An Empirical Reassessment of the Measure of Information System Sophistication

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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.

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).

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 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
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