

**An Empirical Reassessment of the Measure of
Information System Sophistication**

by

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ABSTRACT

For over a decade, Richard Nolan's stage model on the assimilation of information system (IS) technology has received a significant amount of attention from both academicians and practitioners. The existing empirical studies addressing aspects of the stage model have shown mixed results. This might be due to the inability of the existing questionnaires in capturing the essence of the stage model. To provide added perspective, this study adapted Nolan's stage benchmarks to develop and test a questionnaire which seems to better capture the essence of the stage model than the existing ones. One hundred and twenty-three companies participated in the study. The results indicated that the instrument possesses reliability and validity in measuring the stages of IS sophistication. The DP-expenditure benchmark was confirmed to have no discriminating power between IS growth stages. It was found that 1) DP expenditures of most firms grow less than the rate of sales growth regardless of the stage of IS growth, 2) the higher the ratio of EDP/MIS budget to sales, the higher the growth of DP expenditure, 3) a company with a higher applications-portfolio stage tends to have a higher DP-planning-and-control or user-awareness stage, and vice versa, 4) a company with a higher technology stage or a higher DP-organization stage does not necessarily have a higher applications-portfolio, DP-planning-and-control, or user-awareness stage, and 5) the composite average of the five benchmarks (excluding the DP-expenditure one) appears to represent the overall status of an organization's IS sophistication and may be used by prospective researchers as a relative measure to compare stages of IS growth between two or more organizations.

INTRODUCTION

Using information systems (ISs) as competitive weapons has recently become a popular business strategy (Parsons, 1983; Benjamin, et al., 1984; Ives and Learmonth, 1984; McFarlan, 1984; Rockart and Scott Morton, 1984; Porter and Millar, 1985). To implement such a strategy, one must assess the existing IS sophistication of one's organization. By IS sophistication, we mean the *overall status of an organization's IS within its growth process*. A popular theory of IS growth process was proposed by Nolan (1973) almost two decades ago. At first, Nolan proposed that the IS of an average company evolves along four stages, namely, *initiation, contagion, control, integration*. A year later, Gibson and Nolan (1974) redefined the stages as *initiation, expansion, formalization, and maturity*. Finally, Nolan (1979) expanded the process into six stages: *initiation, contagion, control, integration, data administration, and maturity*. During Stage 1, only a few functional cost reduction applications (typically accounting) are automated. Controls are notably lacking. In Stage 2, automation of labor-intensive operational systems proliferates throughout the organization. Some of these systems are poorly designed due to the lack of effective IS management control. Maintenance of such poorly-designed systems begins to occupy 70% to 80% of the productive time. In Stage 3, a basic shift in orientation from management of the computer to management of the company's data resources takes place. The stage, paraphrasing Nolan (1979) is characterized by rebuilding and professionalizing the IS activity to give it more standing in the organization and by initial attempts to develop user accountability for the IS expenditures incurred. During Stage 4, data base and data communication technologies are brought into several key application areas. The computer utility and network reach a point where high-quality services are being reliably provided to the users. Users perceive the real value of IS and demand more support from IS causing IS expenditures to surge. The redundancy of data complicates the use of planning and control systems. Demands grow for better control and more efficiency. In Stage 5, data administration is introduced and organization-wide integration of applications takes place. Computer and data resources are tightly controlled and users are effectively

held accountable for data quality and for value-added end use. Finally, in Stage 6, the applications portfolio is completed and its structure mirrors the information flows in the company. End user and IS staff are jointly accountable for effective design of valued added applications. While controls remain very tight, planning becomes strategic and demand and supply of IS services are balanced. At this point, the organization's IS reaches its maturity.

This growth model was adapted from the stage theories of economic growth which are based on the premise that elements in systems move through a pattern of distinct stages over time and that these stages can be described (Nolan, 1973, p. 399). There are two guidelines for developing a stage theory (Kuznets, 1965, pp. 213-216). First, the characteristics of each stage should be distinct and empirically testable. Second, the analytical relationship of any stage to its predecessor or successor should be well defined; it must be possible to identify what processes cause an element to move from one stage to the next. Following these guidelines, Nolan described a two-level analysis of six benchmarks (or elements) to identify the stage of an organization's IS sophistication. The first-level analysis is based on *DP (data processing) expenditure* and *technology* benchmarks, while the second-level uses *applications portfolio*, *DP organization*, *DP planning and control*, and *user awareness* benchmarks. The characteristics of these benchmarks in each stage are shown in TABLE 1. The purpose was to provide a framework useful for identifying issues and evaluating and controlling the IS growth process. It allows the management to place the life crises of the IS department in perspective, to develop the management techniques necessary at various points, to manage the human issues involved during the IS growth process, and to facilitate communication between the IS manager and the senior management (Gibson and Nolan, 1974, p. 76).

*** INSERT TABLE 1 ABOUT HERE ***

Evaluation of the Stage Model

Being a robust stage model, most of Nolan's benchmark framework can be applied to changing IS environment as information technology advances. Since its inception, Nolan's stage model has received a significant amount of attention from both academicians and practitioners. While many researchers have adopted the stage model to determine a firm's stage of IS sophistication (Drury and Bates, 1979; Benbasat, et al., 1980; Goldstein and McCririck, 1981; Ein-Dor and Segev, 1982; Drury, 1983; Mahmood and Becker, 1986), others (Lucas and Sutton, 1977; King and Kraemer, 1984) have cast a considerable doubt on its validity. Benbasat, et al. (1984) reviewed the existing empirical studies (Lucas and Sutton, 1977; Drury and Bates, 1979; Benbasat, et al., 1980; Goldstein and McCririck, 1981; Ein-Dor and Segev, 1982; Drury, 1983) that have addressed various aspects of Nolan's stage model. They summarized that the hypotheses concerning senior management, user awareness, and the progression of increasingly formalized management of the IS function have been generally supported. However, those concerning the S-shaped budget, the applications portfolio, and data administration have clearly been rejected. The other hypotheses about chargeback systems, organizational positioning of ISs, and steering committees have yielded mixed results. Despite the many criticisms exist in the literature, the stage model has had two theoretical contributions (King and Kraemer, 1984, p. 474):

1. It makes explicit the notion that the growth of computing is influenced by forces both inside and outside the organization.
2. It introduces a powerful construct of interplay between freedom and constraint in the control of computing that yields periodic states of equilibrium.

As Benbasat, et al. (1984, pp. 484-485) stated, Nolan's stage model "played an important role in moving the IS field toward a sounder scientific footing through its coherent explanation of interrelated phenomena." They further argued that "the negative empirical evidence is also subject to the potential criticism that the researchers have failed to properly capture the essence of Nolan's model." Although the existing empirical support for the stage model as a collective indicator of IS sophistication is

unconvincing, "there is evidence that the individual benchmark variables are of interest individually in spite of their collective difficulties" (Drury, 1983, p. 68). It is our contention that such "collective difficulties" might be due to the inability of the existing questionnaires in capturing the "essence" of the stage model.

Bringing the Stage Model Up to Date

In addition to the inability of capturing the essence of the model, there is another shortcoming of Nolan's stage model yet to be overcome. Because it was conceived in 1973 and updated in 1979, the existing model failed to consider two latest IS issues emerging since the 1980s, i.e., end-user computing (Benson, 1983; Rockart and Flannery, 1983; Munro, et al., 1988; Doll and Torkzadeh, 1989) and the use of IS as a competitive weapon (Parsons, 1983; Benjamin, et al., 1984; Ives and Learmonth, 1984; McFarlan, 1984; Rockart and Scott Morton, 1984; Porter and Millar, 1985).

In addition, Nolan's model did not take into account the recent proliferation of microcomputers which has allowed a business of any size to perform on-line database or interactive processing during the earlier stages of IS growth process. To rectify these weaknesses, the existing specifications of stage benchmarks must be modified.

Experience has shown that end-user computing begins to some extent when a company starts distributing microcomputers and database technology to its functional areas. This practice typically begins at the integration stage, after the stage of centralized stringent control of IS. Therefore, the specification of user-awareness benchmark should be modified after stage 3 (see Appendix). Moreover, the use of end-user computing tools such as database management systems, fourth generation languages, decision support systems should be indicated in the application-portfolio benchmark. An effective management of end-user computing should be indicated in stage 6 of the DP planning-and-control benchmark.

Regarding the use of IS as a competitive weapon, it was expected that a company would do so only if its application integration is "mirroring" the information flows. Consequently, the specification of stage 6 in the application-portfolio benchmark should be revised to include such use of IS. For the proliferation of microcomputers, some percentages of microcomputer usage should be assigned to the first three stages of the technology benchmark. These percentages should be less than 10% which is the total possible percentage of microcomputer usage allocated for stage 4 by Nolan (1979).

Given the above updated specifications, this study set out to develop a questionnaire which could better capture the essence of the stage model. The reliability and validity of this new questionnaire were examined and compared with the existing ones. During the process of analysis, the current IS status of the U.S. industries in terms of stage benchmarks was explored.

PREVIOUS STUDIES

Operationalizing the Stage Benchmarks

Among the various empirical studies concerning Nolan's stage benchmarks, only Drury (1983) and Mahmood and Becker (1986) have operationalized the entire six benchmarks and assessed the validity of their instruments. In Drury's study, the respondents were asked to indicate whether their ISs conform closely to the stage characteristics delineated by the benchmarks. The instrument consists of six multiple-choice questions, each measuring a benchmark variable. For each question, six choices were offered (Drury, 1983, p. 60), each describing the characteristics consistent with those listed in TABLE 1. TABLE 2 exhibits an example of Drury's questionnaire items.

*** INSERT TABLE 2 ABOUT HERE ***

In contrast, Mahmood and Becker adopted most of Drury's questionnaire except those questions related to technology and DP-planning-and-control benchmarks. For the technology benchmark, the stages were assigned based on the percentages of the total computer usage for each category of computer technology. The categories include service bureaus, local batch processing, remote job entry processing, etc., which are consistent with Nolan's (1979) specifications. For the DP-planning-and-control benchmark, the respondents were asked to indicate the extent of three planning and control activities being undertaken by their organizations (see TABLE 2). Each of these activities was measured on a 7-point Likert-type scale ranging from 1 (strongly agree) to 7 (strongly disagree). The stage of that benchmark was then subjectively assigned by the authors using the scores of the three activities. However, they did not describe the assignment process in detail.

Using the responses from 144 IS executives, Drury's study disclosed that the DP-expenditure benchmark has no discriminating power between IS growth stages. On the contrary, Mahmood and Becker analyzed the responses from 57 IS executives and found the same benchmark to be significantly (at the 0.01 level) related to not only the other benchmarks but also the composite average of the six benchmarks. While Drury's finding is consistent with an earlier study by Lucas and Sutton (1977), Mahmood and Becker's is not. This contradiction may be due to the small sample size ($N = 57$) of the latter study and perhaps the respondents' bias toward the questions in both studies. In fact, an examination of the stage characteristics reveals that the stages of both the DP-expenditure and technology benchmarks are not as easily distinguishable as are the other (second-level) benchmarks. Each characteristic of the DP-expenditure benchmark is shared by two different stages. Furthermore, many processing modes in the technology benchmark are not mutually exclusive. For example, the characteristic of "DP expenditure growth exceeds the rate of sales growth" may be used to classify the respondent into either stage 2 or stage 4; the percentage of database processing might include some inquiry processing at stage 3, etc. (see the two first-level benchmarks in TABLE 1). It might be this ambiguity which has caused the mixed results from the two studies. In order to overcome this problem, the authors set out to develop a questionnaire whose items are mutually exclusive. The reliability and validity of the new questionnaire were then examined in comparison with those of Drury (1983) and Mahmood and Becker (1986) to confirm the improvement in the new questionnaire design.

Reliability and Validity

Between the studies of Drury (1983) and Mahmood and Becker (1986), only the latter reported the alpha reliability coefficient (Cronbach, 1951). Mahmood and Becker found a 0.78 level of reliability coefficient for the six benchmark variables. However, this alpha value was very questionable for the following reasons. First, their instrument included the DP-expenditure benchmark which was unreliable and highly correlated with the rest of the benchmarks in their sample. Second, their sample size was somewhat small ($N = 57$). Third, their method for assigning separate stages to the technology benchmark was ambiguous as illustrated in TABLE 2 and discussed above. Therefore, the reliability of these benchmark variables needs to be reassessed.

Regarding the content validity, both studies had reported Spearman correlations among the five benchmark variables in which the DP-expenditure benchmark was excluded. Six of 10 possible correlations were significant at the 0.05 level in Mahmood and Becker's study; 9 out of 10 were in Drury's. This indicates that Drury's instrument seems to have a higher content validity than Mahmood and Becker's.

As for construct validation, one method is to examine the Spearman correlations between the benchmark variables and their composite average (Kerlinger, 1973, p. 468). While Drury did not report such correlations, Mahmood and Becker reported that the composite average of the six benchmark variables relates significantly with all the individual benchmark variables at the 0.001 level.

This suggests that the composite variable may serve well as a surrogate measure of an organization's overall IS sophistication. However, because their unreliable DP-expenditure variable was significantly correlated with the other benchmark variables ($0.386 < r < 0.680$, and $0.05 > p > 0.0001$), to include it in the composite variable is bound to deceptively increase the correlations of all the benchmark variables with the composite one. This weakness calls for a reexamination of the construct validity.

In summary, while Drury reported the content validity of five benchmark variables, Mahmood and Becker reported the reliability, the content validity, and the construct validity of all six benchmark variables. However, the ambiguity of the questionnaire design discussed above has made the reliability and validity of both studies questionable. The purpose of this study is to overcome this problem by: 1) redesigning the existing questionnaires into a new one which could better capture the essence of Nolan's model, 2) reassessing the reliability and validity of the redesigned questionnaire, and 3) comparing the reliability and validity of the redesigned questionnaire with those of Drury (1983) and Mahmood and Becker (1986).

RESEARCH METHODOLOGY

Subjects

A random sample of 1000 companies was selected from a recent issue of the *Standard and Poor's* directory. The questionnaire was sent to the IS executives of these companies along with a cover letter assuring the respondent's confidentiality. One hundred and thirty three questionnaires (or 13.3%) were completed and returned. Among them, 10 could not be used due to excessive missing values, leaving 123 (12.3%) usable. Such low response rate was expected for the following reasons:

The questionnaire items for this study were only a part of a large survey which contains over 150 questions.

The questionnaires were sent without prior knowledge on the part of the managers.

Several companies have policies against completing unsolicited questionnaires.

Some companies, especially the small ones, whose DP management activities are performed mainly by external service vendors may not have a DP or IS (EDP/MIS) manager in house to complete the questionnaire.

Several managers on the directory have changed jobs or left the companies and could not be located.

Several companies changed their addresses and the questionnaire could not be forwarded.

Some subjects who were under time pressure refused to answer the questionnaire.

The Questionnaire for Benchmark Variables

For this study, multiple-choice questions were developed to measure all of the benchmarks except the technology benchmark. Each of the questions for the second-level benchmarks offered six choices representing the six stages. The specification of each choice was carefully designed to provide mutually exclusive characteristics that capture the essence of Nolan's stage model. In order to keep the model up to date, the two latest IS issues, end-user computing and the use of IS as a competitive weapon, were incorporated into the choices. It should be noted that there are only three distinctive characteristics offered by Nolan for the DP-expenditure benchmark. Therefore, only three choices are specified in the question. However, due to its lack of discriminating power between stages (Lucas and Sutton, 1977; Goldstein and McCrick, 1981; Drury, 1983), the DP-expenditure benchmark was not included in the equally-weighted composite benchmark which is intended to indicate the overall status of an organization's IS sophistication. That is, the composite score was derived from averaging the scores of the remaining five benchmarks. As for the technology benchmark, a format similar to that of Mahmood and Becker was adopted. A scrutiny of the specification for the technology benchmark as shown in TABLE 1 reveals that it encompasses three aspects of data

processing: *data processing approach, mode of data processing, and computing hardware expenditures*. The respondents were therefore asked to supply the percentage of these three categories. A stage identification was assigned to each category based on the decision rules enumerated in TABLE 3. Note that the percentage assignment is somewhat different from that of Nolan in order to make the characteristics between stages more distinguishable. For example, Nolan did not prescribe any database or interactive processing activities in the first two stages. Nor did he prescribe any microcomputer usage in the first three stages. Such conditions are unreal given the proliferation of microcomputers in today's companies. Therefore, some percentage value between zero and the one prescribed by Nolan for the later stage was assigned to each of these stages (see TABLE 3). The stage identification for the technology benchmark is then assigned according to the rounded-off composite average of the stage scores in the three categories. The questionnaire items for all the six benchmarks are shown in the Appendix. At the end of the questionnaire, two demographic questions related to the DP-expenditure benchmark (i.e., annual company sales and annual EDP/MIS budget) were included. An additional variable, the percentage ratio of EDP/MIS budget to company sales, was computed.

*** INSERT TABLE 3 ABOUT HERE ***

Demographic Characteristics of the Respondents

The respondents are all from for-profit organizations. Eight-five (69%) of them are in manufacturing and 38 (31%) are non-manufacturing. They represent a wide variety of business sectors including auto supplies, computers, electric and electronic products, food products, equipment and machinery, primary and fabricated metal, textile and apparel, retailing, wholesaling, petroleum, investment, printing, telecommunication, entertainment, insurance, mining, hotel services, engineering, consulting services, transportation, medical, and utilities, etc. The annual sales of the companies range from \$11 million to \$50 billion. The numbers of employees in the companies range from 115 to 232,000. The annual EDP/MIS budget ranges from \$100,000 to \$800 million. The ratios of EDP/MIS budget to company sales range from 0.01% to 9.78%. Furthermore, the numbers of EDP/MIS employees range from 1 to 4,000, and the years of company's EDP/MIS experience range from 3 to 44 years. TABLE 4 shows the profile of the respondents' companies. Such diverse distribution in size and type of the surveyed firms as well as in size and experience of their IS organizations allows us to explore the state of IS sophistication in the industries as a whole.

*** INSERT TABLE 4 ABOUT HERE ***

Procedure

The questionnaire was pretested three times with local IS managers to ensure that the format and the wording of the questions were appropriate. The final questionnaire was sent to each of the executives. Three months later, a second wave of mailing was sent to the non-respondents. Between the two waves of mailing, 71 usable questionnaires were from the first wave and 52 were from the second one. In order to examine the non-response bias, a series of chi-square and *t* tests were conducted between the two samples. The former tests are for the questions with ordinal scales and the latter ones are for the ratio (percentage) scale. The results show no significant difference in any responses from the two samples.

Since there is no evidence of non-response bias, the samples of the two waves were merged as one for further analyses. The content validity of the five benchmarks was first examined based on their inter-item correlations. Cronbach's (1951) reliability coefficient was also computed. Partial correlations between the composite benchmark and the individual variables were then examined to identify their latent relationships. The inter-item correlations of the five benchmarks were further compared with those of Drury (1983) and of Mahmood and Becker (1986).

RESULTS AND DISCUSSION

Frequency Distributions

Based on the composite benchmark, none of the firms is located at the first (initiation) stage. Most of them (117 firms, 95.1%) are at the third stage or above. Almost half of them (58 firms, 47.2%) are at the fourth (integration) stage. TABLE 5 shows the frequency distribution of the composite benchmark as well as the six individual benchmarks. In terms of the individual benchmarks, more than half of the firms (65 firms, 54.2%) have their DP-expenditure growths less than the rate of sales growth. The majority of firms (71 firms, 58.7%) have an integration of applications and databases. Many DP organizations (42 firms, 35%) are operating under user-oriented programmers in different functional areas. Most of them (98 firms, 79.7%) have formal IS planning and control for computer or data resources. The acceptance of joint user and DP staff accountability is common to many IS operations (55 firms, 45.5%). Regarding the technology benchmark, most firms (90 firms, 75.6%) are at the fourth stage or above, i.e., they have established various distributed data processing (DDP) structures running on a mix of micro, mini, and mainframe computers. An overwhelming majority (112 firms, 94.1%) have adopted database technology (at the third stage or above) to process their data.

*** INSERT TABLE 5 ABOUT HERE ***

DP Expenditure Benchmark

Since this study excluded the DP-expenditure benchmark from the composite average score, cross-tabulations were performed to confirm the rationale for such exclusion. The DP-expenditure benchmark was cross-tabulated against each of the other benchmarks to see if the DP-expenditures characteristics at each stage of the latter benchmark are significantly different. TABLE 6 indicates that the DP expenditures of the most firms grow less than the rate of sales growth regardless of the stage of IS growth. None of the cross-tabulations reveals any significant difference in DP-expenditure growths between the stages at the 0.05 level of chi-square test. This finding confirms Lucas and Sutton's (1977) argument that the rate of DP-expenditure growth is not an "S" curve as prescribed by Nolan. It is based primarily on a percentage increase in the prior year's budget (Lucas and Sutton, 1977, p. 258) and stable across all development stages (Drury, 1983, p. 60). Therefore, Nolan's DP-expenditure benchmark is not indicative of the status of IS growth process and should be excluded from the benchmark instrument.

Subsequently, an analysis of variance was conducted to explore the significant differences of the three demographic variables as a function of the DP-expenditure benchmark. Only one demographic variable (the ratio of EDP/MIS budget to sales) was found to have significantly different means among the stages of the DP-expenditure benchmark (see TABLE 7). The result indicates that those companies whose DP-expenditure growths exceed the rates of sales growth appear to have higher ratios (2.18 on average) of EDP/MIS budget to sales than the others. The average ratio drops (to 1.29) as the DP-expenditure growth starts tracking the rate of sales growth. Companies whose DP-expenditure growths are less than the rates of sales growth appear to have the smallest ratio (1.10 on average). This finding suggests that the growth of DP expenditure does not relate to the company's annual sales or the annual EDP/MIS budget alone. It relates to the percentage ratio of the two. The higher the ratio of EDP/MIS budget to sales, the higher the growth of DP expenditure.

*** INSERT TABLE 6 ABOUT HERE ***

*** INSERT TABLE 7 ABOUT HERE ***

Validity and Reliability of the Five Benchmarks

To examine the content validity of the five benchmarks, both Pearson and Spearman correlations among the benchmarks were computed. TABLE 8 shows that 8 Pearson correlations and 7 Spearman correlations (out of 10 examined) are significant at the 0.05 level, indicating the content validity of the benchmarks. In terms of Spearman correlations, the three correlations among the

technology, applications-portfolio, and DP-organization benchmarks were found to be insignificant. A scrutiny of TABLE 8 discloses that both the technology and the DP-organization benchmarks relate only slightly (from -0.096 to 0.245) with each other and with the other three benchmarks. This implies that each of the two benchmarks may measure a specific domain of IS sophistication, completely different from the other benchmarks. This finding is manifested by the Spearman partial correlations among the benchmark variables. As shown in TABLE 8, the partial correlations of the technology and DP-organization benchmarks with the rest of the individual benchmarks are invariably insignificant. However, those among applications-portfolio, DP-planning-and-control, and user-awareness benchmarks have remained significant ($p < 0.05$).

Since there are many low Pearson correlations among the benchmark variables, the value of the reliability coefficient (Cronbach's alpha) is expected to be negatively affected. As a result, the reliability coefficient of the five-benchmark instrument was found to be 0.65, which is somewhat below the 0.70 minimum recommended by Nunnally (1978, p. 245). Nevertheless, given that the instrument has only five benchmark variables, this level of reliability is quite respectable. Besides, all the Spearman correlations and partial correlations between the five benchmark variables and their composite average were found to be significant at the 0.001 level, supporting the validity of the composite benchmark in representing the underlying structure of IS sophistication (Kerlinger, 1973, p. 468). Such validity is known as the construct validity (Kerlinger, 1973, p. 461). In short, the empirical evidence obtained by this study appears to support the reliability, the content validity, and the construct validity of the instrument.

*** INSERT TABLE 8 ABOUT HERE ***

Comparison with Previous Studies

The Spearman correlations among the benchmark variables were further compared with those of Drury (1983) and Mahmood and Becker (1986). TABLE 9 indicates that while this study has 7 significant correlations, Drury's study has 9 and Mahmood and Becker's has 6 (out of 10 possible correlations). The correlations from this study are consistent with most (6 out of 10) of Drury as well as most (7 out of 10) of Mahmood and Becker. However, only four correlations were found to be consistently significant across the three studies. While applications-portfolio benchmark appears to relate significantly with the user-awareness benchmark, the DP-planning-and-control benchmark relates significantly with the technology, DP-organization, and user-awareness benchmarks. Regarding the alpha reliability coefficient, only Mahmood and Becker reported a doubtful level of 0.78 which is somewhat higher than the one (0.65) reported in this study. Nevertheless, the significant correlations between the composite and the individual benchmarks in their study are consistent with this study. Unfortunately, Drury did not report these correlations, otherwise, further comparison could provide additional insight.

*** INSERT TABLE 9 ABOUT HERE ***

CONCLUSIONS AND IMPLICATIONS

Measuring an organization's IS sophistication is undoubtedly a complex matter. The theoretical foundation of Nolan's stage benchmarks seems to provide a plausible direction to proceed with this measuring endeavor. The empirical assessments of the stage benchmarks in the literature have shown mixed results, which we have attributed to the differences in their questionnaire designs. To provide an added perspective, this study refines the existing questionnaires and analyzes the data collected from 123 IS executives. The results support the reliability and validity of the five stage benchmarks (excluding the DP-expenditure one). Overall, several conclusions and their implications may be drawn from this study:

The questionnaire designed for this study possesses reliability and validity. It minimizes the ambiguity

in the characteristics identifying the IS growth stages. It is superior to those of Drury (1983) and Mahmood and Becker (1986) in capturing the essence of stage theory while maintaining ease of operationalization.

The DP-expenditure benchmark is not indicative of the stage of IS sophistication. Mahmood and Becker (1986) should have excluded it from calculating the composite benchmark. However, such a benchmark can be used as a demographic variable similar to the EDP/MIS budget and the ratio of EDP/MIS budget to sales to indicate the growth of DP expenditure. Most of the firms have growths in their DP expenditures less than the rate of sales growth regardless of the stage of IS growth.

The growth of DP expenditure does not relate to the company's annual sales or annual EDP/MIS budget alone, but to the percentage ratio of the two. Companies having high ratio of EDP/MIS budget to sales tend to have higher growth rate of DP expenditure than the others. However, high ratio does not mean high IS sophistication. That is, the budget-to-sales ratio or DP-expenditure growth rate only indicates how much IS resources are available, not how well they are used and managed --- a question left to be addressed by the second level benchmark analysis.

The technology and the DP-organization benchmarks each seems to measure a specific domain of IS sophistication completely different from the other benchmarks. That is, a company with a higher technology stage or a higher DP-organization stage may not have a higher applications portfolio, DP planning-and-control, or user awareness stage.

The inter-item correlations among the applications-portfolio, DP-planning-and-control, and user-awareness benchmarks are consistently significant and positive. This implies that a company with a higher applications-portfolio stage tends to have a higher DP-planning-and-control or user-awareness stage, and vice versa.

Finally, the five-item composite benchmark seems to represent the overall status of an organization's IS sophistication; it correlates significantly with each individual benchmark (excluding the DP-expenditure one). It can be used as a relative measure to compare the overall stages of IS growth between two or more organizations. However, it should be expected that unless a company has all its benchmarks in stage 6, it is very difficult to have a stage-6 composite benchmark. Only 5 of the 123 surveyed companies have reached that stage. Moreover, if a company did not reach the top score of the composite benchmark, it is very likely to have a "stage disparity" between the individual benchmarks. By "stage disparity," we mean that there exist two benchmarks whose stage scores are different (e.g., one is in stage 2 while the other in stage 4). A plausible rule of thumb is to allocate more resources to those benchmarks that are two or more stages lower than the highest benchmark. The wider the stage disparity, the more resources the poor benchmark should receive. For instance, if a company has a stage 6 in the technology benchmark, a stage 4 in the applications-portfolio benchmark, and a stage 2 in the DP-organization benchmark, attention should be directed to the DP-organization benchmark. More resources should be directed to moving the position of IS management to the upper level of organizational hierarchy and to changing the organizational culture into managing information as a corporate resource. Therefore, the use of a composite benchmark should be accompanied by the scores of the individual benchmarks to ensure appropriate interpretation. Such practice would allow the management of an organization having a stage disparity to realize the strengths and weaknesses of its ISs.

To measure how its IS sophistication stacked up against other firms, the management of a firm may follow the self-assessment process below:

1. complete the questionnaire as shown in the APPENDIX,
2. identify the stage of technology benchmark according to TABLE 3,
3. transcribe the stage number of each benchmark from the questionnaire to TABLE 5, and

4. compare the stage numbers with the corresponding industry means in TABLE 5. If so desired, the management may also total the percent of firms, as indicated in TABLE 5, having the stage number higher (or lower) than its own number. Once these comparative data are in place, IS management would be able to analyze the individual benchmark status so as to formulate specific strategies for improving the exceptionally poor benchmark status, and in turn, allocate its computing resources more effectively to different IS functional components.

We strongly believe that the revised questionnaire is the most concise short form for measuring Nolan's stage benchmarks. Based on the results of this study, the questionnaire seems to be reliable and valid. It is our hope that we have provided IS researchers with a tool for collecting relative measures of IS sophistication from companies across different industries. One possible future study is to present some real-life cases which use the questionnaire to diagnose the strengths and weaknesses of the ISs in various companies and provide IS management with guidelines for managing their IS resources. Another plausible study is to use the data collected from this questionnaire to further explore the relationships between IS sophistication and the demographic characteristics (e.g., size, industry, IS budget, years of IS experience, etc.), the organizational characteristics (e.g., innovation, IS climate, organizational mission, organizational policies, flexibility of organizational processes, quality of organizational resources, etc.), among other organizational variables.

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TABLE 1. Benchmarks of IS Growth Stages

		Stage Identification					
Levels	Benchmarks	Stage 1-- Initiation	Stage 2-- Contagion	Stage 3-- Control	Stage 4-- Integration	Stage 5-- Data Administration	Stage 6-- Maturity
First-level analysis	DP expenditure benchmark	Tracks rate of sales growth	Exceeds rate of sales growth	Is less than rate of sales growth	Exceeds rate of sales growth	IS less than rate of sales growth	Tracks rate of sales growth
	Technology benchmark	100% batch processing	80% batch processing 20% remote job entry processing	70% batch processing 15% data base processing 10% inquiry processing 5% time-sharing processing	50% batch and remote job entry processing 40% data base and data communications processing 5% personal computing 5% minicomputer and microcomputer processing	20% batch and remote job entry processing 60% data base and data communications processing 5% personal computing 15% minicomputer and microcomputer processing	10% batch and remote job entry processing 60% data base and data communications processing 5% personal computing 25% minicomputer and microcomputer processing
Second-level analysis of growth processes	Applications portfolio benchmark	Functional cost reduction applications	Proliferation	Upgrade documentation and restructuring existing applications	Retrofitting existing applications using database technology	Organization integration of applications	Application integration "mirroring" information flows
	DP organization benchmark	Specialization for technological learning	User-oriented programmers	Middle management	Establish computer utility	Data administration	Data resource management
	DP planning and control benchmark	Lax	More lax	Formalized planning and control	Tailored planning and control systems	Shared data and common systems	Strategic planning for data resource
	User awareness benchmark	"Hands off"	Superficially enthusiastic	Arbitrarily held accountable	Accountability learning	Effectively accountable	Acceptance of joint user and data processing accountability

Source: Adapted from Nolan (1979).

TABLE 2. Sample Questionnaire Items from Previous Studies

DP Expenditure Benchmark:^{a,b}

Which of the following statements best describes the DP expenditure in your organization?

- (1)Initiation: DP expenditure growth tracks the rate of sales growth
- (2)Contagion: DP expenditure growth exceeds the rate of sales growth
- (3)Control: DP expenditure growth is less than the rate of sales growth
- (4)Integration: DP expenditure growth exceeds the rate of sales growth
- (5)Data Administration: DP expenditure growth is less than the rate of sales growth
- (6)Maturity: DP expenditure growth tracks the rate of sales growth

Technology Benchmark:^{a,b}

Which of the following statements best describes the information systems technology in your organization?

- (1)100% batch processing
- (2)80% batch/ 20% remote job entry processing
- (3)70% batch/ 15% data base/ 10% inquiry/ 5% time-sharing processing
- (4)50% batch and remote job entry/ 40% data base and data communications/
5% personal computing/ 5% minicomputer and microcomputer processing
- (5)20% batch and remote job entry/ 60% data base and data communications/
5% personal computing/ 15% minicomputer and microcomputer processing
- (6)10% batch and remote job entry/ 60% data base and data communications/
5% personal computing/ 25% minicomputer and microcomputer processing

DP Planning and Control Benchmark:^{a,c}

To what extent do each of the following statements describe the type of planning and control activities typically undertaken by your organization?

- (a)Lax to facilitate applications development activity growth

1 2 3 4 5 6 7

Strongly agree | | | | | | | Strongly disagree

- (b)Formalized planning and control systems

Strongly agree | | | | | | | | Strongly disagree

(c) Data resource strategic planning

Strongly agree | | | | | | | | Strongly disagree

^a Adapted from Nolan (1979).

^b This question was constructed based on Drury's (1983) description because he did not publish his questionnaire. According to Drury (1983, p. 60), each respondent was offered six choices when evaluating a benchmark variable and each choice is consistent with one of the development stages for each variable.

^c Developed by Mahmood and Becker (1986).

TABLE 3. Stage Identification for Technology Benchmark

<i>Questionnaire Items for Technology Benchmark*</i>	<i>Stage Identification</i>					
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
1. Percent of shared database processing 0%, < 5% 5%, < 15% 15%, < 40% 40%, < 60% 60%, < 80% >= 80%	X	X	X	X	X	X
2. Mode of data processing Percent of interactive processing 0%, < 10% 10%, < 30% 30%, < 50% 50%, < 80% 80%, < 90% >= 90%	X	X	X	X	X	X
3. Computing hardware expenditures Percent of multi-/single-user micro's 0%, < 2% 2%, < 5% 5%, < 10% 10%, < 20% 20%, < 30% >= 30%	X	X	X	X	X	X

* The stage of technology benchmark is the rounded-off average of the three item's stage scores.

TABLE 4. Demographic Profile of the Companies

Characteristic	Number of Companies	Percent
Industry Type:		
Manufacturing	85	69
Non-manufacturing	38	31
Annual Company Sales:		
Small (less than \$100 million)	17	14
Medium (\$100 million to less than \$500 million)	29	24
Large (\$500 million to less than \$1 billion)	32	26
Very large (\$1 billion or more)	45	37
Number of Company Employees:		
500 or less	13	11
501 to 2,000	20	16
2,001 to 10,000	48	39
Over 10,000	42	34
Annual EDP/MIS Budget:		
Small (less than \$1 million)	21	17
Medium (\$1 million to less than \$5 million)	34	28
Large (\$5 million to less than \$20 million)	36	29
Very large (\$20 million or more)	11	9
No response	21	17
Ratio (%) of EDP/MIS Budget to Company Sales:		
Less than 0.5%	32	26
0.5% to less than 1%	25	20
1% to less than 2%	26	21
2% to less than 3%	10	8
3% or more	9	7
Unknown	21	17
Number of EDP/MIS Employees:		
10 or less	18	15
11 to 50	42	34
51 to 200	41	33
Over 200	11	9
No response	11	9
Years of Company's EDP/MIS experience:		
Less than 5 years	3	2
5 to 10 years	15	12
11 to 20 years	28	23
21 to 30 years	46	37
Over 30 years	7	6
No response	24	19

TABLE 5. Frequency Distribution of the Benchmark Variables

Stage Characteristics of Benchmark Variables	Item Code	Frequency	(%)	Mean	Std Dev
DP Expenditure Benchmark:					
DP expenditure growth exceeds the rate of sales growth	(1)	22	18.3		
DP expenditure growth is less than the rate of sales growth	(2)	65	54.2		
DP expenditure growth tracks the rate of sales growth	(3)	33	27.5		
		N = 120	100.0	2.092	0.674
Applications Portfolio Benchmark:					
Functional cost reduction applications	(1)	0	0.0		
Proliferation of labor-intensive applications	(2)	4	3.3		
Restructuring into database applications	(3)	12	9.9		
Retrofitting into more database applications	(4)	34	28.1		
Integration of applications and databases	(5)	39	32.2		
Application integration "mirroring" information flows	(6)	32	26.4		
		N = 121	100.0	4.686	1.073
DP Organization Benchmark:					
Specialization for technological learning	(1)	3	2.5		
User-oriented programmers supporting functional areas	(2)	42	35.0		
DP organization is moved up to middle management	(3)	20	16.7		
Focuses on data custodian and computer utility	(4)	29	24.2		
Focuses on data administration	(5)	6	5.0		
Become top management focusing data resource mgt.	(6)	20	16.7		
		N = 120	100.0	3.442	1.488
DP Planning and Control Benchmark:					
Lax management and lack of controls	(1)	7	5.7		
More lax, sales-oriented management and lax controls	(2)	18	14.6		
Formalized planning and control	(3)	34	27.6		
Tailored planning and control systems	(4)	29	23.6		
Effective planning and control systems	(5)	18	14.6		
Strategic planning and control for data resource	(6)	17	13.8		
		N = 123	100.0	3.683	1.410
User Awareness Benchmark:					
User is hands off but knows advantages of automation	(1)	5	4.1		
User is superficially enthusiastic	(2)	7	5.8		
User is arbitrarily held accountable	(3)	9	7.4		
User is accountable for data quality and data use	(4)	31	25.6		
End-user computing and effective chargeback system	(5)	14	11.6		
Acceptance of joint user and DP staff accountability	(6)	55	45.5		
		N = 121	100.0	4.711	1.457
Technology Benchmark:^a					
0.0, < 1.5	(1)	0	0.0		
1.5, < 2.5	(2)	7	5.9		
2.5, < 3.5	(3)	22	18.5		
3.5, < 4.5	(4)	55	46.2		
4.5, < 5.5	(5)	32	26.9		
5.5	(6)	3	2.5		
		N = 119	100.0	4.017	0.892
Composite Benchmark:^b					
0.0, < 1.5	(1)	0	0.0		
1.5, < 2.5	(2)	6	4.9		
2.5, < 3.5	(3)	18	14.6		
3.5, < 4.5	(4)	58	47.2		
4.5, < 5.5	(5)	36	29.3		

5.5	(6)	5	4.1		
		N = 123	100.0	4.130	0.887

^a Composite average of the three categories: data processing approach, mode of data processing, and computing hardware expenditures.

^b Composite average of the five benchmarks: applications portfolio, DP organization, DP planning and control, user awareness, and technology. Missing values were excluded from calculation.

TABLE 6. Frequency Distributions of DP Expenditure by Benchmark Variables

Stage Characteristics of DP Expenditure Benchmark	Item I.D.	Stage Identification						Row Total
		1	2	3	4	5	6	
Composite Benchmark:^a								
DP expenditure growth exceeds the rate of sales growth	(1)	0	2*	4	8*	8	0	22
DP expenditure growth is less than the rate of sales growth	(2)	0	3	12*	32	15*	3	65
DP expenditure growth tracks the rate of sales growth	(3)	0*	1	2	16	12	2*	33
		0	6	18	56	35	5	120
		0.0	5.0	15.0	46.7	29.2	4.2	100.0
Technology Benchmark:								
DP expenditure growth exceeds the rate of sales growth	(1)	0	2*	6	11*	2	1	22
DP expenditure growth is less than the rate of sales growth	(2)	0	5	9*	31	18*	1	64
DP expenditure growth tracks the rate of sales growth	(3)	0*	0	7	12	12	1*	32
		0	7	22	54	32	3	118
		0.0	5.9	18.6	45.8	27.1	2.5	100.0
Applications Portfolio Benchmark:								
DP expenditure growth exceeds the rate of sales growth	(1)	0	1*	2	5*	7	7	22
DP expenditure growth is less than the rate of sales growth	(2)	0	3	7*	24	18*	12	64
DP expenditure growth tracks the rate of sales growth	(3)	0*	0	2	5	14	11*	32
		0	4	11	34	39	30	118
		0.0	3.4	9.3	28.8	33.1	25.4	100.0
DP Organization Benchmark:								
DP expenditure growth exceeds the rate of sales growth	(1)	0	13*	3	3*	2	1	22
DP expenditure growth is less than the rate of sales growth	(2)	1	18	12*	18	3*	12	64
DP expenditure growth tracks the rate of sales growth	(3)	2*	10	5	7	1	7*	32
Column Total:		3	41	20	28	6	20	118
Percent:		2.5	34.7	16.9	23.7	5.1	16.9	100.0
DP Planning and Control Benchmark:								
DP expenditure growth exceeds the rate of sales growth	(1)	2	3*	5	4*	4	4	22
DP expenditure growth is less than the rate of sales growth	(2)	3	13	20*	12	9*	8	65
DP expenditure growth tracks the rate of sales growth	(3)	2*	2	8	11	5	5*	33
Column Total:		7	18	33	27	18	17	120
Percent:		5.8	15.0	27.5	22.5	15.0	14.2	100.0
User Awareness Benchmark:								
DP expenditure growth exceeds the rate of sales growth	(1)	1	1*	3	4*	3	9	21
DP expenditure growth is less than the rate of sales growth	(2)	2	5	5*	17	8*	27	64
DP expenditure growth tracks the rate of sales growth	(3)	2*	1	1	10	2	17*	33
Column Total:		5	7	9	31	13	53	118
Percent:		4.2	5.9	7.6	26.3	11.0	44.9	100.0

* This cell is expected to have the largest value among the cells on the same column based on Nolan's (1979) specifications of DP-expenditure stages.

^a Composite average of five benchmarks (without the DP expenditure benchmark).

TABLE 7. Demographic Variables by the Stage of DP Expenditure Benchmark

Demographic Variables	Stage^a	N	Mean	Std. Dev.	Minimum	Maximum
Annual sales in \$,000,000	1	22	4,042.98	10,999.27	15	49,860
	2	65	1,357.79	1,691.63	11	9,400
	3	33	1,997.35	3,462.16	35	14,000
Annual EDP/MIS budget in \$,000	1	19	11,362.63	19,950.50	115	90,000
	2	56	7,400.84	9,306.95	100	42,000
	3	26	39,612.69	155,933.23	150	800,000
Ratio (%) of EDP/MIS budget to sales *	1	19	2.18	1.78	0.42	6.25
	2	56	1.10	1.52	0.01	9.78
	3	26	1.29	1.47	0.02	6.78

^a Only three distinct stage characteristics are available for this benchmark variable.

* $p < 0.05$ based on *F* test.

Table 8. Correlation Matrices of Benchmark Variables

Benchmark Variables	Technology	Applications Portfolio	DP Organization	DP Planning & Control	User Awareness
Pearson Correlations: (Average Correlation = 0.268599)					
Applications Portfolio	0.22341 (.0155)*				
DP Organization	-0.04376 (.6395)	0.17428 (.0569)			
DP Planning and Control	0.21759 (.0174)*	0.41577 (.0001)***	0.25518 (.0049)**		
User Awareness	0.30243 (.0009)***	0.42272 (.0001)***	0.21509 (.0188)*	0.50328 (.0001)***	
Composite Benchmark	0.40107 (.0001)***	0.61729 (.0001)***	0.53429 (.0001)***	0.70842 (.0001)***	0.74647 (.0001)***
Spearman Correlations: (Average correlation: 0.224902)					
Applications Portfolio	0.13887 (.1354)				
DP Organization	-0.09587 (.3039)	0.11845 (.1976)			
DP Planning and Control	0.19013 (.0383)*	0.41391 (.0001)***	0.20780 (.0228)*		
User Awareness	0.24489 (.0078)**	0.37046 (.0001)***	0.18506 (.0439)*	0.47532 (.0001)***	
Composite Benchmark	0.31927 (.0004)***	0.57723 (.0001)***	0.51466 (.0001)***	0.69597 (.0001)***	0.71292 (.0001)***
Spearman Partial Correlations:^a					
Applications Portfolio	0.02720 (.7749)				
DP Organization	-0.16122 (.0880)	0.00303 (.9746)			
DP Planning and Control	0.09043 (.3408)	0.28616 (.0021)**	0.17978 (.0567)		
User Awareness	0.18147 (.0544)	0.20695 (.0279)*	0.08542 (.3683)	0.36803 (.0001)***	
Composite Benchmark ^b	0.40939 (.0001)***	0.48299 (.0001)***	0.68426 (.0001)***	0.61547 (.0001)***	0.64255 (.0001)***

^a Partial correlation of each two benchmarks was computed by controlling the other three benchmarks.

^b Partial correlation of the composite benchmark with each benchmark was computed by controlling the other four benchmarks.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ based on two-tailed t test.

Table 9. Comparison of Spearman Correlation Matrices from Different Studies

Benchmark Variables	Technology	Applications Portfolio	DP Organization	DP Planning & Control	User Awareness
Applications Portfolio:					
This Study	0.13887 (.1354)				
Drury ^a	0.239 (.002)**				
Mahmood and Becker ^b	0.339 (.0086)**				
DP Organization:					
This Study	-0.09587 (.3039)	0.11845 (.1976)			
Drury	0.237 (.002)**	0.348 (.001)***			
Mahmood and Becker	0.085 (.5215)	0.214 (.1029)			
DP Planning and Control:					
This Study	0.19013 (.0383)*	0.41391 (.0001)***	0.20780 (.0228)*		
Drury	0.1945 (.010)**	0.0882 (.147)	0.214 (.005)**		
Mahmood and Becker	0.315 (.0152)*	0.539 (.0001)***	0.380 (.0030)**		
User Awareness:					
This Study	0.24489 (.0078)**	0.37046 (.0001)***	0.18506 (.0439)*	0.47532 (.0001)***	
Drury	0.159 (.028)*	0.158 (.028)*	0.234 (.002)**	0.300 (.001)***	
Mahmood and Becker	0.206 (.1172)	0.350 (.0067)**	0.213 (.1059)	0.356 (.0057)**	
Composite Benchmark:					
This Study ^c	0.31927 (.0004)***	0.57723 (.0001)***	0.51466 (.0001)***	0.69597 (.0001)***	0.71292 (.0001)***
Drury	N/A	N/A	N/A	N/A	N/A
Mahmood and Becker ^d	0.631 (.0001)***	0.733 (.0001)***	0.507 (.0001)***	0.751 (.0001)***	0.637 (.0001)***

- ^a Adapted from Drury (1983).
- ^b Adapted from Mahmood and Becker (1986).
- ^c Composite average of five benchmarks (without the DP expenditure benchmark).
- ^d Composite average of six benchmarks (including the DP expenditure benchmark).
- * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ based on two-tailed t test.

Appendix. Questionnaire Items for the Benchmarks of IS Growth Process

1. Which of the following best characterizes the **budget and expenditure** of your **current** EDP/MIS?

- (1)DP expenditure growth exceeds the rate of sales growth.
- (2)DP expenditure growth is less than the rate of sales growth.
- (3)DP expenditure growth tracks the rate of sales growth.

2. Please estimate the **percentage** of your **company-wide** EDP/MIS component or service in each category. Please write in your estimates as accurately as possible. Note that the **TOTAL** percentage of a category must be **equal to 100 %** as indicated at the bottom of each category.

DATA PROCESSING APPROACH:

Individual file approach: _____ %

Shared database approach: _____ %

Total:100 %

MODE OF DATA PROCESSING:

Off-line batch: _____ %

Remote job entry: _____ %

On-line batch: _____ %

On-line interactive: _____ %

Total:100 %

COMPUTING HARDWARE EXPENDITURES:

Mainframe/Super's: _____ %

Mini-computers: _____ %

Multi-user micro's: _____ %

Single-user micro's: _____ %

Total:100 %

3. Which of the following best characterizes the applications portfolio of your current EDP/MIS?

- (1) **First computer acquisition.** Begin functional cost reduction applications.
- (2) **Intense proliferation** of labor-intensive applications.
- (3) **Restructuring** existing applications and upgrade documentation. Begin time-sharing database applications.
- (4) **Retrofitting** existing applications using database technology. More on-line applications built around an integrated database. Easier access to data via data base management systems and 4th generation languages. Better timing of information.
- (5) **Organization-wide integration** of applications and databases. Flexible interactive data retrieval and application prototyping with a full-scale data base management system. Increasing use of decision models and decision support systems.
- (6) **Balance** between centralized shared data/common system applications and decentralized user-controlled applications. Application integration "mirroring" information flows. Use of EDP/MIS as a competitive weapon.

4. Which of the following statements best characterizes the organization of your current EDP/MIS?

- (1) DP organization is composed of technologists and operated as a "closed shop" with specialization for technology-learning.
- (2) DP organization consists of user-oriented programmers supporting each functional area.
- (3) DP organization is moved up to middle management level and assigned greater responsibility.
- (4) DP organization focuses on data custodian and the management of computer capacity, utility, and user accounts.
- (5) DP organization focuses on data administration.
- (6) DP organization is moved up to top management level and focuses on data resource management.

5. Which of the following statements best characterizes the **planning and control systems** of your **current** EDP/MIS?
- (1) **Lax management.** Controls notably lacking. Priorities assigned by FIFO.
 - (2) **More lax, sales-oriented management.** Lax controls. Few standards, informal project control.
 - (3) **Formalized planning and control.** Regard computer as a resource. Proliferation of controls. Control-oriented management. Formal priority setting, project management, and programming standards. Systems quality control and post system audits. Formal DP budget planning and justification.
 - (4) **Tailored planning and control systems.** Formal data-base standards and policies. Establish computer utility and reliability. Focus on capacity planning and pricing of computer services for engendering effective use of the computer.
 - (5) **Effective planning and control systems.** Formation of steering committee. Integrated shared databases and compatible systems.
 - (6) **Resource-oriented planning and control systems.** Regard data as a resource. Strategic planning for data resource. Effective management of end-user computing and databases.
6. Which of the following statements best characterizes the **user awareness** of your **current** EDP/MIS?
- (1) User is "hands off" but aware of the advantages of automation.
 - (2) User is superficially enthusiastic.
 - (3) User is arbitrarily held accountable.
 - (4) User is directly involved with data entry and data use and accountable for data quality and for value-added end use.
 - (5) Formalized end-user computing and effective value-added user chargeback system.
 - (6) Acceptance of joint user and DP staff accountability for data quality and for effective design of valued added applications.