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ABSTRACT This paper presents a comprehensive framework for the evaluation of online bibliographic retrieval services and provides an example of its use with the Educational Information System for Ontario (EISO). A systems approach, incorporating traditional categories of input, output, process, and feedback, is used to develop the model; in its application, particular emphasis is placed upon assessing relationships between variables of interest at different stages in order to measure EISO user satisfaction. Methodology is described, including the sociological variables used to characterize EISO users; path diagrams and data tables are provided; and findings are discussed. (Author/JD)

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A Path Analysis Model Using Sociological
Variables to Examine User Satisfaction
- with On-Line Education Information
Systems*

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A Path Analysis Model Using Sociological Variables to Examine User Satisfaction with On-Line Education Information Systems

Accompanying the widespread introduction of on-line bibliographic retrieval services has been a recognition of the need for their careful evaluation. Several approaches have been taken to this problem including price-demand analyses (Cooper and DeWath, 1977), organizational studies (Wax, 1976), data-base evaluations (Lancaster, 1969), and end-users (Brickley and Trohoski, 1974). However, because these studies have taken relatively narrow perspectives, they have failed to assess the inter-relationships of various components of the services in question. In order to facilitate this type of analysis, a comprehensive framework for the evaluation of on-line bibliographic retrieval services is needed. The purposes of this paper are to present one such framework, and to provide an example of its use.

A systems approach was used in developing the framework, incorporating the traditional categories of input, process, output, and feedback. In its application, particular emphasis is placed upon assessing the relationships between variables of interest at different stages, such as input and output, while controlling for the effects of intervening variables. It is hoped that in achieving a better understanding of such relationships, those operating search services can make more rational decisions about policies and procedures.

Systems Framework for Evaluation

In the evaluation framework proposed here, a systems approach is used to describe the cycle of activities that occur whenever an on-line bibliographic retrieval service responds to a user's request. In doing so, four basic questions must be answered. What inputs are required? What processes take place? What outputs are produced? What feedback

occurs at each stage? A description of the sequence of events that occur during a search cycle provides answers to these questions.

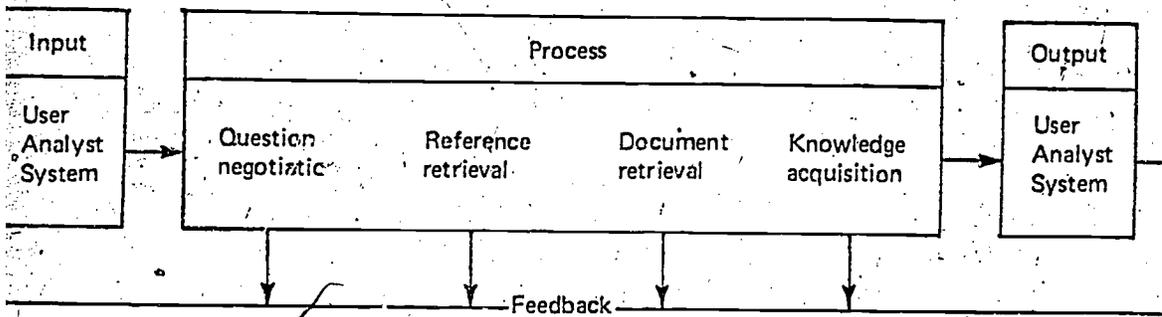
The search cycle begins with the submission of a request by a user to the search analyst, a specially trained reference librarian. They then "negotiate" the question, until it can be restated in a form that the search analyst can employ to develop a search strategy that can be used to retrieve relevant citations from appropriate data-bases such as the Educational Resources Information Center (ERIC) or the Ontario Educational Research Information System (ONTERIS) files. The analyst then queries the data-base(s) using a retrieval system such as Lockheed Information System (LIS)'s DIALOG, System Development Corporation's (SDC)'s ORBIT, or United Nations Educational Scientific and Cultural Organization (UNESCO)'s CDS/ISIS. When combinations of terms are entered, the number of relevant citations and a few sample citations are printed. If the citations are judged to be relevant to the client's question, the complete bibliography is printed offline and mailed to the requestor.

The user, on receipt of the bibliography, reviews its contents and makes a personal assessment of its relevance and thoroughness. As a result, a request for original documents may be made. When these are delivered and read, the search cycle, as we define it, is complete.

Feedback may occur at almost any stage of the search cycle. During question negotiation the search analyst makes inquiries and suggestions about the search topic, and the user responds. During the retrieval of references, a discovery that an excessive number of citations have been located, that citations are not relevant to the topic, or that other terms should be used, may cause negotiations to be reopened and the search strategy altered. Even at the end of the entire cycle, feedback occurs when an informed and satisfied (or uninformed and dissatisfied) user returns an evaluation questionnaire.

This cycle of activities forms the system portrayed in Figure 1. At each stage, three "actors" are involved: the user, the search analyst, and the retrieval system. Each of the three is the referent for a number of variables which describe the characteristics of the search service's inputs, the nature of its processes, and qualities of its outputs.

FIGURE 1
INFORMATION SYSTEM MODEL



This systems framework provides a temporal sequence to events occurring during a search cycle, thereby allowing the evaluator to make reasonable inferences about cause and effect relationships. This is important, since policy makers must have a realistic idea of the ultimate effects of different decisions about inputs and the organization of processing activities. In addition, the framework suggests a categorization scheme for variables according to their roles as measures of inputs, processes, or outputs.

Application of Model

The remainder of this paper describes the evaluation of one aspect of the Educational Information System for Ontario (Auster and Lawton, 1976; Lawton and Auster, 1979) using the systems framework portrayed in Figure 1. The purpose of this application is to determine to what extent a client's personal and professional background is related to his or her satisfaction with EISO. This assessment should provide an indication of those identifiable sub-populations of users whose needs are not currently being satisfied as fully as are those of others.

Sample

The population for this study is the universe of all 371 searches requested from EISO between May 1, 1976 and April 30, 1977. Though some data were available on all searches, the present analysis was restricted to those which had been run on ERIC and for which the requestor had returned an evaluation questionnaire. The total number was 148 (40% of all searches), but missing responses on some variables result in a smaller number being used for some analyses.

Virtually all searches were placed by users from the professional education community in Ontario, which EISO was designed to serve. In general, 40% of EISO's users were from school boards, 40% were from OISE, 10% from other universities and faculties of education, and 10% miscellaneous. Approximately 30% of the users reported that they were engaged in administration, 17% in teaching, 12% in research, 18% in graduate study, 7% in librarianship, and 14% other.

Methodology

Path analysis was selected to analyze the relationships among input, process, and output variables because it provides a method of testing the validity of causal inferences for pairs of variables while controlling for the effects of other variables (Nie, 1975, pp. 383-397). In addition, path diagrams provide heuristic portrayals of systems relationships which are well suited to the systems framework used to organize the variables in this study.

The analytic technique used in this investigation follows the practices advocated by Goldberger (1970). In particular, the path coefficients presented here are the standardized regression coefficients resulting from regression of the dependent variable in question on those variables directly affecting it, and those alone. In cases where there is but one predecessor variable, the path coefficient is identical to the zero-order correlation coefficient; in other cases it is equivalent to the partial correlation coefficient of the dependent variable on the standardized predecessor variable controlling for other variables directly affecting the dependent variable.

The amount of unexplained variance in any dependent variable X_i is assumed to be accounted for by hypothetical "error" variables denoted by e_i . The correlation between e_i and X_i is equal to $\sqrt{1 - R^2}$ where R^2 is the multiple correlation between X_i and all the predecessor variables directly affecting it.

Not all relationships for which no causal inferences are plausible may be omitted. Second, relationships between exogenous variables (portrayed at the left of the path diagram) are typically unanalyzed, though they are sometimes controlled for if they are considered to interact with one another. Finally, correlations among the e_i are assumed to be zero and remain unanalyzed.

Path analysis requires three principal assumptions which may or may not be valid. First, all relationships are assumed to be linear; second, relationships are assumed to be additive; and third, it is assumed no interactions (i.e., multiplicative effects) exist among variables. As well, some authors would hold that the variables are assumed to be measured on a ratio scale with some fixed unit of measure.

For the dichotomous variables, such as sex, and those measured in standard units of measure, such as the turn-around time, none of the assumptions would be violated. Those measured on Likert scales, such as satisfaction, may violate assumptions as to linearity and unitary measurement. However, because monotonic, if not linear, relations are expected for all relationships involving these variables, violation of the first assumption would, at worst, cause the relationships to be underestimated.

Collection of Data

The major sources of data used in these evaluations were a User Evaluation Questionnaire and a Data Sheet completed by the search analyst. In all, 131 different variables were regularly collected for each search that was completed. Selection of these items was guided by key concepts in the disciplines of sociology, psychology and economics. Most were drawn from the literature of previous evaluation studies but only those that were defensible measures of roles, status, knowledge, opinion, cost, price or demand were included. Where gaps appeared, additional items were developed.

Measurement of Variables

Descriptions of the items used to measure the variables included in the analysis which focuses on the influence of the sociological background of clients on their level of satisfaction are listed in Table 1.

The first five variables in Table 1 are input variables related to the backgrounds of clients. All are dichotomies coded 1 or 0. LOCATION refers to the location of the organization in which the user was employed or enrolled as a student. SEX needs no explanation. ORGANIZN is the organization in which the user was employed or enrolled as a student. The PURPOSE of the search refers to the use made of the search, whether it was for professional or academic purposes. PROFROLE indicates the user was in an administrative or non-administrative professional position.

TABLE 1
 VARIABLES USED IN EVALUATION OF USER'S BACKGROUND
 AND LEVEL OF SATISFACTION

Variable [†]		Item Description and Coding	
Number	Name	Description	Coding
1	LOCATION	Metropolitan Toronto	1
		Outside Metro Toronto	0
2	SEX	Female	1
		Male	0
3	ORGANIZN	Student or staff of OISE	1
		Non-OISE	0
4	PURPOSE	Purpose of search:	
		Non-academic	1
		Academic	0
5	PROFROLE	Professional role:	
		Administrative	1
		Non-administrative	0
6	SYSTEM	Search system used:	
		SDC ORBIT	1
		LIS DIALOG	0
7	SATIS6 [§]	Overall satisfaction	
8	SATIS1	Satisfaction with publicity materials and directions	
9	SATIS2	Satisfaction with convenience and helpfulness	
10	SATIS3	Satisfaction with timeliness of service	
11	SATIS4	Satisfaction with quality of technology	
12	SATIS5	Satisfaction with value of bibliography	

[†]Variables 1 through 4 and 6 are recorded by search analyst on data sheets. Variables 5 and 7 through 12 indicated by client on User Evaluation Questionnaire.

[§]See Table 2, for complete list of satisfaction items and construction of subscales.

The final input variable, SYSTEM, refers to the computer search service that was used in executing the search: SDC ORBIT or LIS DIALOG. Although this variable is a system rather than user input, it was included in the analysis because differences between the two influenced the selection of the system used in conducting searches. In particular, the direct mail service provided by SDC, which allows the computer-produced bibliography to be sent directly to the client from SDC, meant that this service might be preferred for users located some distance from Toronto.

User satisfaction with various aspects of the search service were measured by five subscales (SATIS1 to SATIS5) consisting of scales that included satisfaction with publicity materials and directions (SATIS1), with convenience and helpfulness (SATIS2), with timeliness of service (SATIS3), with the quality of the bibliography (SATIS5).

Individual items used in constructing subscales are reported in Table 2 and include those used in the scale used to measure overall satisfaction (SATIS6). The latter scale used five items selected from the subscales; not all items were included because many clients had not been exposed to all aspects of the service and therefore had failed to respond to some items. Instead, only those items referring to matters to which all clients had been exposed were included in the scale.

Reliability coefficients for the six scales were .80, .62, .78, .27, .79, and .80 respectively. Overall, these coefficients are sufficiently high for the scales to be used in assessing the satisfaction of EISO's users with the service.

The fact that all input variables are dichotomies calls for special care in interpreting correlation or path coefficients between these and other variables. For example, a positive correlation between location and organization would imply that users from Metro Toronto (coded 1) tend to be associated with OISE (also coded 1), whereas those from outside Toronto (coded 0) tend to be associated with other institutions (also coded 0). Where the second variable is continuous, as in the case of satisfaction, a positive correlation implies high satisfaction is associated with the trait coded 1 and low satisfaction with the trait coded 0. In the case of the relationship between, say, location and satisfaction, a positive correlation would imply that users from Metro Toronto (coded 1) were more satisfied than those from outside Toronto (coded 0).

TABLE 2
ITEMS USED IN SIX SATISFACTION SUBSCALES

Question: Please indicate your satisfaction with the following elements of your EISO search.

SATIS1 - Publicity Material and Directions

- a. Convenience of arrangements and adequacy of directions
- b. Accuracy and comprehensiveness of publicity materials
- c. Adequacy of directions for ordering materials

SATIS2 - Convenience and Helpfulness

- a. Convenience of arrangements and adequacy of direction
- b. Helpfulness of search analyst

SATIS3 - Timeliness of Service

- a. Time taken to deliver bibliography
- b. Time taken to deliver materials from EDRS
- c. Time taken to deliver materials from EISO

SATIS4 - Quality of Technology

- a. Length of bibliography
- b. Readability of microfiche copies
- c. Availability of microfiche readers

SATIS5 - Value of Bibliography and Materials

- a. Bibliography itself
- b. Materials located via bibliography

SATIS6 - Overall Satisfaction

- 1a, 2b, 3a, 4a, 5a

Note: Scale scores were adjusted for the number of items by dividing total scale scores by the number of items. Scale: Low = 1; medium = 2; high = 3.

Sociological Input Model

Who are EISO's users and how does their identity affect their levels of satisfaction with the service? As suggested above, these are important questions which reflect the success of the service in achieving its goals. By implication, if one kind of client is less satisfied than another, changes in the service might be necessary in order to raise their level of satisfaction.

The question as to the users' identities is answered here in terms of the two sociological concepts noted earlier, role and status. We view these as characteristics that clients bring with them to their encounter with the search service, and as such represent inputs to the system. Since status is itself in large part an attribute associated with a given role, it is difficult to measure these two aspects separately. Most of the variables we have selected reflect, to one degree or another, both the role and status of the individual client.

Description of Model

The image guiding the selection of sociological variables to characterize EISO's users was that of a professional educator working or studying at some location in Ontario. The user's geographic location (LOCATION) and sex (SEX) were viewed as two background variables of possible importance. Location is a factor of considerable policy importance since one of EISO's major purposes is to make the resources of a major research library available to educators throughout the province. To be sure, current limitations of automated retrieval systems make this a distant goal, yet the quick retrieval of both references and original documents in RIE, CIJE, and ONFRIS does provide access to a large and important body of knowledge. While the sex of a client is not, in and of itself, of primary importance, it is a factor known to be related to the role of professional educators; in particular, relatively few women currently hold administrative positions within Ontario's educational system. Thus, sex was viewed as a background variable that should be controlled.

A client's organization (ORGANIZN), professional role (PROFROLE) and purpose in conducting the search (PURPOSE) were viewed as the major

characteristics defining his or her role. Though the coding scheme used in this analysis greatly simplifies the original categorization scheme, we originally determined whether or not a user was in any one of 29 different types of organizations or units; e.g., preschool, public school board, separate school board, private school, College of Applied Arts and Technology, faculty of education, etc. Professional roles were classified into 14 categories; e.g., administration or supervision, teaching, pupil personnel services, research, etc. Finally, the purpose of the search, which we saw as an objective in large part determined by the individual's organization and role, was initially placed in one of eleven categories; e.g., keeping abreast of the field, class assignment, preparation of a bibliography, curriculum development, etc.

To illustrate the connection among PROEROLE, ORGANIZN; and PURPOSE, consider two typical users. One might be a full-time graduate student at a faculty of education conducting a literature search for a class assignment; the other might be a senior administrator in a public school board seeking information about curriculum guidelines.

Another input variable related to the service's activities is the particular search system used (SDC's or LIS's). While not a sociological variable, this characteristic (SYSTEM) is included as a factor of possible importance because one of the systems SDC, offers the capability of mailing bibliographic output directly to the client. For those clients in remote locations, therefore, SDC may be a preferred service in terms of their satisfaction with the service's turnaround time.

Finally, the output variable of interest is satisfaction, which was measured by 12 items relative to five distinct aspects of the service: publicity materials and directions (SATIS1), convenience and helpfulness (SATIS2), timeliness of service (SATIS3), quality of technology (SATIS4), and value of the bibliography (SATIS5). A subscale of six items was also derived to measure overall satisfaction (SATIS6).

Organizing the variables described above into a formal path model results in the diagram pictured in Figure 2. LOCATION and SEX are background variables whose relationship to one another remains unanalyzed, but whose effects on other variables are considered. Location may affect

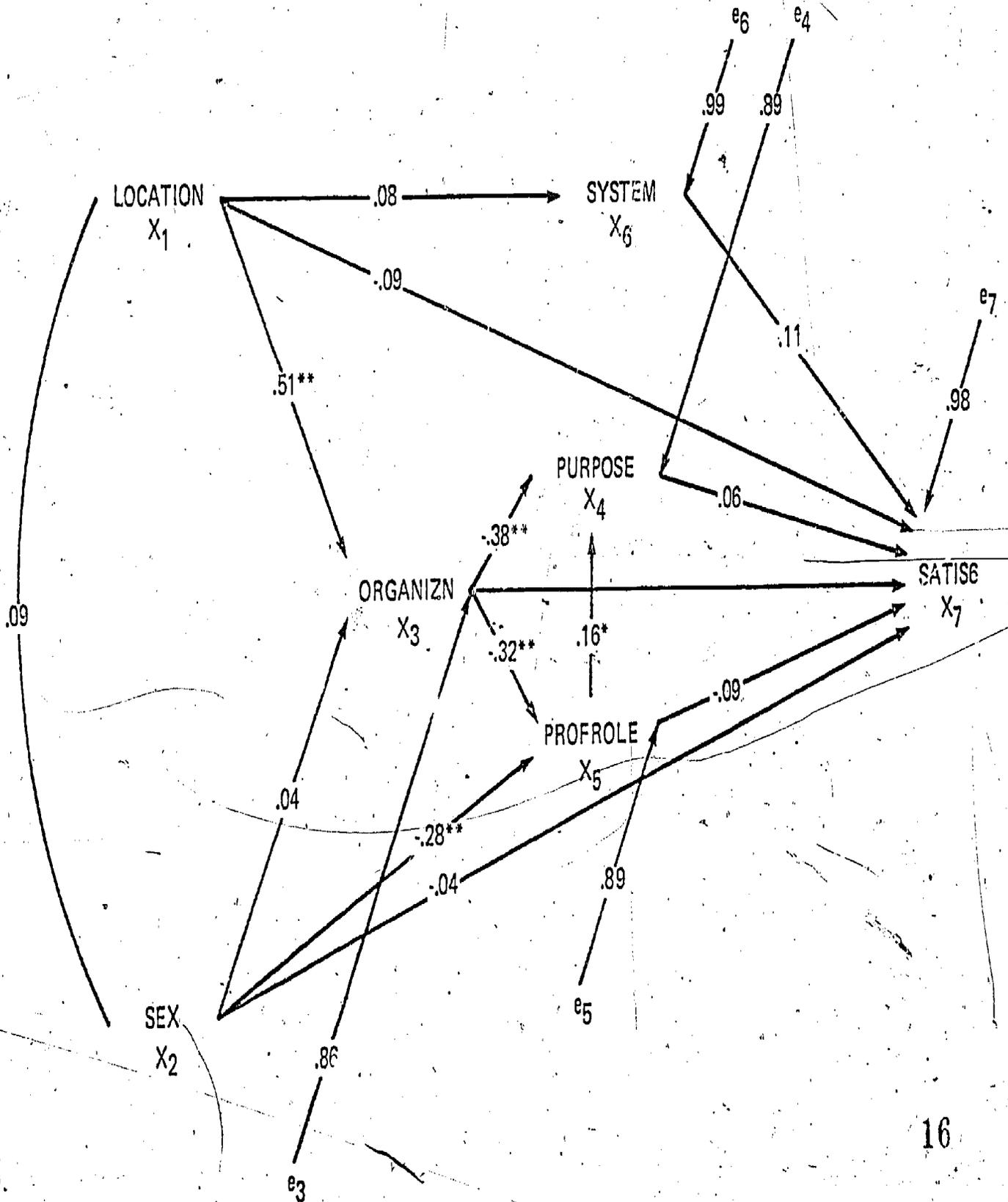
satisfaction both directly and indirectly. One indirect path is through its influence on the system used. The second effect is via its influence on the type of organization from which the client comes. Sex, too, may affect satisfaction both directly and indirectly. The indirect effects may be through the type of organization or the individual's professional role.

Organization stands as a key intervening variable between the background variables and satisfaction, on which it may have a direct effect. However, it may also have indirect effects via the individual's professional role and the purpose of the search. Similarly, professional role may affect satisfaction directly or through the purpose of the search, while the latter variable is postulated to have only direct effects.

It may be noted that other paths than those noted are possible; however, we are including only those which seem logical given known relationships and the meaning of the variables. Thus, for example, we have omitted paths connecting, say SEX and SYSTEM. It should also be noted that where direct effects are suggested, these effects are residual to the effects through other variables. Thus, the path connecting organization and satisfaction represents the effect on satisfaction of the individual's organizational status after the effects of the person's professional role and purpose in conducting the search have been removed. All residual variation which is not accounted for by any of the variables in the model is assumed to be caused by external variables, represented by the e_i 's.

The problem for this particular analysis, then, is to test the validity of the inferences about cause and effect relationships suggested by the path analysis model depicted in Figure 2. While confirmation of the relationships described by the model does not prove the existence of the implied causal relationships, it would provide evidence supporting their plausibility.

FIGURE 2
 PATH DIAGRAM FOR SOCIOLOGICAL INPUT MODEL



Findings

In this section, we shall proceed from the general to the specific, presenting first the findings for the path analysis in which overall satisfaction (SATIS6) is the dependent or output variable, and then the results for the five satisfaction subscales. Table 3 lists the correlation coefficients, means, and standard deviations for the seven variables that appear in the path diagram in Figure 2. The means for the sociological background variables need some interpretation since the variables themselves are dichotomies.

TABLE 3
CORRELATION MATRIX, MEANS, AND STANDARD DEVIATIONS
FOR VARIABLES IN SOCIOLOGICAL INPUT MODEL EXPLAINING
OVERALL SATISFACTION WITH SERVICE

	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇
X ₁ LOCATION							
X ₂ SEX	.095						
X ₃ ORGANIZN	.511 [†]	.087					
X ₄ PURPOSE	-.430 [†]	-.197 [†]	-.434 [†]				
X ₅ PROFROLE	-.135 [§]	-.309 [†]	-.348 [†]	.294 [†]			
X ₆ SYSTEM	.093	.004	.007	-.059	.030		
X ₇ SATIS6	-.050	-.024	.053	.035	-.081	.094	
Mean	.531	.364	.352	.469	.327	.154	2.59
Standard Deviation	.501	.483	.479	.501	.471	.362	0.37

N = 162

[†]p < .01

[§]p < .05

The mean of .53 for LOCATION indicates that 53% of the users in the sample were from Metro Toronto and, conversely, that 47% were from outside Toronto. Similarly, the means for SEX, ORGANIZN, PURPOSE, PROFROLE, and SYSTEM can be interpreted in terms of percentages: 36% were students or staff at OISE; 47% of all searches were for professional as opposed to academic purposes; and 15% of all searches were conducted using SDC. The mean of 2.59 (on a scale from 1 to 3) for overall satisfaction indicates the average user was highly satisfied.

The zero-order correlations among the five sociological background variables are seen, for the most part, to be statistically significant. In contrast, neither SYSTEM nor SATIS6, overall satisfaction, have any statistically significant relationships with the other variables included in the analysis.

The path analysis in Figure 2 shows that the pattern of correlations exhibited in the correlation matrix are present even when all of the background variables are entered.

LOCATION has a very weak, non-significant positive correlation with SYSTEM, indicating that SDC was not used more often for clients distant from Toronto. Given the coding system, a negative relationship would have been indicated. Location has a non-significant negative correlation with satisfaction. What slight relationship there is would suggest greater satisfaction among those users outside the immediate metropolitan area where EISO is located. Finally, location does have a strong positive correlation with organization, confirming that most of OISE's staff and students who use the system are associated with the main campus in Toronto rather than one of its nine field centres.

SEX, the other prior variable contained in the path model in Figure 2 exhibits only one significant relationship, that with PROFROLE. This relationship implies that EISO's women clients tend to hold non-administrative positions, and that its male clients tend to hold administrative positions.

At the next stage of analysis, ORGANIZN is seen to have significant relationships with both the purpose of the search (the negative path coefficient implies those outside OISE are more likely to request searches for professional rather than academic purposes) and the professional role of the individual (the negative relationship implies that OISE users tend

TABLE 4

PATH COEFFICIENTS FOR SOCIOLOGICAL INPUT MODEL EXPLAINING SUBSCALE SCORES
FOR SATISFACTION WITH SERVICE

Path	Statistic	Variable					
		SATIS1	SATIS2	SATIS3	SATIS4	SATIS5	SATIS6
1. LOCATION-SEX	r ₁₂	.11	.16 ^s	-.06	.11	.08	.09
2. ORGANIZN-LOCATION	p ₃₁	.52 [†]	.55 [†]	.25	.70 [†]	.48 [†]	.51 [†]
3. ORGANIZN-SEX	p ₃₂	.05	.06	-.01	-.04	.04	.04
4. PURPOSE-ORGANIZN	p ₄₃	-.36 [†]	-.39 [†]	-.36	-.33 [†]	-.34 [†]	-.38 [†]
5. PURPOSE-PROFROLE	p ₄₅	.11	.15 ^s	-.07	.27 ^s	.15	.16
6. PROFROLE-SEX	p ₅₂	-.32 [†]	-.28 [†]	-.42 ^s	-.35 [†]	-.31 [†]	-.28 [†]
7. PROFROLE-ORGANIZN	p ₅₃	-.31 [†]	-.34 [†]	-.39 [†]	-.33 [†]	-.30 [†]	-.32 [†]
8. SYSTEM-LOCATION	p ₆₁	.06	.04	.18	.02	.07	.08
9. SATIS-LOCATION	p ₇₁	.11	.11	.37	-.11	-.23 ^s	-.09
10. SATIS-SEX	p ₇₂	.08	-.05	-.21	.11	.02	-.04
11. SATIS-ORGANIZN	p ₇₃	.03	.11	.06	.07	.04	.10
12. SATIS-PURPOSE	p ₇₄	.18 ^s	.13	.19	.02	-.08	.06
13. SATIS-PROFROLE	p ₇₅	-.08	-.06	-.31	-.07	.03	-.09
14. SATIS-SYSTEM	p ₇₆	.01	.11	.07	.12	-.09	.11
n		171	182	32	75	148	162
\bar{X}		2.57	2.77	2.41	2.51	2.32	2.59
s		.46	.37	.43	.38	.56	.34

†p < .01

s_p < .05

not to be administrators, while professional clients tend to hold administrative positions). Finally, ORGANIZN has a residual positive effect on satisfaction, after the removal of effects due to SEX, LOCATION, PURPOSE AND PROFROLE.

The last stage of the path diagram involves SYSTEM, PURPOSE, and PROFROLE. SYSTEM is seen to have no statistically significant effect on satisfaction. Similar conclusions hold for PURPOSE -- academic and non-academic users are equally satisfied -- and PROFROLE -- administrators and non-administrators are equally satisfied.

Turning now to the path analyses for the satisfaction subscale reported in Table 4, we note that that pattern of path coefficients is very similar to that observed for overall satisfaction. In fact, all coefficients not involving a satisfaction subscale are in fact estimates of the same coefficients reported under the preceding analysis. They differ only because of the different sizes of the subsamples for which complete data were available.

Concentrating on the satisfaction subscales, we note two significant correlations. Since, among the 36 path coefficients, we would expect about this number to be statistically significant at the .05-level by chance alone even when there were no real relationships, we should not place much weight upon them. The two paths we refer to are between PURPOSE and SATIS1, satisfaction with publicity materials and directions. This relationship would imply slightly greater satisfaction with these among users requesting searches for non-academic purposes. The second significant relationship between LOCATION and SATIS5, satisfaction with the value of the bibliography and materials, is negative. This would imply that users from outside are more satisfied with the end result of searches than are those from inside Toronto.

Conclusion

This path analysis shows that EISO has satisfied both of its major markets with equal effectiveness. One of these markets, the professional market, is composed especially of male administrators located throughout Ontario. The other, academic market, is composed of students and academicians. This group has a higher percentage of women than the other, and is concentrated in Toronto, especially at OISE.

The fact that the sociological input model fails to explain different levels of client satisfaction can be taken as mark of EISO's success. Housed as it is in an academic library at OISE in Toronto, one would expect a tendency for it to serve its immediate constituency best. The very lack of such a relationship indicates it has been successful in satisfying the needs of professional educators with equal effectiveness.

It should be emphasized that EISO is effective. The mean score for the clients' overall satisfaction was 2.6 on a three-point scale. The subscale means in Table 4 show that users are also highly satisfied with EISO's publicity materials and directions (SATIS1), its convenience and helpfulness (SATIS2), and the quality of its technology (SATIS4). The users reported a moderately high level of satisfaction on the remaining two subscales, timeliness of service (SATIS3) and the value of the bibliography and materials (SATIS5). Given that the timeliness of service was in part dependent on delivery of materials from EDRS in the U.S., we can even discount, to some extent, one of these two.

The fact that the sociological input model has failed to explain different levels of satisfaction does not mean the small variation observed in these variables cannot be explained; there may be other models that are more effective at this task.

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