENERAL CONSIDERATIONS

The most important consideration in selecting information system property measures is that the properties must be related to the question under investigation. That is, the information system dimension to be measured should be related to other dimensions in the research model by one or more underlying concepts (Kerlinger, 1973). If system use is being explored then the researcher must ask what aspects of an information system either promote or create barriers to use.

From a practical standpoint, one is severely limited in the amount of data that can be gathered about an information system, although this depends on the survey method used. This is particularly true of large scale field studies where one respondent in a firm is the data source. Because of demands on the respondent, only a few questions about each system may be asked. In addition, the number of cases in the sample limit the number of variables that can be represented in a model, a rule of thumb being that the number of variables should not exceed one tenth the number of cases (Nunnally, 1978). Since only a few of these variables will be information systems variables, the researcher must carefully decide which information system properties are most important for the study.

Sometimes measures of information system properties and use are confused. This occurs when a question contains a reference to both properties and use without independently determining that the system possesses the properties. For example, consistently low responses to a question like 'to what extent do you use ad hoc query features' may be interpreted to either mean respondents are not using that feature or the feature is not present in most systems. Therefore, property measures are precursors to measures of use [1].

The researcher must decide between using measures that are unique to a specific application area or more general measures that apply to many application areas. For example, if the application area being studied is police manpower planning, then the researcher may be interested in whether an allocation model is available in the system (Kraemer et al., 1980). In a broader study it may be sufficient to know whether the system has any modeling capability. Highly specific questions leave little margin for interpretation on the part of the respondent. However, they are subject to error in specification and probably tend to understate a factor because of respondent uncertainty or lack of knowledge. Broader questions permit comparisons of results among different studies, but probably tend to overstate the presence of factors. They also may preclude inferring more specific results. For instance, general system satisfaction may not be a good predictor of specific feature satisfaction.

Because of these constraints on and considerations in selecting information system property measures, the researcher is faced with decisions that influence the quality of his research design and the strength of the implications to be drawn from it.

CONCEPT DEVELOPMENT

This section illustrates the specific issues involved in deciding which information system properties to measure using an example from a study of savings bank systems.

In a study of mortgage loan servicing in mutual savings banks, the author (Turner, 1980) required a method of measuring information system properties. The hypothesis being investigated in the study was that the task environment and productivity of workers would be related to properties of the systems used. It was therefore necessary to decide which aspects of information systems were likely to influence job design and performance. In this situation, general measures were desired that would permit differentiating among systems that performed the same application (mortgage loan servicing [2]) as well as among systems supporting different bank functions.

For operative jobs, the most fundamental aspect of system design is work flow. From this, the extent of labor division and processing organization are derived (Buffa, 1977). Serial work flows suggest specialized jobs (high division of labor) where workers perform short duration, repetitive tasks at fast rates (e.g., key punching, coding). They also suggest systems with batch processing organizations where each procedure step is executed before the next one is initiated and restricted or one way communication between system and operator.

Parallel work flows suggest integrated jobs (low division of labor) where the operator is responsible for a complete work unit (e.g., all activity for a particular group of accounts). These jobs tend to have greater variety and longer task cycles than serial work flow jobs. Parallel work flows also suggest processing systems with on-line organizations, and concurrent or two way communication between operator and system. System work flow might be expected to be related to operator work load and productivity.

A frequent theme in the literature is that both technical and organizational aspects of systems influence workers (e.g., Lucas, 1978). Large processing systems with much concurrent activity place demands on designers to meet performance requirements. Designers respond by using complicated system implementation techniques (for instance, non standard access methods and complex data structures). The resulting systems are hard to operate because of the difficulty of determining the system state from status messages and because connectivity among the many parts makes them interrelated. This, in turn, places demands on operators to learn and understand systems. When technically complex systems fail, they are difficult to back up and recover. Thus, technically complex systems might be expected to be associated with operator work load.

The notion of complexity, usually involving the number of actors and relationships among them, is an important theme in sociology. Information systems may serve large, diverse, geographically dispersed communities. Under these conditions any one operator's job represents a compromise with the needs of other workers. Because of the complexity of the user community, it may be difficult to reach agreement on system changes and the amount of time needed to make a change may be long. Such systems could be thought of as having high organizational inertia. The organizational complexity of a system might be expected to be related to operator satisfaction.

Another aspect of systems likely to influence operators is the degree of functional completeness. Systems may be rich in the functional activities of a particular application area. Since each function requires its own processing routine, a positive association would be expected between functional completeness of a system and its technical complexity. A system's functional completeness might be expected to be related to operator productivity.

Finally, systems differ in what they do or how they are used (Gorry and Scott-Morton, 1971). Systems may be primarily transaction processing (TPS) where they edit data, update files, and provide predefined reports. Or, systems may mostly support decision making (DSS) with facilities for building models, running calculations, and providing ad hoc access to data. Or, they may be some combination of these two types. As Anthony (1965) observes, different types of systems might be expected to be used by different organizational levels. For instance, TPS being used primarily at operational levels.

While a number of writers maintain that it is the way a system is used or the purpose for which it is used that determines it's type (e.g., Keen, 1980), this is frequently difficult to assess. We would argue that what a system does and who uses it are reasonable surrogates for purpose, since purpose is constrained by what a system can actually do. This approach is similar to Alter's (1978) typing of DSSs on the basis of their being more data or model orientated.

For the purpose of the mortgage loan processing study, five information systems properties have been identified as being likely to influence an operators's task environment and productivity. System processing organization is derived from work flow and is related to division of labor and task content. Both technical and organizational aspects of information systems have consequences for workers. Technical complexity is a representation of the technical structure of a system; organizational complexity describes the system's community of users. Functional completeness describes the functional content of the system and type is a representation of the form of the system derived from what it actually does.

A number of researchers have used other information system properties in their studies. Kraemer et al. (1980) developed a measurement framework for information systems that included the degree of automation, the degree of sophistication, the degree of structure, and the organizational context in which the system operated. While some of these measures are similar to the ones used in the mortgage loan servicing study, for instance, the degree of automation is roughly equivalent to functional complexity, Kraemer's measures tend to apply more to the quality of a system, performance of the applications area, and environmental context than to the properties of the system itself. Their measures are also less general than the ones we use.

Lucas (1981) is currently performing a study where he has gathered data on 13 aspects of information systems. He used three categories of measures: those describing the site on which the application runs (including site location and computer type), measures of application size (number of lines of code and transaction volume), and measures of the community served by the application (number of departments that receive output or provide input). Lucas' last two categories are similar to the system technical and organizational complexity dimensions used in this study.

The approach taken to information system property measurement in the mortgage loan servicing study draws heavily on Ginzberg's (1975) work. He introduced the notion of complexity as a way of grouping systems into categories. Ginzberg observed that DSSs were more likely to have analytic capabilities that go beyond data access (e.g., modeling) and to be exclusively on-line than were TPSs. He then scored systems on the bases of their possessing these attributes and used this score to group them into three categories: DSS, one shot models, and TPS. We have expanded on Ginzberg's complexity notion by separating it into three factors believed to be relatively independent descriptors of information systems: processing organization, technical complexity and system type. Two other factors, organizational complexity and functional completeness have been added to capture additional aspects of information systems.

While this measurement framework includes many information systems dimensions likely to be related to the task environment of operators, it does not contain a number of other factors. For instance, descriptors of the implementation process are not included, nor are measures of system quality or output form (Lucas, 1981). Because of the cross sectional nature of the study and the fact that most of the systems were implemented many years prior to the study, implementation measures were not considered to be relevant. The type of system being studied (routine data processing system) suggested that general system properties would be more important than quality in influencing the task environment of operators. Similarly, in this study, the form of system outputs was considered to be less important than general information system properties.

The hypotheses being investigated in this paper are that the five information system properties identified above can be made operational, and that the resulting measures appear to be reasonably valid and reliable [3].

APPLYING THE MEASUREMENT METHOD - AN EXAMPLE

Mortgage loan servicing is one of the primary operational record keeping systems in savings banks. Banks obtain funds from passbook savings, CDs, term deposits, and other interest bearing instruments which they market to customers. They then loan these funds to private or commercial customers in the form of mortgages or other loans.

Mutual Savings Banks differ from Savings and Loan Associations (S and Ls) in that they are chartered by the states in which they operate rather than by the federal government. State banking laws determine the proportion of a Mutual Savings Bank's assets that can be invested in publically held securities. Because of this restriction, banks often have about 60 percent of their assets committed to mortgages.

All Mutual Savings Banks perform basic mortgage loan processing functions including mortgage initiation, posting payments to accounts, following up on delinquent payments, retiring mortgages, handling foreclosure procedures, and preparing management reports. These functions are usually done by a single group, although sometimes one or more of the functions may be done by another group. As of the time of the study (1979), there were 469 Mutual Savings Banks in the country located mostly in the northeastern, mid-atlantic, midwest, and northwest.

As part of a larger study (Turner, 1980), questionnaires were sent to the Operations Directors of the 100 largest banks. The questionnaires were developed and pretested with the assistance of three bank Vice Presidents of Information Systems and their respective staffs. The questionnaire was application area specific and restricted to systems in production.

Completed questionnaires were received from 38 banks, for a 38 percent response rate [4]. This low response rate was due partially to questionnaire length and partially to a lack of familiarity with application system details. The low response rate suggested that there might be bias in the sample. Median and Chi-Square tests on deposit size and bank location [5] indicate that the sample is not biased on this basis.

Measures

Operations Managers were asked to respond to questions about computer based application system(s) that supported mortgage loan servicing in their bank. A five, six, or seven value grounded scale was used, or respondents were asked to provide a numeric value, such as a percentage (copies of the questionnaire are available from the author).

Processing Organization (PORG)

It was postulated that systems could have processing structures that ranged from almost completely batch processing to almost completely on line, or some combination of the two [6]. Operations managers were asked to indicate the general processing structure of the application system (question 9). This is similar to Ginzberg's measurement approach.

A particular processing structure implies certain restrictions on operator-system communication; batch systems have mostly one way communication with operators in that they require structured inputs, provide predefined outputs, and only provide feedback after execution. On-line systems permit users to have a two way dialogue with the system and to obtain immediate feedback. Respondents were asked to describe the communication between user and system on a scale that ranged from 'one way' to 'two way' (question 14).

Technical Complexity (TCPX)

The number of modules in an application system determines the number of possible internal communications paths. Transaction activity is a factor in establishing internal buffer size, queueing requirements, and internal timing. Data base size is related to key to physical storage location translation techniques. All these factors are representative elements of an application system's technical complexity.

Respondents were asked to indicate the number of programs or modules in the system (question 11), the number of transactions or input messages received per week (question 12), the proportion of the data base or master file changed per week (question 13), and the physical size of the data base or file (question 10).

Organizational Complexity (OCPX)

Systems may be customized for one user, or they may serve many heterogeneous users. The number of different groups that interact with a system and the number of different geographic locations that require service from a system are descriptors of user community homogeneity. Further, it was reasoned that systems with a large number of entities would require proportionally more workers and that this would be another indication of user community complexity.

Respondents were asked to indicate the number of organizational units that received direct output from the system (question 16), the number of different geographic locations that received direct output from the system (question 17), and the number of logical records contained in the system (question 19). This is similar to the approach taken by Lucas (1981).

Functional Completeness (FCOMP)

The number of application area functions included in a system is a measure of the functional completeness of that system. Respondents were asked to indicate the degree of completeness of the application system (question 8). This is similar to the approach used by Kraemer et al., (1980).

System Type (STYP)

Systems differ in the processing functions they perform. Ten prototype data processing functions were identified; five suggestive of TPSs, four suggestive of DSSs, and one common to both system types. Respondents were asked to prorate the cost of running the application system for the past year among the prototype data processing functions (question 6).

Functions indicative of TPSs included data entry and edit, file update, end of day file and report preparation, end of quarter or year processing, and standing reports. DSS functions included running formal models, ad hoc inquires, complex calculations, and one time reports. File back up and recovery was prorated among the two system types. The values for TPS were aggregated and a value ranging from 0 to 99 was assigned indicating the extent to which the application system exhibited TPS properties.

Systems also differ in the levels of an organization they support. Respondents were asked to prorate the direct use of system output among three organizational levels: operational, managerial, and executive (question 7). A variable was created, with a range of 0 to 99, that indicated the proportion of system output used by the operational level of the organization.

Discussion

One would expect routine data processing applications, such as mortgage loan servicing, to exhibit the properties of a classical DP system, that is, a TPS (Gorry and Scott-Morton, 1971). The data supports this notion (refer to table 1). On the DSS/TPS scale (TPS), the mean rating is 87 percent, indicating that the system performs

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PLACE TABLE 1 ABOUT HERE (variable statistics)

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mostly transaction processing functions.

Another characteristic of TPS is that they are supposed to be used mostly by operations level personnel. Again, the data support this notion with the operational level of banks (OPUSE), on the average, accounting for 75 percent of the system use.

What was not expected, however, was for these systems to be more than 50 percent on-line [7]. TPSs are more likely to be batch processing than on-line systems (Ginzberg, 1975). The finding of the mean value of processing structure (PSTR) being more than 50 percent on-line suggests that either the question was not understood or the systems are atypical. One explanation for this finding is that mortgage loan servicing involves a lot of data entry. Possibly this data entry is being done by key to disk systems and is enough to shift the mean value of processing structure from batch to on-line. Another possible explanation is that some banks using service bureaus may have confused remote access (which would probably still be a batch processing structure) with on-line computing [8]. One way of investigating this possibility is to inspect the relationship between a banks use of outside computer services and the processing structure of their mortgage loan processing system.

Table 2 presents a cross tabulation of external computer

PLACE TABLE 2 ABOUT HERE (ex comp use by proc org crosstab)

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use versus processing organization. Banks that obtain their computer resources externally (i.e., from a service bureau) tend to have on-line systems (11 out of 15 systems) while banks that have systems that run on internal machines tend to have batch systems (13 out of 20 systems). This supports the conjecture that respondents confused remote entry with on-line systems since it unlikely that service bureau mortgage loan processing systems would have significantly different processing structures than bank developed systems. This issue should be clarified in future studies and the question probably should be reworded. It also illustrates the ease with which questions about systems can be misunderstood and the need to gather information about factors (in this case, using an external service bureau) that could alter the interpretation of responses.

Communication between user and system is mostly one way (about 85 percent one way communication) which is consistent with our expectations about TPSs having primarily batch processing organizations and inconsistent with our finding of the systems being more than 50 percent on-line. This is another reason to be skeptical of the data on processing structure.

The systems are quite functionally complete, the mean value of 4.0 indicating that most major business functions are included in the systems. This correlates with an independent measure of the number of functions performed by each servicing group ($r=.22$, $p=.09$, $n=38$) [9] suggesting good validity for the measure. Kraemer et al., (1980) concluded in their study that the best predictor of area performance was the level of automation, although it is not clear from their results whether a high level of automation results in high performance or whether high performing groups request systems with more functions [10]. The implication being that this measure may be important in predicting system impacts.

We can summarize the results of applying the information system measurement technique as follows. Operational measures for a set general information system properties were constructed. Data gathered on 38 mortgage loan processing systems support the reasonableness (content validity) of most of the measures. The only exception was processing structure (PSTR) and there is some evidence that respondents may have confused remote entry with on-line systems.

Table 3 provides the pearson product moment correlation

PLACE TABLE 3 ABOUT HERE (var corr matrix)

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coefficients for the variables. Several clusters of variables suggest indices, particularly NMOD (number of modules - 6), PDBSIZE (physical DB size - 7), NTRANS (number of transactions - 8), and PCDBCH (percent DB change - 9) as well as NOUT (number of units using output - 10), NLOC (number of locations receiving output - 11), and LDBSIZE (logical DB siz. 12).

Functional complexity is positively associated with NMOD, number of modules in the system. This appears reasonable since systems with more functions should have more program modules.

Indices were constructed by either scaling or collapsing scales when necessary and averaging variables across the case. Table 4 provides index statistics and table 5 shows association among

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PLACE TABLE 4 AND 5 ABOUT HERE (index stats and corr matrix)

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variables. Cronbach's Alpha, a measure of the consistency among variables, was used as an indication of index reliability. While three of the indices are significant, two, PORG and STYP, are not. The negative value of Alpha for STYP suggests that the component variables, TPS and OPUSE are inversely related even though the means of both variables are in the expected region. PORG contains the measure PSTR we all ready have reason to be sceptical about.

Table 6 presents a cross tabulation of TPS with OPUSE. From

PLACE TABLE 6 ABOUT HERE (TPS and OPUSE crosstab)

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the table it can be seen that most (14 or 52%) of the systems are in both high TPS and high OPUSE categories. Thus, the data suggest that what ever inverse association exists between these variables, it involves a relatively small number of cases at the other end of both scales. While the sample data do not permit combining these two variables together into an index, a more diverse set of systems with greater variation on these dimensions may yet produce a reliable scale.

Except for the correlation (r=0.29) between technical (TCPX) and organizational (OCPX) complexity, the scales are independent of each other. Some relationship between these indices would be expected; systems serving a more complex user community would probably tend to be technically complex.

CONCLUSION

Our objective was to develop a method for measuring the properties of information systems and to evaluate it using empirical data on one type of system. We desired to find measures that would portray differences among systems performing the same functional activity as well as permit comparisons of systems across application areas.

Systems were conceived as having both technical and organizational components. Processing organization is a representation of the system work flow on which job design is based. Technical complexity is a measure of system size and internal structure. Functional completeness is a measure of the degree to which application area functions are included in the system. Organizational complexity is a representation of the user community supported by the system. System type describes what processing functions the system actually performs.

Based on testing with data from one class of TPS (mortgage loan servicing systems), the measures exhibit reasonable reliability and validity. Exceptions are the measure of system type. While these results are encouraging, the measurement approach can not be considered valid until it is tested with other types of systems. Specifically, we would like to see whether the measures appear as reasonable when applied to a DSS and if a DSS can be distinguished from a TPS on the basis of the measures (convergent and discriminate validity).

We have shown that information system measures can be constructed and tested. Whether these particular measures are useful depends on interpretation of the results of the studies for which these measures were constructed [3]. Hopefully, other researchers will become interested in this subject and a family of validated measures similar to those used in organizational theory will evolve (c.f., Handbook of Organizational Measurement, Price, 1972). New measures of important information system properties should be developed and existing measures refined. Researchers will then have a legacy upon which to draw and will not be faced with creating their own measures each time they perform a study of information systems.

Our recommendation to other researchers is that they identify those aspects of information systems likely to be related to issues under investigation. It may turn out that there is more similarity among these information system concepts than is now apparent. Hopefully, a relatively small number of important concepts will emerge. When a similar concept measure exists, it should be used in order to reduce proliferation of measures, to take advantage of established validity and reliability, and to promote comparisons among studies. However, when a measure of a concept does not exist, researchers should move forward boldly and establish new measures. These measures (as well as the supporting construction and validation techniques) should be communicated to the IS research community.

There are many notions about information systems. Translating these notions to concepts and then making them operational forces the researcher to think in concrete terms. This can only clarify our work and reduce misinterpretation. As Kerlinger (1973, p. 32) observes:

The importance of operational definitions can not be overemphasized. They are indispensible ingredients of scientific research because they enable researchers to measure variables and because they are bridges between the theory - hypothesis - construct level and the level of observation. There can be no scientific research without observation, and observations are impossible without clear and specific instructions on what to observe.

FOOTNOTES

[1] - For a interesting discussion of the methodological issues involved in measuring computer use see Ginzberg (1981).

[2] - Mortgage loan servicing was selected to study because it was representative of routine data processing activity and because each bank had a recognizable mortgage loan servicing function.

[3] - Those readers interested in the results of the study on which the selection of these properties are based should read Turner (1980) or Turner and Karasek (forthcoming). Processing organization (PORG), technical complexity (TCPX), and organizational complexity (OCPX) all had significant associations with intervening or dependent variables.

[4] - When missing data is taken into account, the number of cases drops to 27.

[5] - The sample was dichotimized on the basis of a bank being located in or outside of New York City.

[6] - It is not uncommon to find on-line data entry and batch night file update.

[7] - The mean value of PSTR is 3.2. A value of 3.0 is 50 percent batch processing and 50 percent on-line.

[8] - Some banks have remote job entry (RJE) links to service bureaus. Periodically, the bank calls into the service bureau and transmits data which is stored in the input queue until the update program is run. Output for the bank is held in the output queue until the bank calls in to request it.

[9] - The heads of each mortgage loan servicing group were asked whether each of 11 functions were performed by that group.

[10] - Our study found no significant association between functional completeness (FCOMP) and group performance as measured by the number of loans serviced per worker or level of arrears.

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TABLE 1

MORTGAGE LOAN SERVICING SYSTEMS VARIABLE STATISTICS

No.	Question No.	Variable	No. Cases	Mean	STD Deviation	Index
1	9	Processing Structure	38	3.2	1.8	PORG
2	14	Communication	37	1.5	1.1	PORG
3	6	TPS Processing Characteristics	27	86.8[1]	14.9	STYP
4	7	Operational Use	37	74.5[1]	17.6	STYP
5	15	Functional Completeness	38	4.0	0.9	-
6	11	Number of Modules	31	3.1	1.3	TCPX
7	10	Physical DB Size	33	3.0	1.3	TCPX
8	12	Number Of Transactions	33	3.1	1.0	TCPX
9	13	% DB Change	33	2.6	1.1	TCPX
10	16	Number Units Receiving Output	37	2.6	0.9	OCPX
11	17	Number Locations	37	2.3	1.4	OPCX
12	19	Logical DB Size	34	2.7	0.9	OCPX
13	72	Others Use Computers	1407	4.0	1.3	CUSE

Note: 1 - means in percentage

TABLE 2

CROSS TABULATION OF
PROCESSING ORGANIZATION OF THE SYSTEM VS
EXTERNAL COMPUTER USE

Inside Lo ------------------------------------> Hi Outside

Processing Organization		0 - 10	11 - 35	36 - 69	70 - 89	90 - 100	Total	
On-Line Hi	5	5 13.5%	0 0	2 5.4%	3 8.1%	6 16.2%	6 29.7%	95% on-line
Processing Organization	2-4	4 10.8%	1 2.7%	0	3 8.1%	2 5.4	10 27.0%	95% Batch
Batch Processing Lo	1	8	2 5.4%	0	0	1 2.7%	11 43.2%	
		17 45.9%	3 8.1%	2 5.4%	6 16.2%	9 24.3	37 100.0%	

External Computer Use

TABLE 3
VARIABLE CORRELATION[1] MATRIX
MORTGAGE LOAN SERVICING SYSTEMS

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1 - Proc Structure	-											
2 - Communication	.26	-										
3 - TPS Proc Char	-.10	.04	-									
4 - Operational Level Use	-.01	.02	-.23	-								
5 - Funct Completeness	.32*	.09	.07	.03	-							
6 - No. Modules	.01	.07	.00	.23	.32*	-						
7 - Physical DB Size	.34*	.08	-.10	.31*	.39*	.54*	-					
8 - No. Trans	-.08	-.01	-.12	.44*	.26	.68*	.62*	-				
9 - % DB Change	.10	-.08	-.15	.33*	.10	.53*	.42*	.45*	-			
10 - No. Receive Output	.21	-.07	-.03	.22	.04	-.01	.33*	.25	.14	-		
11 - No. Loc Output	.14	.09	-.08	.15	.19	.16	.13	.27	-.08	.48*	-	
12 - Logical DB Size	-.04	-.03	-.16	.38*	.18	.36*	.37*	.48*	.41*	.16	.49*	-

Notes:

1 - Pearson Product moment correlations
2 - * - Significant at the 0.05 level or better
3 - Variables scaled low to high
4 - N between 37-27

TABLE 4

INDEX STATISTICS

MORTGAGE LOAN SERVICING SYSTEMS

No.	Index	No. Cases	Mean	STD Deviation	Alpha	SIG
1	PORG (Processing Organization)	37	2.3	1.3	.41	NS
2	STYP (System Type)	27	3.2	0.4	-.59	NS
3	TCPX (Technical Complexity)	28	2.9	1.6	.82	.05
4	OCPX (Organization Complexity)	37	2.4	1.5	.61	.1

TABLE 5

INDEX CORRELATION MATRIX
MORTGAGE LOAN SERVICING SYSTEMS

Index	1	2	3	4	5
1. PORG (Processing Organization)	-				
2. STYP (System Type)	-.15	-			
3. TCPX (Technical Complexity)	.16	.30	-		
4. OCPX (Organization Complexity)	.17	.18	.29	-	

Notes

1. Pearson Product Moment Correlation
2. - * - Significant at the 0.05 level or better
3. Variables scaled low to high
4. N between 37-27

TABLE 6
CROSS TABULATION OF
TPS PROCESSING CHARACTERISTICS VS
OPERATIONAL LEVEL USE
MORTGAGE LOAN SERVICING SYSTEMS

OPERATIONAL LEVEL USE (Lo -->Hi)

TPS Processing Characteristics		0 - 24	25 - 49	50 - 74	75 - 99	Total	
Hi	5.0 - 4.0	1 3.7%	1 3.7%	8 29.6%	14 51.9%	24 88.9%	75% TPS
	3.9 - 3.0	0	0	0	2 7.4%	2 7.4%	50% TPS
Lo	2.9 - 2.0	0	0	0	1 3.7%	1 3.7%	25% TPS
		1 3.7%	1 3.7%	8 29.6%	17 63.0%	27 100.0	