Management Science

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

Individual Differences and MIS Success: A Review of the Empirical Literature

Robert W. Zmud,

To cite this article:
Robert W. Zmud, (1979) Individual Differences and MIS Success: A Review of the Empirical Literature. Management Science 25(10):966-979. http://dx.doi.org/10.1287/mnsc.25.10.966

MANAGEMENT SCIENCE
Vol. 25 No. 10, October 1979
Printed in U.S.A.

INDIVIDUAL DIFFERENCES AND MIS SUCCESS: A REVIEW OF THE EMPIRICAL LITERATURE*

ROBERT W. ZMUD†

Of the numerous factors believed to influence MIS success, the area of individual differences has by far been the most extensively studied. This paper synthesizes the findings of empirical investigations of the manner in which individual differences impact MIS success. Suggestions are made regarding those aspects which would benefit most from future research. (MANAGEMENT INFORMATION SYSTEMS; HUMAN BEHAVIOR; PERFORMANCE)

1. Introduction

Many factors are believed to impinge upon the success experienced by organizations regarding their development of management information systems (MIS). Although clearly not exhaustive, the following typifies the variety of issues addressed by both academics and practitioners [23], [54], [64], [70]: organizational characteristics, environmental characteristics, task characteristics, personal characteristics, interpersonal characteristics, MIS staff characteristics, and MIS policies.

Those factors generating the largest amount of research activity have involved the influence of individual differences upon MIS design, implementation, and usage. While researchers from a variety of disciplines have shared a common interest in examining the effect of a number of cognitive, personality, demographic, and situational variables upon information processing and decision behavior, no attempt has been made to synthesize this material as it relates to MIS. It is the intent of this paper to provide such a synthesis.

The paper is organized around a model that is believed to portray the manner in which individual differences influence MIS success. First, the basic elements of the model are introduced. Then, empirical studies involving the various model elements and their relationships are critically examined. Finally, the implications of these findings and needs for future research are discussed.

2. A Model Illustrating the Impact of Individual Differences upon MIS Success

Figure 1 shows a model which illustrates the manner individual differences are believed to influence MIS success. Two distinct paths are conceptualized. An upper path finds individual differences amplifying or dampening limitations in human information processing and decision behavior, which in turn impose or suggest MIS design alternatives directed toward motivating or facilitating MIS usage. A lower path reflects the impact of individual differences upon the attitudes held by potential MIS users and upon the tendencies for MIS users to involve themselves in the MIS development effort. These paths can thus be characterized as representing the *cognitive* and *attitudinal* influences of individual differences upon MIS success. Two relationships are depicted in Figure 1 as dotted lines. These lines represent research studies bypassing the upper and lower paths described above. The remainder of this section more completely describes the model elements.

* Accepted by Charles H. Kriebel; received January 21, 1977. This paper has been with the author 11 months for 3 revisions.

† Georgia State University.

0025-1909/79/2510/0966$01.25

Individual Differences

The individual differences believed most relevant to MIS success are grouped into three classes: cognitive style, personality, and demographic/situational variables.

Cognitive styles represent characteristic modes of functioning shown by individuals in their perceptual and thinking behavior. While such behaviors are dependent on task and situational elements [16], many individuals exhibit pervasive tendencies toward particular cognitive behavior and consistent individual differences can be observed. Although the cognitive style construct is acknowledged to be multidimensional, the number of such dimensions and the relationships between dimensions are not clear. Most MIS-related research, however, has focussed on three dimensions [9]. The *simple/complex* dimension [95] pertains to structural characteristics of perception and thinking and has been operationalized as three distinct properties: differentiation, i.e., the number of elements sought and assimilated in cognition; discrimination, i.e., the assigning of slightly varying stimuli to the same or different categories; and integration, i.e., the number and completeness of rules used in cognition. The *field-dependent/field-independent* dimension (low analytic/high analytic) was initially conceptualized as an ability to disembed a context field in perception but has since been broadened to reflect whether an individual is bound by external referrents or can make use of internal referrents in structuring cognitions [116]. The *systematic/heuristic* dimension reflects whether an individual utilizes abstract models and systematic processes in cognition or whether the approach taken is based more on experience, common sense and the practicalities of a situation [46], [121].

Personality refers to the cognitive and affective structures maintained by individuals to facilitate their adjustments to the events, people and situations encountered in life [38]. Personality variables believed to strongly impact MIS success include locus of control, dogmatism, ambiguity tolerance, extroversion/introversion, need for achievement, risk taking propensity, evaluative defensiveness, and anxiety level [54].

The demographic/situational variables cover a broad spectrum of personal characteristics [54]. Both general intellectual abilities and a knowledge of specific content areas are believed to influence MIS usage, as have attributes such as sex, age, experience, education, professional orientation, and organizational level.

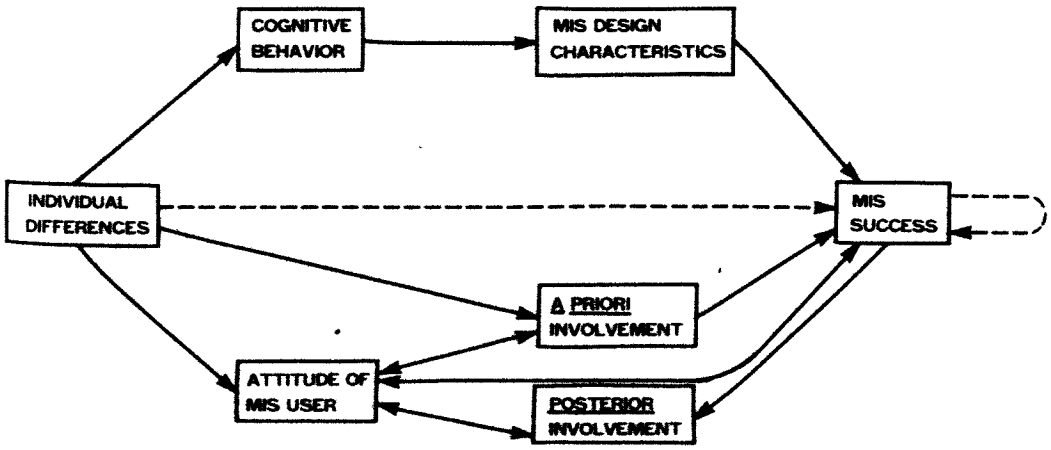

FIGURE 1. Impact of Individual Differences upon MIS Success.

Cognitive Behavior

Cognition refers to the activities involved in attempts by individuals to resolve inconsistencies between an internalized conceptualization of the environment and what is perceived to be actually transpiring in the environment. While not directly oriented toward MIS, three distinct research areas have evolved. Information processing theory is concerned with explaining the types of memory structures utilized in cognition and how data is perceived, organized and retrieved in terms of these memory structures [10], [89]. Artificial intelligence is concerned with replicating how problem situations are represented and resolved in human cognition [81]. Behavioral decision theory is concerned with describing the ways in which beliefs and values are incorporated into the decision making process [102]. The most relevant aspects of these research areas to MIS success involve the uncovering of human limitations in cognition, which then become critical elements to be supported by a computer-based MIS.

MIS *Design Characteristics*

The perspective adopted of a MIS is that its organizational role is to support decision making activity [37]. The design characteristics of concern can be broadly classified as belonging to three groups: the information received, the decision aids provided, and the delivery system which serves as the interface between the MIS user and a computer-based MIS.

Information has value only when it reduces the uncertainty that pervades decision making [52]. When designing the information component of a MIS, a number of factors need to be addressed, including the source, timeliness, level of aggregation, completeness, accuracy, reliability, validity, frequency, and currentness of information [37], [119].

Decision aids are provided to overcome limitations inherent in human cognition and to ensure that available information is sensed and used. While numerous decision aids can be identified, most fall into the categories of analytic models [50] or display enhancements [106]. With both categories, the intention is to increase the comprehensibility of information.

The convenience and ease of use of a MIS are considered as important to MIS usage as is the quality of information received [83]. Delivery system factors cover a broad range of items ranging from technical issues such as man-computer response times [75] and query languages [70] to human factors issues [20] and organizational issues such as the adequacy of training provided MIS users [123] and the relationships existing between MIS users and the MIS staff [30].

Attitude of MIS *User*

Organizational members possess preconceived attitudes, i.e., beliefs, values and expectations [111], regarding the role of MIS within the organization. These attitudes have been seen to be expressed toward perceptions of the capabilities of and need for a MIS, perceptions of the organizational environment for MIS, perceptions of the MIS staff and the need for user interaction with this staff, and perceptions toward organizational change in general [40], [92], [98].

A Priori Involvement

The implementation stages that precede the introduction of a MIS into an organization, i.e., project initiation, feasibility study, requirements analysis, system design, and system development, provide numerous opportunities for user involvement [30], [55], [62], [107], [123]. *A priori* involvement includes all active contributions by potential MIS users toward this effort.

Posterior Involvement

The opportunities for users to contribute toward MIS success also exist after implementation [55]. It is the exception rather than the norm if no modifications are required once a MIS has become operational and users gain experience with it; and, as all organizations undergo continual change, even a well-designed MIS would benefit from periodic adjustments to ensure it remains compatible with user requirements [60]. *Posterior* involvement thus refers to all active contributions by actual MIS users once a MIS has been introduced into the organization.

MIS *Success*

Evaluation of MIS success is a complex and perplexing issue [34], [53]. While it is easiest to simply examine actual usage, success ultimately depends on how well the MIS has, in fact, supported decision making. Thus, user satisfaction with a MIS and user performance with a MIS become important evaluation measures. All three of these success variables are considered.

3. Results from Empirical Studies

Empirical research is surveyed and evaluated in the context of the model presented above. Not all these studies directly relate to MIS; however, as the intent of the paper is to synthesize a number of interdisciplinary studies that touch upon issues related to MIS design, both studies oriented specifically toward MIS and studies oriented toward information processing and problem solving behavior are included.

The discussion that follows is organized around the relationships displayed in Figure 1. In general, these relationships should be considered as associative, rather than causal, in nature.

Individual Differences—Cognitive Behavior

Information requirements of decision makers are dependent upon task, situational and individual factors [16], [71], [73], [109], and the role of individual differences is quite clear. A decision maker's information requirements to a large extent are based upon the individual's "world-view," which is totally reflective of the individual. Depending upon the scope of a MIS, one may design for the individual [50] or for a group of individuals [2]. The objective of this aspect of MIS research on individual differences is to locate the critical individual differences and determine how best to design a MIS for individuals so characterized.

Cognitive Style. In contrasting the information processing behaviors of simple and complex individuals, complex subjects have been found to search for [95], [49] and use [95], [100], [112] more information, to prefer aggregate rather than raw data [2], and to use more rules [42] when integrating information. A slightly different outcome, however, found that complex subjects used more complex, but less simple, information [26]. Regarding their decision making behavior, complex subjects have been found to generate more decision alternatives [42], [100] resulting in greater flexibility [13], [99] but less confidence [100] and more decision time [26].

In contrasting the decision behavior of field-dependent and field-independent individuals, field-independent subjects have been found to seek more information [36], to prefer detailed, aggregate, quantitative reports [2], [7], [24], [67], and to require more decision time [7]. Another finding indicated that when a mismatch existed between field-dependency/field-independency and report format, subjects tended to request additional reports [7].

In contrasting the decision behavior of heuristics and systematics both consistent and inconsistent findings have been observed. Systematics have been seen to consis-

tently prefer more quantitative information [46] and require more decision time [77], [78], [113] than heuristics. However, systematics have been found to prefer more [39], [77], [113] and less [3], [86] information and to prefer aggregated [3] and raw [5], [86], [105] data when compared with heuristics. One study does suggest possible explanations for these inconsistencies [8]: systematics with access to decision aids requested less information than heuristics while systematics without decision aids requested more information than heuristics; and, heuristics with low task knowledge requested the most information.

Finally, a related issue involves individual perceptions of cognitive styles. The systematic and complex styles have been perceived as being more potent than the heuristic and simple styles [120]. While highly speculative at best, it would appear that such perceptions would have a long-term impact upon MIS design.

Personality. Greater information search activity has been observed for subjects possessing an internal locus of control [58], [84], a low degree of dogmatism [56], [61], and high risk-taking propensity [110]. Low dogmatic subjects have also been characterized as more deliberate [61] and less confident [110] decision makers.

Evidence is also available regarding other personality variables. Extroverted subjects were found to more quickly retrieve information stored in their own minds and to retain information better over short intervals, but not for long intervals when compared with introverts [31]. Subjects classified as being intolerant of ambiguity were found to prefer concrete stimuli and to perceive more information as being valuable [21].

Demographic and Situational. Subjects with higher general intelligence have been observed to process information faster, select information more effectively, retain information better, make decisions faster [110], and to better organize information in their minds [45]. Subjects with higher quantitative abilities make more use of short-term memory but less use of long-term memory than do subjects with lower quantitative abilities [45], and subjects with greater verbal abilities possess enhanced short-term memory when compared with subjects with lesser verbal abilities [44].

Experienced decision makers were shown to select information more effectively but to integrate it less effectively and to be more flexible but less confident [110]. Three factors related to experience are task knowledge, age, and management level. Subjects possessing a high level of task information were observed to engage in less information search [8]. Older subjects were found to engage in more information search [108], to select information more effectively and be more flexible [110], to require more decision time [108], [110], and to exhibit depressed long-term memory capabilities [31]. Subjects in higher management levels, however, were found to require less decision time [108].

Cognitive Behavior—MIS *Design Characteristics*

The limitations [74] and other peculiarities of human cognition provide numerous opportunities for MIS designs to aid the user in task accomplishment. The studies undertaken that indicate areas for computer-aided support are broadly categorized as involving information or decision aid considerations.

Information. While search activity [59], decision accuracy [1], [25], [59], [103], and decision confidence [103] all increase as the quantity of relevant information increases, it has become generally acknowledged that humans do not understand their own information requirements. They often demand too little or too much information [6], [94] and have been observed to prefer more information than economically justified [26] as well as using less information than their own prior expectations [113]. A major role of a MIS, thus, is to both select and filter appropriate information elements for the decision maker.

The inclusion of irrelevant information in a report has been found to degrade performance [17], [29] and should be avoided. Redundancy, in the form of contextual or elaborative information, is desirable as it aids the user in recognizing, evaluating, and remembering critical information [25], [43], [76], [91], [103]. Overredundancy, however, can hinder information processing when capacity limitations are reached [43].

A related consideration is the order of information presentation. When information quantities prohibit presenting all information at once, care must be taken to minimize primacy or recency effects [6], [94].

Decision Aids. Humans have been found to be slow in initiating action [114], to delay too long when making decisions [41], [94], and to be reluctant to change prior decisions [94], [114]. Decision performance would benefit, thus, from decision aids that direct, to a certain degree, a decision maker's behavior.

Humans are also typically unable to make full use of provided information, particularly when it is multidimensional [94] or if it must first be stored in memory, inferred from a report, or otherwise transformed [101]. Humans develop and consider too few alternatives [96] and often accept the first alternative that makes sense [114]. It has been consistently observed the simple models and decision rules are extremely good predictors of human decision behavior [18], [102]. Such models have tended to outperform man [35] even when model parameters are arrived at in an *ad hoc* manner [19]. As decision makers apparently develop effective strategies but fail to use them, it might be beneficial to have these strategies automatically invoked by a MIS.

Probabilistic analysis appears extremely uncomfortable for most individuals. Humans tend to be reluctant to work with probabilistic data [18], to systematically violate the rules of rational decision making [79], [102], and to exhibit difficulties in weighing new evidence as it effects a decision situation [6], [12], [72], [103]. The provision of probabilistic aids would appear to be a necessity in most situations.

MIS *Design Characteristics*—MIS *Success*

As indicated in the previous section of this paper, MIS design attributes were classified as belonging to three groups: information needs, decision aids, and delivery system components. Studies have been undertaken to examine aspects of each of these design areas with regard to MIS success.

Information. User satisfaction with a MIS has been shown to be positively related to the degree to which information needs are perceived to be met [4], [93] but to be negatively related to the amount of information being received [62]. Also, a group of MIS users receiving an unalterable report were less satisfied than another group receiving reports which could be modified [28].

Decision Aids. The availability of quantitative models has resulted in improved decision performance [8], [15], [104] but was found to lengthen decision time [8], [15] and decrease confidence [15]. Graphical reports have been shown to result in better performance than tabular reports [8], [96] and were preferred when compared with tabular or bar chart reports [119]. Color-coded graphics have improved performance [96], a single multi-line graph resulted in better performance than multiple single-line graphs [97], and format improvements were observed to be positively associated with increased MIS usage [32].

Delivery System. Management personnel have proven to be very intolerant of poor MIS-user interface designs [14], [28]. Ease of use and favorable user interfaces have both been positively associated with MIS satisfaction [4], [64].

On-line usage, as opposed to batch usage, has resulted in faster and more consistent performance [23], [85], [90] and a higher degree of user satisfaction [62], [64], [90] but only when the MIS is accessible and reliable [90]. With on-line usage, CRT terminals

were observed to result in better performance [57] and higher user satisfaction [48] even though users took longer and made more errors [57] than did typewriter-like terminals. A study contrasting the concerns of on-line versus batch users uncovered some interesting differences [92]: while batch users emphasized access time and MIS availabilities with regard to data and decision aids, on-line users stressed response time, training, and their relations with the MIS staff.

Other studies have underscored the importance of response time to on-line MIS usage. Delays longer than 10 seconds, irregular delays, and uncertain delays in the flow of communications from a MIS to a user have consistently been shown to lower user satisfaction [75], [82], [90], [93]. Enforced delays in the communication flow from a user to a MIS were observed to improve performance but to lower satisfaction [11].

A related delivery system feature is the query language provided users to communicate with a MIS. Vocabulary enhancements have been positively associated with increases in MIS usage and satisfaction [32].

Two organization-oriented delivery system attributes are user compatibility with the MIS staff and the quality of training provided users. Both factors have been demonstrated to be positively associated with higher user satisfaction [4], [93]. While management personnel are often too busy to attend formal training sessions [14], it is possible to provide self-teaching through the MIS. Such a strategy has, in fact, been shown to result in better user performance than traditional training sessions [51].

Individual Differences—MIS *User Attitudes*

Extroverted, perceptive individuals were found to possess more positive attitudes toward MIS [117] while males [69], older individuals [64], [80], and less educated individuals [66] were observed to exhibit less positive attitudes.

Individual Differences—A Priori Involvement

Cognitive differences between MIS users and MIS designers have been suggested as a major deterrent to effective user involvement in MIS design [30], [122]. Differences have been observed between designers and the MIS user for both cognitive style and self-image [33].

MIS *User Attitude—A Priori Involvement*

One study has uncovered a positive association between MIS attitude and *a priori* involvement [62].

A Priori Involvement—MIS *Success*

A priori user involvement in MIS design has consistently been observed to be positively associated with user satisfaction with a MIS [22], [30], [47], [62], [68], [107]. A related finding was that ineffective user-designer communication during design was negatively associated with satisfaction [30]. The results of studies examining the association between *a priori* involvement and MIS usage, however, have not been consistent: while one study did uncover a positive association [107], two others have found no association [68], [53].

MIS *User Attitude*—MIS *Success*

Preconceived attitudes toward MIS are associated with MIS usage to a much greater extent than MIS satisfaction. Usage has been positively associated with attitudes regarding the potential of a MIS [53], [63], [66], [87], [88], the urgency of a MIS [87], [88], the extent of top management support for a MIS [63], [64], [68], [87], and the quality of the MIS staff [68], [87]. Regarding MIS satisfaction, only a positive

association with attitudes of top management support [64], [66] and mixed results regarding MIS potential [66] have been observed.

Posterior Involvement—MIS *Success*

The results of a single study indicate the existence of a negative association between *posterior* involvement and MIS satisfaction [62]. Apparently, MIS users involved in this modification effort tended to be those dissatisfied with the MIS.

Posterior Involvement—MIS *User Attitudes*

No empirical studies have been reported.

Individual Differences—MIS *Success*

A number of research studies have directly examined the impact of individual differences upon MIS success. These results will be reported regarding MIS usage, MIS satisfaction, and for decision performance via a MIS.

MIS *Usage.* Systematics have been observed to utilize a MIS more [62] and less [92] than heuristics. Subjects with greater risk-taking propensities utilized a MIS less [110]. Individuals characterized by more education [62], longer tenure in an organization [62], [63], [64], [115], and a greater degree of organizational success [62] were seen to utilize a MIS less, while individuals with higher task knowledge and those of a professional status tended to use a MIS more [115]. Findings regarding organizational level, however, have been mixed [27], [28], [62], [68].

MIS *Satisfaction.* Systematics were seen to exhibit less satisfaction with a MIS than heuristics [64]. Individuals characterized by more education [65] and longer tenure [62], [64], [68] tended to be less satisfied with a MIS but individuals shown to have achieved greater degrees of organizational success tended to be more satisfied [65].

Decision Performance. Systematics [77], [78], [86] and field-independents [7] have been observed to perform better when using a MIS than, respectively, heuristics and field-dependents. While risk taking propensity was shown to be positively associated with better performance, need-for-achievement was seen to be characterized by a non-linear association with individuals possessing moderate need-for-achievement performing best [118]. A complex association was uncovered in a study examining evaluative defensiveness and anxiety [118]. Here, individuals with a high evaluative defensiveness under conditions of debilitating anxiety performed best while individuals with a high evaluative defensiveness under conditions of facilitating anxiety performed worse. Both general intelligence level [110] and quantitative ability [15] were positively associated with performance. Results of studies examining tenure [62], [108] and education level [62], [113] were mixed.

MIS *Usage*—MIS *Success*

Consistently positive associations have been observed between MIS usage and MIS satisfaction [4], [62], [64], [65], [68], [92], [107], [113].

4. Discussion of the Empirical Results and Suggestions for Future Research

The model presented as Figure 1 is used as a structure for evaluating the research already undertaken and for indicating those areas about which least is known. In addition to focussing upon the cognitive and attitudinal influences of individual differences upon MIS success, the interaction of these two elements will also be explored.

Cognitive Influences

A large number of studies have addressed the impact of individual differences upon information processing and decision behavior. As might be expected, the strongest associations have been observed with regard to the personal characteristics that directly relate to individual perception and structuring of environmental stimuli, i.e., cognitive styles and related personality constructs that construct and sustain an individual's "world view." While fewer studies have focused upon affective personality variables and upon demographic attributes, these individual differences have also been associated with distinct cognitive behaviors. What is not clear is whether the influence of noncognitive individual differences directly influences cognitive behavior or moderates the relationships between cognitive styles and cognitive behaviors. Studies investigating this issue are needed.

A related concern is that many of the studies reported were not conducted in a MIS context; and, many of the MIS-based studies were of a laboratory nature and/or utilized students as subjects. The replication of these studies in *real* MIS environments would be beneficial.

The variations in cognitive behaviors attributable to individual differences as well as the documented limitations inherent to human information processing and decision behaviors provide ample opportunities for designers to provide MIS that extend the decision making capabilities of organizational members. Although some research in this direction has been pursued, much remains unknown as to how best to support the individual decision maker *throughout* the entire decision process: problem finding, problem structuring, solution generation, analysis, and choice. Past studies have primarily addressed issues of information presentation. Future studies would benefit from the adoption of a decision support system, rather than an information system, perspective.

Finally, it is becoming increasingly realized that cognitive behaviors are dependent on contextual, i.e., task and environmental, factors as well as individual differences. In order for the results of research studies to be interpretable and generalizable, experimental designs for individual difference research must incorporate relevant contextual variables. To neglect to do so will result in ambiguous, inconsistent, and, possibly, meaningless findings.

Attitudinal Influences

While a number of studies clearly indicate that the attitudes and *a priori* involvement of MIS users are positively associated with MIS success, very few studies have examined the influence of individual differences upon either user attitudes toward MIS or user involvement in MIS design efforts. That such associations do exist is apparent from the number of studies indicating a strong association between individual differences and MIS success. Little is known regarding the characteristics of individuals who tend to possess negative attitudes or who tend to disassociate themselves from MIS design activities. Such knowledge would enable organizations to focus educational and promotional efforts upon those user groups most likely to inhibit MIS success.

A number of other potentially beneficial research avenues suggest themselves given the paucity of empirical studies evident with respect to the relationships denoted as the lower path of Figure 1. First, it seems intuitive that a relationship would exist between MIS attitude and user involvement. Only a single study touched upon this issue, and then only as a small part of a very broad investigation. Second, an interesting outcome observed was that MIS-user *attitudes* are associated with MIS usage while MIS-user *involvement* is associated with MIS satisfaction. Apparently, the relationship between attitudes, involvement, satisfaction, and usage is quite complex.

Again, no studies have investigated this issue. Third, little attention has been given to *posterior* involvement. As software maintenance costs typically exceed software development costs, it would seem that the role of the user in specifying MIS modifications and enhancements is crucial. When do users get involved? What type of users get involved? How can users be motivated to become involved?

The Cognitive-Attitudinal Interface

An important research area involves the relationship between user attitudes toward MIS and MIS design characteristics, particularly with regard to delivery system components. It seems apparent that the attributes of most delivery system components, i.e., query languages, response times, the physical interface, training, organizational arrangements between users and the MIS staff, etc., would directly reflect user attitudes. No studies, however, have been uncovered that examine this issue.

5. Conclusion

This analysis of the empirical literature regarding the influence of individual differences upon MIS success indicates rather clearly that individual differences do exert a major force in determining MIS success. It is just as apparent, however, that much remains unknown regarding the specific relationships involved and the relative importance of individual differences when contrasted with contextual factors. With organizations committing an increasing portion of their MIS efforts toward the utilization of the computer to *actively* support decision making, the potential payoff from further research investigating the relationships between MIS success and the personal characteristics of MIS users is high.

References

1. Adams, J. R. and Swanson, L. A., "Information Processing Behavior and Estimating Accuracy in Operations Management," *Acad. Management J.*, Vol. 19 (1976), pp. 98–110.
2. Bariff, M. L. and Lusk, E. J., "Cognitive and Personality Tests for the Design of Management Information Systems," *Management Sci.*, Vol. 23 (1977), pp. 820–829.
3. Barkin, S. R. and Dickson, G. W., "An Investigation of Information System Utilization," *Information and Management*, Vol. 1 (1977), pp. 35–45.
4. Barrett, G. V., Thornton, C. L. and Cabe, P. A., "Human Factors Evaluation of a Computer-Based Information Storage and Retrieval System," *Human Factors*, Vol. 10 (1968), pp. 431–436.
5. Barrett, M. J., "Information Processing Types and Simulated Production Decision Making," MISRC Working Paper 73-02, University of Minnesota, 1973.
6. Beach, B. H., "Expert Judgement about Uncertainty: Bayesian Decision Making in Realistic Settings," *Organizational Behavior and Human Performance*, Vol. 14 (1975), pp. 10–59.
7. Benbasat, I. and Dexter, A. S., "Value and Event Approaches to Accounting: An Experimental Evaluation," *Accounting Rev.*, Vol. 54 (1979), pp. 735–749.
8. ——— and Schroeder, R. G., "An Experimental Investigation of Some MIS Design Variables," *MIS Quart.*, Vol. 1, No. 1 (1977), pp. 37–49.
9. ——— and Taylor, R. N., "The Impact of Cognitive Styles on Information System Design," *MIS Quart.*, Vol. 2, No. 2 (1978), pp. 43–54.
10. Bither, S. W. and Ungson, G., "Consumer Information Processing Research: An Evaluative Review," Working Paper No. 25, College of Business Administration, Pennsylvania State University, 1975.
11. Boehm, B. W., Seven, M. J. and Watson, R. A., "Interactive Problem—An Experimental Study of 'Lockout' Effects," *Proceedings*, AFIPS Spring Joint Computer Conference, Vol. 38 (1971), pp. 205–210.
12. Brightman, H. J. and Urban, T. F., "The Influence of the Dogmatic Personality upon Information Processing: A Comparison with a Bayesian Information Processor," *Organizational Performance and Human Behavior*, Vol. 11 (1974), pp. 226–276.
13. Bruner, J. S. and Tajfel, H., "Cognitive Risk and Environmental Change," *J. Abnormal and Social Psych.*, Vol. 62 (1961), pp. 231–241.
14. Carlson, E. D., Grace, B. F. and Sutton, J. A., "Case Studies of End User Requirements for Interactive Problem Solving Systems," *MIS Quart.*, Vol. 1, No. 1 (1977), pp. 51–63.

15. CHERVANY, N. L. AND DICKSON, G. W., "An Experimental Evaluation of Information Overload in a Production Environment," *Management Sci.*, Vol. 20 (1974), pp. 1335–1344.
16. ——— AND ———, "On the Validity of the Analytic-Heuristic Instrument Utilized in 'The Minnesota Experiments': A Reply," *Management Sci.*, Vol. 24 (1978), pp. 1091–1092.
17. COFFEY, J. C., "A Comparison of Vertical and Horizontal Arrangements of Alphanumeric Material," *Human Factors*, Vol. 3 (1961), pp. 93–98.
18. CONRATH, D. W., "From Statistical Decision Theory to Practice: Some Problems with the Transition," *Management Sci.*, Vol. 19 (1973), pp. 873–883.
19. DAWES, R. M., "The Robust Beauty of Improper Linear Models in Decision Making," paper presented at Division V, American Psychological Association Meeting, San Francisco, August 1977.
20. DEGREENE, K. B., "Man-Computer Interrelationships," in K. B. DeGreene (ed.), *System Psychology*, McGraw-Hill, New York, 1970.
21. DERMER, J. D., "Cognitive Characteristics and the Perceived Importance of Information," *Accounting Rev.*, Vol. 48 (1973), pp. 511–519.
22. DICKSON, G. W. AND POWERS, R. F., "MIS Project Management: Myths, Opinions and Reality," *California Management Rev.*, Vol. 15 (1973), pp. 147–156.
23. ———, SENN, J. A. AND CHERVANY, N. L., "Research in Management Information Systems: The Minnesota Experiments," *Management Sci.*, Vol. 23 (1977), pp. 913–923.
24. DOKTOR, R. H. AND HAMILTON, W. F., "Cognitive Style and the Acceptance of Management Science Recommendations," *Management Sci.*, Vol. 19 (1973), pp. 884–894.
25. DORRIS, A. L., SADOSKY, T. L. AND CONNOLLY, T., "Varying Data and Information in a Decision Making Task," *Ergonomics*, Vol. 20 (1977), pp. 643–649.
26. DRIVER, M. J. AND MOCK, T. J., "Human Information Processing, Decision Style Theory, and Accounting Information Systems," *Accounting Rev.*, Vol. 50 (1975), pp. 490–508.
27. DUNLOP, R. A., "Some Empirical Observations on the Man-Machine Interface Question," in C. H. Kriebel, R. L. Van Horn and J. T. Heames (Eds.), *Management Information Systems: Progress and Perspectives*, Carnegie Press, Pittsburgh, 1971.
28. EASON, K. D., "Understanding the Naive Computer User," *Computer J.*, Vol. 19 (1976), pp. 3–7.
29. EBERT, R. J., "Environmental Structure and Programmed Decision Effectiveness," *Management Sci.*, Vol. 19 (1972), pp. 435–445.
30. EDSTRÖM, A., "User Influence and the Success of MIS Projects," *Human Relations*, Vol. 30 (1977), pp. 589–607.
31. EYSENCK, M. W., *Human Memory: Theory, Research and Differences*, Pergamon Press, Oxford, 1977.
32. FERGUSON, R. L. AND JONES, C. H., "A Computer Aided Decision System," *Management Sci.*, Vol. 15 (1969), pp. B550–B561.
33. GINGRAS, L. AND MCLEAN, E. R., "A Study of Users and Designers of Information Systems," Information Systems Working Paper 2-79, Graduate School of Management, UCLA, 1979.
34. GINZBERG, M. J., "Finding an Adequate Measure of OR/MS Effectiveness," *Interfaces*, Vol. 8, No. 4 (1978), pp. 59–62.
35. GOLDBERG, L. R., "Man Versus Models of Man: A Rationale, Plus Some Evidence, for a Method of Improving on Clinical Inference," *Psychological Bull.*, Vol. 73 (1970), pp. 422–432.
36. GOODENOUGH, D. R., "The Role of Individual Differences in Field Dependence as a Factor in Learning and Memory," *Psychological Bull.*, Vol. 83 (1976), pp. 675–694.
37. GORRY, G. A. AND SCOTT MORTON, M. S., "A Framework for Management Information Systems," *Sloan Management Rev.*, Vol. 13, No. 1 (1971), pp. 55–70.
38. GOUGH, H., "Personality and Personality Assessment," in M. D. Dunnette (Ed.), *Handbook of Industrial and Organizational Psychology*, Rand-McNally, Chicago, Ill. 1976.
39. GROCHOW, J., "Cognitive Style as a Factor in the Design of Interactive Decision Support Systems," Unpublished Ph.D. Dissertation, MIT, 1973.
40. GUTHRIE, A., "Middle Managers and MIS: A Attitude Survey," *J. Economics and Business*, Vol. 26 (1973), pp. 59–66.
41. HAMMER, C. H. AND RINGEL, S., "The Effects of Amount of Information Provided and Feedback of Results on Decision Making Efficiency," *Human Factors*, Vol. 7 (1965), pp. 513–519.
42. HARVEY, O. J. AND SCHROEDER, H. M., "Cognitive Aspects of Self and Motivation," in O. J. Harvey (Ed.), *Motivation and Social Interaction*, Ronald Press, New York, 1963.
43. HSIA, H. J., "Redundancy: Is it the Lost Key to Better Communication?" *Audio Visual Comm. Rev.*, Vol. 25 (1977), pp. 63–85.
44. HUNT, E., FROST, N. AND LUNNEBORG, C., "Individual Differences in Cognition: A New Approach to Intelligence," in G. H. Bower (Ed.), *The Psychology of Learning and Memory*, Academic Press, New York, 1973.
45. ——— AND LANSMAN, M., "Cognitive Theory Applied to Individual Differences," in W. K. Estes (Ed.), *Handbook of Learning and Cognitive Processes*, Lawrence Erlbaum Associates, Hillsdale, N. J., 1975.

46. HUYSMAN, J. H. B. M., "The Effectiveness of the Cognitive Style Constraint in Implementing Operations Research Proposals," *Management Sci.*, Vol. 17 (1970), pp. 92–104.
47. IGERSHEIM, R. H., "Managerial Response to an Information System," *Proceedings*, AFIPS National Computer Conference, Vol. 45 (1976), pp. 877–882.
48. JONES, C. H., HUGHES, J. L. AND ENGVOLD, K. J., "A Comparative Study of Management Decision-Making From Computer Terminals," *Proceedings*, AFIPS Spring Joint Computer Conference, Vol. 36 (1970), pp. 599–605.
49. KARLINS, M., "Conceptual Complexity and Remote Associative Proficiency as Creativity Variables in a Complex Problem Solving Task," *J. Personality and Social Psych.*, Vol. 6 (1967), pp. 264–278.
50. KEEN, P. G. W. AND SCOTT MORTON, M. S. *Decision Support Systems: An Organizational Perspective*, Addison-Wesley, Reading, Mass., 1978.
51. KENNEDY, T. C. S., "Some Behavioral Factors Affecting the Training of Naive Users of an Interactive Computer System," *Internat. J. Man-Machine Studies*, Vol. 7 (1975), pp. 817–834.
52. KING, W. R. AND EPSTEIN, B. J., "Assessing the Value of Information," *Management Datamatics*, Vol. 5, No. 4 (1976), pp. 171–180.
53. ——— AND RODRIQUEZ, J. I., "Evaluating Management Information Systems," *MIS Quart.*, Vol. 2, No. 3 (1978), pp. 43–51.
54. KLAUSS, R. AND JEWETT, J., "Issues and Methodology for MIS Research," paper presented at Joint TIMS/ORSA Meeting, April 1974.
55. KLING, R., "The Organizational Context of User-Centered Software Designs," *MIS Quart.*, Vol. 1, No. 4 (1977), pp. 41–52.
56. LAMBERT, Z. V. AND DURAND, R. M., "Purchase Information Acquisition and Cognitive Style," *J. Psych.*, Vol. 97 (1977), pp. 3–13.
57. LANCASTER, F. W. AND FAYEN, E. G., *Information Retrieval On-Line*, Melville, Los Angeles, Calif., 1973.
58. LEFCOURT, H. M., "Recent Developments in the Study of Locus of Control," in B. A. Maher (Ed.), *Progress in Experimental Psychological Research*, Academic Press, New York, 1972.
59. LEVINE, J. M., SAMET, M. G. AND BRAHLEK, R. E., "Information Seeking with Limitations on Available Information and Resources," *Human Factors*, Vol. 17 (1965), pp. 502–513.
60. LIENTZ, B. P., SWANSON, E. B. AND TOMPKINS, G. E., "Characteristics of Application Software Maintenance," *Comm. ACM*, Vol. 21 (1978), pp. 466–471.
61. LONG, B. H. AND ZILLER, R. C., "Dogmatism and Predecision Information Search," *J. Appl. Psych.*, Vol. 49 (1965), pp. 376–378.
62. LUCAS, H. C., JR., *Why Information Systems Fail*, Columbia University Press, New York, 1975.
63. ———, "Behavioral Factors in System Implementation," in R. L. Schultz and D. P. Slevin (Eds.), *Implementing Operations Research/Management Science*, American Elsevier, New York, 1975.
64. ———, *The Implementation of Computer-Based Models*, National Association of Accountants, New York, 1976.
65. ———, "The Use of an Interactive Information Storage and Retrieval System in Medical Research," *Comm. ACM*, Vol. 21 (1978), pp. 197–205.
66. ———, "Empirical Evidence for a Descriptive Model of Implementation," *MIS Quart.*, Vol. 2, No. 2 (1978), pp. 27–52.
67. LUSK, E. J., "Cognitive Aspects of Annual Reports: Field Independence/Dependence," *J. Accounting Res.*, Vol. 11 (1973 Supplement), pp. 191–201.
68. MAISH, A. M., "A User's Behavior Toward His MIS," *MIS Quart.*, Vol. 3, No. 1 (1979), pp. 39–52.
69. MANN, F. C. AND WILLIAMS, L. K., "Observations on the Dynamics of a Change to Electronic Data Processing Equipment," *Administrative Sci. Quart.*, Vol. 5 (1960), pp. 217–256.
70. MARTIN, J., *Design of Man-Machine Dialogues*, Prentice-Hall, Englewood Cliffs, N. J., 1973.
71. MASON, R. O. AND MITROFF, I. I., "A Program for Research on Management Information Systems," *Management Sci.*, Vol. 19 (1973), pp. 475–487.
72. ——— AND MOSKOWITZ, H., "Conservatism in Information Processing: Implications for Management Information Systems," *Decision Sci.*, Vol. 3 (1972), pp. 35–54.
73. MILLER, D. AND GORDON, L. A., "Conceptual Levels and the Design of Accounting Information Systems," *Decision Sci.*, Vol. 6 (1975), pp. 259–269.
74. MILLER, G. A., "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological Rev.*, Vol. 63 (1956), pp. 81–97.
75. MILLER, R. B., "Response Times in Man-Computer Conversational Transactions," *Proceedings*, AFIPS Fall Joint Computer Conference, Vol. 33 (1968), pp. 267–277.
76. MITROFF, I. I., NELSON, J. AND MASON, R. O., "On Management Myth-Information Systems," *Management Sci.*, Vol. 21 (1974), pp. 371–382.
77. MOCK, T. J., "A Longitudinal Study of Some Information Structure Alternatives," *Data Base*, Vol. 5 (1973), pp. 40–45.

78. MOCK, T. J., ESTRIN, T. L. AND VASARHELYI, M. A., "Learning Patterns, Decision Approaches, and Value of Information," *J. Accounting Res.*, Vol. 10 (1972), pp. 129–153.
79. MOSKOWITZ, H., "An Experimental Investigation of Decision Making in a Simulated Research and Development Environment," *Management Sci.*, Vol. 19 (1973), pp. 676–687.
80. MUMFORD, E. AND BANKS, O., *The Computer and the Clerk*, Routledge and Kegan Paul, London, 1967.
81. NEWEL, A. AND SIMON, H. A., *Human Problem Solving*, Prentice-Hall, Englewood Cliffs, N.J. 1972.
82. NICKERSON, R. S., "Man-Computer Interaction: A Challenge for Human Factors Research," *Ergonomics*, Vol. 12 (1969), pp. 501–517.
83. PAISLEY, W. J., "Information Needs and Uses," *Annual Rev. Information Sci. and Technology*, Vol. 3 (1968), pp. 1–30.
84. PHARES, E. J., *Locus of Control in Personality*, General Learning Press, Morristown, N. J., 1976.
85. PROKOP, J. S. AND BROOKS, F. P., "Decision Making with Computer Graphics in an Inventory Control Environment," *Proceedings*, AFIPS Fall Joint Computer Conference, Vol. 37 (1970), pp. 597–607.
86. RITTENBERG, L. E., "Information Processing Types and Simulated Production Decision Making: A Comparison of Two Methods of Classification," *Proceedings*, AIDS National Meeting, Vol. 5 (1973), p. 271.
87. ROBEY, D., "Attitudinal Correlates of MIS Use," *Proceedings*, National AIDS Meeting, Vol. 10 (1978), pp. 170–172.
88. ——— AND ZELLER, R. F., "Factors Affecting the Success and Failure of an Information System for Product Quality," *Interfaces*, Vol. 8, No. 2 (1978), pp. 70–78.
89. RUMELHART, D. E., *Human Information Processing*, Wiley, New York, 1977.
90. SACKMAN, H., "Advanced Research in Online Planning," in H. Sackman and R. L. Citrenbaum (Eds.), *Online Planning: Towards Creative Problem Solving*, Prentice-Hall, Englewood Cliffs, N. J., 1972.
91. SARBIN, T. R., TAFT, R. AND BAILEY, D. E., *Clinical Inferences and Cognitive Theory*, Holt, New York, 1960.
92. SCHEWE, C. D., "The Management Information System User: An Exploratory Behavioral Analysis," *Acad. Management J.*, Vol. 19 (1976), pp. 577–590.
93. ———, WIEK, J. L. AND DANN, R., "Advanced Marketing Information Systems: An Empirical Investigation of System User Problems," *Proceedings*, AIDS National Meeting, Vol. 6 (1974), pp. 356–359.
94. SCHRENK, L. P., "Aiding the Decision Maker—A Decision Process Model," *Ergonomics*, Vol. 12 (1969), pp. 543–557.
95. SCHROEDER, H. M., DRIVER, M. J. AND STREUFERT, S., *Human Information Processing*, Holt, New York, 1967.
96. SCHULTZ, H. G., "An Evaluation of Formats for Graphics Trend Displays," *Human Factors*, Vol. 3 (1961), pp. 99–107.
97. ———, "An Evaluation of Methods for Presentation of Graphic Multiple Trends," *Human Factors*, Vol. 3 (1961), pp. 108–119.
98. SCHULTZ, R. L. AND SLEVIN, D. P., "Implementation and Organizational Validity: An Empirical Investigation," in R. L. Schultz and D. P. Slevin (Eds.), *Implementing Operations Research/Management Science*, American Elsevier, New York, 1975.
99. SCOTT, W. A., "Cognitive Complexity and Cognitive Flexibility," *Sociometry*, Vol. 25 (1962), pp. 405–414.
100. SEIBER, J. E. AND LONZETTA, J. T., "Some Determinents of Individual Differences in Predecision Information-Processing Behavior," *J. Personality and Social Psych.*, Vol. 2 (1965), pp. 736–740.
101. SLOVIC, P., "About Man's Ability to Process Information," *Oregon Research Institute Res. Bull.*, Vol. 12 (1972).
102. ———, FISCHHOFF, B. AND LICHTENSTEIN, S., "Behavioral Decision Theory," *Annual Rev. Psych.*, Vol. 28 (1977), pp. 1–30.
103. ——— AND LICHTENSTEIN, S., "Comparison of Bayesian and Regression Approaches to the Study of Information Processing in Judgement," *Organizational Behavior and Human Performance*, Vol. 6 (1971), pp. 649–744.
104. SMITH, H. T. AND CRABTREE, R. G., "Interactive Planning: A Study of Computer Aiding in the Execution of a Simulated Scheduling Task," *Internat. J. Man-Machine Studies*, Vol. 7 (1975), pp. 213–231.
105. STABEL, C., "The Impact of a Conversational Computer System on Human Problem Solving Behavior," Working Paper, Sloan School of Management, MIT, 1973.
106. STEWART, T. F. M., "Special Report on Terminals," in I. L. Auerback (Ed.), *Best Computer Papers*, Petrocelli/Charter, New York, 1975.

107. SWANSON, E. B., "Management Information Systems: Appreciation and Involvement," *Management Sci.*, Vol. 21 (1974), pp. 178–188.
108. TAYLOR, R. N., "Age and Experience as Determinents of Managerial Information Processing and Decision Making Performance," *Acad. Management J.*, Vol. 18 (1975), pp. 74–81.
109. ———, "Psychological Determinents of Bounded Rationality: Implications for Decision Making Strategies," *Decision Sci.*, Vol. 6 (1975), pp. 409–429.
110. ——— AND DUNNETTE, M. D., "Relative Contribution of Decision-Maker Attributes to Decision Process," *Organizational Behavior and Human Behavior*, Vol. 12 (1974), pp. 286–298.
111. TRIANDIS, H. C., *Attitudes and Attitude Change*, Wiley, New York, 1971.
112. TUCKMAN, B., "Personality Structure, Group Composition and Group Functioning," *Sociometry*, Vol. 27 (1964), pp. 469–487.
113. VASARHELYI, M. A., "Man-Machine Planning Systems: A Cognitive Style Examination of Interactive Decision Making," *J. Accounting Res.*, Vol. 15 (1977), pp. 138–153.
114. VAUGHAN, W. S., JR. AND MAVOR, A. S., "Behavioral Characteristics of Men in the Performance of Some Decision Making Task Components," *Ergonomics*, Vol. 15 (1972), pp. 266–277.
115. WERNER, D. J., "A Study of the Use of an Experimental Information System in a Medical Environment," *Management Information*, Vol. 3, No. 3 (1974), pp. 133–142.
116. WITKIN, H. A., OLTMAN, P. K., RASKIN, E. AND KARP, S. A., *A Manual for the Embedded Figures Test*, Consulting Psychologists Press, Palo Alto, Calif., 1971.
117. WYNNE, B. A., "Cognitive Bases for Man-Machine Decision Information System User Attributes," *Proceedings*, Northeastern AIDS Meeting, Vol. 4 (1975), pp. 62–67.
118. ——— AND DICKSON, G. W., "Experienced Managers' Performance in Experimental Man-Machine Decision System Simulation," *Acad. Management J.*, Vol. 18 (1975), pp. 25–40.
119. ZMUD, R. W., "An Empirical Investigation of the Dimensionality of the Concept of Information," *Decision Sci.*, Vol. 9 (1978), pp. 187–195.
120. ———, "Perceptions of Cognitive Styles: Acquisition, Exhibition and Implications for Information System Design," *J. Management*, Vol. 5 (1979), pp. 7–20.
121. ———, "An Information Processing Conceptualization of the Systematic-Heuristic Cognitive Style," Working Paper, Department of Information Systems, Georgia State University, 1979.
122. ——— AND COX, J. F., "The Implementation Process: A Change Approach," *MIS Quart.*, Vol. 3, No. 2 (1979), pp. 35–43.
123. ——— AND CAIN, D. D., "Conceptual Framework and Systems Analyst Job-Fit," Working Paper, Department of Information Systems, Georgia State University, 1979.