Managing IS Development:
A Contingency-Growth Approach

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Since Nolan had proposed a growth stage model for information systems (IS) development, the term has become very popular in IS research areas. The research model proposed has made significant contributions to the IS field. For IS managers, this model provides a guideline to build and manage information systems effectively. For researchers, it has been used as an important tool controlling the confounding effects of the different information systems. Many researchers have made efforts to access the model’s validity and plausibility. Overall, these efforts have not been supportive to Nolan’s stage model. This paper will review Nolan’s growth stage model and its subsequent related research. Changes that have occurred during the last ten years in the IS area will be investigated. Based on a review of literature and our experience, a new conceptual framework for managing IS resources will be proposed.

Richard Nolan’s stage model is the best known and most widely cited model for describing and managing the growth of information systems. In 1973, Nolan proposed a model for the stages of growth of computer usage in organizations. Nolan elaborated on this model in the 1979 version in which the original four stages were expanded to six. Because of the model’s clarity in explaining growth patterns, it soon gained popularity with practitioners and researchers and became a widely cited model of computer evolution in organizations.

There are two main areas where growth stage models have been applied. The first application, as Nolan himself specified, is to provide a guideline to managers in explaining and analyzing the complex nature of IS development and to aid them in planning and managing IS resources.

The second application is to use the growth stage model as a confounding variable in designing IS research. IS research has been criticized for its inability to control confounding variables which influence the typical dependent variable - IS success. IS maturity, also called system complexity, has been known as an important confounding variable, but many times ignored by researchers. Several researchers recognized this problem but used it as a wrong measure. Delone
(1981) and Raymond (1985) in his critical success factor study in small business information systems included system maturity as an intervening variable to success, but age was used as an operational measure for this variable. It is not insightful to use age as a surrogate measure since it is based on the assumption that as time passes, a system becomes more mature: this assumption is not realistic. A better way is to use a growth stage model to control the intervening effects since the stage model can classify a specific IS into a stage not by the time factor but by many characteristics of the IS and its usages. Kim (1988) used Nolan’s stage model to control the maturity variable in his research.

As it gained fame, subsequent efforts have also been made to assess its empirical validity and plausibility (Benbasat et. al., 1984; Drury, 1983; King & Kraemer, 1984; Lucas & Sutton, 1977). Overall, several subsequent empirical studies have not been supportive of Nolan’s stage model although these studies have confirmed some value of the stage model. In this paper, various stage models including Nolan’s and the following criticisms are reviewed and investigated. Finally a new development model is suggested for the effective management of IS for practitioners and for the effective control of confounding variables for researchers.

**Growth Stage Models**

**Nolan’s Stage Model**

A model for the stages of growth of computer usage in organizations was proposed by Nolan in 1973 and is the best known growth stage model (Gibson & Nolan, 1974; Nolan, 1973; Nolan, 1979). After an extensive case study of three companies, he uncovered that the pattern of growth for the computer budget had shown a crude S-shaped curve behaviour. He proposed that the computer budget curve would serve as a useful surrogate for representing the growth phenomenon for use of computers in organizations and that the tasks such as planning, organizing, and controlling were closely aligned with the growth of the computer budget. Thus, the major tasks in the management of computing can be identifiable in stages along the growth path of computing use. Based on these arguments, he proposed a four-stage model.

In 1974, Nolan and Gibson claimed that the S-shaped curve is driven primarily by changes in computing technology. They asserted that particularly database management systems would be the driving force for the shift to the next stage.

Nolan elaborated on his earlier model in the 1979 revision in which the original four stages were expanded to six with some accompanying changes in names: initiation, contagion, control, integration, data administration, and maturity. Three new concepts are incorporated in this paper: the growth in knowledge and technique, organizational control, and the shift from management of computers to management of data resources.

1) **Burgeoning of Knowledge:** Organizational learning and movement through the stages are pushed by changes in external and internal environment. Changes in external environment are such as the emergence of new technologies and the knowledge of how to use them. Changes in internal environment are what managers, specialists, and operators learn firsthand as the system develops.

2) **Control and Slack:** Two alternative strategies can be adopted by organizations according to stages. They are “control” and “slack” environment. In the control environment, all financial and managerial activities are controlled to ensure that DP activities are effective and efficient. In the slack environment, sophisticated controls are absent, and instead, incentives to use DP in an experimental manner are present. Rapid growth of IS expenditures occurs in this slack environment.

3) **Shift in management emphasis:** In the expanded six stages, at some point in stage 3, an important shift occurs in orientation from management of computers to management of data resources pushed by an increased use of data base technology. This shift in orientation is, in other terms, a shift from emphasis on consolidation and coordination in the DP activities, operational con-
trol, and transaction processing perspective to emphasis on management control and planning activities. As the shift is made, a greater concern is imposed on how best to assimilate and manage database technology in terms of organizational goals and objectives and emphasis on users do increase, which in result, increases user involvement in IS activities. As a result of this shift, in later stages, the terms such as data administration, user accountability, data sharing, charge-out system, user support, steering committee, interactive applications, and control are widespread among the members of the organization.

In addition to the introduction of these three new concepts, Nolan proposed benchmarks of the six stages with which management can gain a perspective on where its DP activities stands and on what developments lie down the road.

**Criticisms for Nolan’s Model**

As Nolan’s model gained fame, subsequent efforts have been made to assess its empirical validity and plausibility (Benbasat et. al., 1984; Drury, 1983; King Kraemer, 1984; Lucas & Sutton, 1977). The first empirical test of the stage model was done by Lucas and Sutton (1977). Their major concern was whether the S-shaped budget curve could act as a surrogate for situational variables which determine the set and nature of the tasks for managing the computer resource. Their study of computing budgets in California local government showed that growth in computing expenditures tended to be linear rather than S-shaped, which suggests that the budget was not an appropriate basis for the stage model. King and Kraemer (1984) also questioned the use of budget curve as a surrogate, pointing out: “That change in budgets for computing serve as a surrogate measure for such important and different variables as organizational environment, managerial strategies for growth of computing, and the organization’s learning curve in dealing with computing. Is it reasonable to assume that a single variable serves as a suitable surrogate for so much? We think not.”

Another important issue in Nolan’s model is to identify the stage at which a specific information system is. According to Nolan, this may be done by applying benchmarks to the organization. Drury (1983), in his study of computing in 144 firms, tested whether the benchmark variables could classify information systems in firms into the six stages. In his test, the benchmark variables generally failed to classify them.

Benbasat et al (1984) incorporated many completed empirical tests and provided a comprehensive picture of them. The general conclusion of the paper is that empirical support for the stage hypothesis is unconvincing. Still they suggested that, while evidence to date is not very encouraging, it does not definitely reject the stage hypothesis. According to them, hypothesis concerning planning and control techniques, user awareness, and the progression of increasingly formalized management of the IS function generally supports the stage hypothesis even though the existence of the IS maturity concept is questionable.

King and Kraemer (1984) also came up with a comprehensive picture of Nolan’s stage model and subsequent empirical studies. They asserted that Nolan’s model can be fit into the evolutionist theory of social sciences, thus suffering the same weakness the evolutionist theory has - the lack of mechanistic explanation which makes the model difficult to test empirically at the level of individual instances of change. As a conclusion, however, they asserted that the model made two significant theoretical contributions. First, it makes explicit the notion that the growth of computing must be due to the influence of forces inside and outside the organization (organizational learning and technology change). Second, it introduces an intellectually powerful construct of diatetical interplay between freedom (slack) and constraint (control) in the control of computing.

**Recent Growth Stage Models**

In the early 1980’s, an important phenomenon occurred in the computing field - the introduction of the PC. The impact PC’s have made on business environment has been surprisingly significant. User-friendly, sophisticated softwares have ap-
peared and the price of computer hardware has declined significantly. What we see now as the result of these changes is an introduction of new development in MIS - end user computing (EUC). Nowadays, most large organizations are involved in EUC in any form. EUC has grown rapidly at a rate of about 50-90% per year (Rockart & Flannery, 1983). Several researchers rigorously attempted to incorporate this new trend in explaining IS development in the organization.

Henderson and Treacy (1986) developed the three stage normative model for EUC management termed as initiation, integration, and the mature stage. In the initiation stage, with the objective of increased usage, user satisfaction, and diffusion of technology, implementation and marketing perspectives are proposed, emphasizing education and minimal control. An operation perspective, in the integration stage, is employed with the objective of integration and efficiency. In this stage, centralized policies are needed to ensure data integrity and security and to develop technological standards to facilitate integration and efficiency. In the last stage, an economic perspective is adopted to achieve competitive advantage by linking IS plan to strategy. Distributed operations and incentive systems are recommended.

The five stage descriptive growth model for EUC management developed by Huff, Munro, and Martin (1988) is based on Nolan’s stage model. A primary proposition of this model is that, to a great extent, the same set of general conditions that prevailed in the 1970s regarding computing growth in organizations also prevails today with regard to the growth of EUC. They named the five stages as isolation, stand-alone, manual integration, automated integration, and distributed integration. The brief description of each stage is as follows: 1) Isolation: little or no exchange of data or programs with other applications. 2) Stand-alone: applications operate in a stand-alone fashion - data entered into an application is keyed in manually. 3) Manual Integration: data is transferred from application to application by manual file interchange (e.g., hand-carried diskett or manually controlled file transfer over a local area network or via one or more connected mainframes). 4) Automated Integration: applications connect with one or more corporate databases and routinely transfer data between micro workstation and mainframe databases, or among mainframes, using automated processes designed into the applications. 5) Distributed Integration: applications are part of a network which accesses data distributed throughout the organization-- distinctions concerning the location of data (e.g., whether on a micro computer or mainframe) disappear.

Brown and Bostrom (1988), based on prior research works and primarily on Duncan’s model of management effectiveness for organization innovation, proposed the two-stage model: Initial and Integration stage. With the assumptions that 1) EUC is an organizational innovation and 2) organizations have an objective of maximum EUC growth rate, they proposed a model of EUC management effectiveness which integrates the evolutionary model of Henderson and Treacy (1986) with Duncan’s model.

In an initial stage, to be effective, organizations would implement an “organic” structure for EUC management tasks characterized by low centralization, low formalization, and high complexity. In an integrated stage, effective organizations are recommended to implement a “mechanistic” structure characterized by high centralization, high formalization, and low complexity. Huff et al’s model (1988) was adopted as the operational measures for the EUC implementation stage.

According to Kuznets (1965), a stage model should have two features: 1) the characteristics of each stage should be distinct and empirically testable, and 2) 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.

To satisfy these two requirements, clear and reliable operational measures are necessary to place an IS in a specific stage. Without reliable measures, stage model is of no use for practical
purposes.
Nolan failed to provide reliable measures. His six benchmarks were not supported by subsequent validation efforts (1983). Henderson and Treacy did not include any specific measures in their study. Huff, Munro, and Martin suggested the extent of interconnectedness of the applications as measures. Brown and Bostrom adopted Huff et al’s measure for their model, but this measure is closely related to hardware. Transition into the next stage is largely dependent on the computer configuration of the specific company; it certainly lacks the software perspective.

**Proposed Conceptual Framework**

In this paper, we present a framework for understanding the growth of an information system and the strategies used by organizations.

**Two Dimensions of the Framework**

1) *The first dimension: Growth.* Numerous researchers have referred to the importance of the growth stage model in comprehending the nature of information system development in the organization. But, as we discussed earlier, there does not exist a reliable and usable model which practitioners and researchers can exploit at the present time. Thus, there is a clear need for new framework for the revised, practical model that can manage the IS growth effectively. The framework proposed in this paper is developed based on several models mentioned in prior sections.

One important improvement in Nolan’s 1979 version is the introduction of a new concept in IS planning and control area. In his six stages, Nolan proposed that, at some point in stage 3, an important shift occurs in orientation from management of computer to management of data resources pushed by increased use of data base technology. Different from many other assertions of Nolan’s stage theory, the shift assertion has been empirically supported by the subsequent research work by Drury (1983).

Drury named the stages before and after this shift operating control and resource planning respectively, then tested whether these two stages are really separated in real world. The result was supportive of Nolan’s shift concept, statistically separating two groups of planning and control techniques proposed by Nolan more toward operating control and resource planning.

According to Nolan, the driving force which pushes the shift is data base management system software. Functions of IS in stages before the shift are primarily operational ones—computerizing transaction processing and operational control type activities. After the shift occurs, typically integration takes place. Integration comes with several changes in organizations: 1) organizational goals begin to be considered 2) integration of data and subsystems are developed 3) strategic decisions begin to be addressed. Basically, data is viewed as an important resource by senior managers.

After Nolan had proposed the concept of shift from management of computers to management of data resources, it became somewhat manifest that subsequent researchers have incorporated the “shift” concept into their models.

The subsequent stage models developed incorporate this shift concept in some ways. The initiation stage of Herderson and Treacy’s model (1986), the isolation and standalone stages of Huff et al’s (1988), and the initial stage of Brown and Bostrom’s (1988) share common characteristics with the stages before Nolan’s shift. The integration and maturity stages of Herderson and Treacy’s model, the manual, automated, and distributed integration stages of Huff et al’s, and the integrated stage of Brown and Bostrom’s contain the common features of the stages after the shift in Nolan’s model. From the literature review, it has been identified that it is unrealistic to force the organizations which are distinctively different in nature into six specific stages because of the complex nature of their growth patterns and many factors interrelating with one another. But, from the previous discussions, it can be derived that, even though classifying growth pattern into six specific stages does not hold true, a typical growth
pattern of information system can be divided into two broadly defined stages based on Nolan’s shift concept. Taking this view as valid, a two stage model named as “operational control” and “integration” is developed and proposed based on prior research. These two stages form the first dimension of a proposed framework.

The operational stage is brought on by the introduction of the computer in the organization. Setting up an environment for future sophisticated IS is accomplished in this stage by developing a transaction processing system. The basic hardware configuration is analyzed and operational control activities such as accounting are computerized: automation of time consuming and repetitive jobs is the major concern of this stage. Typically, each department manages its own IS resources independently. Software packages are purchased but they are run in a stand-alone fashion, usually aiding individual decision making. End user computing activities are to be seen but in a sporadic and isolated fashion.

As the end of this stage is approached, there arises a cry for integration. Managers complain of difficulties in obtaining data and the IS department acknowledges the difficulties in managing the computer activities of the organization. Concepts such as data sharing and data integrity begin to be seriously considered. Communication devices are to be purchased. As a result, data resources, not computers, becomes a main focus in management of IS. This is the point where the shift from management of computers to management of data resources occurs.

In the integration stage, information systems are reviewed by an organization not from departmental uses but from organizational goals and objectives. A communication network is required and data integrity is accomplished. Usually, data administration is formalized to manage the complicated data resources. A steering committee is established to manage IS resources from an organizational point of view. End users begin to exchange applications and data files electronically through network systems.

2) The second dimension: Strategic choice. The prior stage models fail to incorporate an important perspective which can be called “strategic choice.” Nolan, in 1979 version, came up with the idea of “control” and “slack” as two alternative strategic choices management can employ in managing the IS. His basic assertion is that the slack environment prevails in early stages but, as IS grows to maturity, the control environment takes over. Finally, in the sixth stage (maturity stage), balance between control and slack is achieved. In fact, this assertion Nolan has made has a serious default. He did not consider that this type of strategic choice is not followed by stages but that these decisions must be made by top or middle management depending on the objectives and goals of the specific organization. An organization can set a goal of controlled growth from the initial stage. The choice of appropriate strategy concerning development of IS entirely depends on goals and objectives of the specific organization. Since previous models did not incorporate this perspective, the validity of the models seem to be doubtful. Thus a framework for the growth stages of IS is developed with an effort of alleviating the aforementioned problems found in previous research works.

Munro, Huff, and Moore (1965) proposed the two constructs of strategies concerning IS development similar to Nolan’s: expansion and control. In their proposal, they denied Nolan’s view and suggested that the choice decision is up to the organizations. Based on this argument, we propose that an organization can choose any of these two strategies in any stage according to its needs. This contingency factor, strategic choice, forms the second dimension of the proposed framework.

Model Cells and Implementation Strategies

In Figure 1, the proposed framework is shown. Combining two growth stages and two possible strategies results in a matrix of four cells. Each cell represents a distinguishable strategy for the stage. The cell names were chosen to describe the corresponding nature of management policy. Each of the four strategies is discussed below.
1) **Cell I: Growth Acceleration (G.A.).** In the growth acceleration cell, the organization’s strategy is to computerize operational control activities in a slack environment. Penetration of computer technology is accelerated by more resources committed to IS and encouragement. Growth maximization is a key concern in this cell. This strategy is typically adopted by the companies which have ample financial resources and need to speed up the IS acquisition.

2) **Cell II: Controlled Growth (C.G.).** For an organization in the controlled growth cell, management has decided to develop IS slowly and carefully. The intention is to expand at a low rate in such a way that tight control on expenditures on IS can be accomplished. Efficiency is a main concern in this cell. Small businesses not having enough resources usually take this strategy. They buy small PCs at the first time and expand to purchase related hardware gradually within the budget limits. In fact, many small business experts warn that a hasty decision to purchase a computer system without considering and controlling hidden costs such as maintenance and training is detrimental to small-sized business (Newpeck & Hallbauer, 1981; Senn & Gibson, 1981).

3) **Cell III: Decentralization.** In the decentralization cell, an organization provides a slack environment to users/managers so that local computing can be encouraged. Instead of tight control, users are given a certain range of freedom. The concern is to enable users to have their own decisions regarding solutions for the problems being addressed. An information center is desired in this cell to coordinate IS activities. Nurturing of innovation is a main concern in this cell.

4) **Cell IV: Centralization.** In the centralization cell, organization retains control on IS activities. In many cases, a centralized IS department manages and controls the IS activities of the firm. Standards are enforced and security is emphasized; end users does not gain much attention and support. Standards and control are two key issues in this cell.

**Development Strategy**

In developing a strategy for an information system, management must decide toward which cell it wants to move. Many factors should be considered to make the decision. Important factors would include 1) the amount of budget allocated for IS development, 2) the degree of expertise of users, 3) general attitude of users concerning whether extensive controls would be accepted, 4) and the structure of the organization. These factors are important considerations for managers to make choice decision—either slack environment or control environment.

For example, let us make up a fictional firm which started its opening position with a growth acceleration strategy. As an IS manager, he would like to know the next strategy the firm should go for. There are three possible strategies an IS manager can employ, which is the best move for the firm really depends on the situation. Let us assume that the growth acceleration strategy has been successful with this firm. Users’ responses have been favorable and they are asking for more autonomy in the more creative jobs. The organizational structure takes a decentralized form and the firm is geographically disperse. The IS manager would go for decentralization strategy. Another possible case is that, after successfully diffusing technology, the firm may want to regain the con-
Control because of excessive expenditures spent or security concerns related to data. The structure of the firm is of a centralized form. In this case, the next movement would be toward centralization. The third possibility is the worst case when the firm failed to implement the growth acceleration strategy successfully. Management faces serious problems such as strong resistance from users or severe budget problems. The firm itself may be in a difficult financial position. When these problems occur before shift to the integration stage, management may have to change the strategy to controlled growth. Figure II shows the possible paths management can take. Since the adoption of the next strategy depends on the situations the specific organization is at, there is no single, best movement for a firm. Management must rely on judgement, intuition, and experience in analyzing the situation.

Operational Measures

Determining in which stage of development a specific IS is placed is an important task. Nolan provided six benchmarks to identify the stages and Brown and Bostrom used Huff et al’s model as operational measures. Six benchmarks of Nolan’s have not been supported by following validation efforts and Huff et al’s model is only focused on the hardware perspective. Transition from operational control stage to integration stage requires changes in both hardware and software perspectives. In hardware, Huff et al’s five stage model seems to be a good measure. The five stages can be classified as follows: 1) operational control—iso-
lация, stand-alone stages 2) integration-- manual integration, automated integration, distributed integration stages.

For the transition to occur, there must be changes in software perspective in addition to hardware. As Nolan specified, the shift is mainly pushed by an increased use of database management system (DBMS). Nolan prosed that, mainly due to use of DBMS, different planning and control techniques would be used in the integration
stage compared to the operational control stage. Drury tested this concept and concluded that two groups of techniques could be statistically separated. Since these different groups of techniques can be separated by the use of DBMS, use of DBMS can be used as a meaningful operational measure for the shift to Integration stage. The primary importance is placed on data integrity. Data integrity is known as an important factor in achieving integration. To achieve data integrity, appropriate data base management software should be employed. Thus, the acquirement of DBMS to accomplish data integrity is a necessary condition for the transition.

To shift into integration stage, two conditions prescribed must be met. If IS is in stage 3, 4, or 5 of Huff et al’s model and the organization is making use of a specific DBMS to work on data integrity, the information system can be said to be in integration stage. Otherwise, it is in operational control stage.

Summary

Nolan’s stage model has received high attentions since its inception in 1973, but subsequent research has lowered the empirical validity of this model. There have been many criticisms. One main criticism is that firms do not follow the specified six stages. But, one of Nolan’s assertion called the “shift” concept, has been supported and generally accepted. Another contribution of Nolan’s model is the introduction of strategic concepts, “slack” and “control”, into IS development. But, as we discussed, this strategic choice is not usually followed by stages but the choice is made by the organization itself.

Based on findings from Nolan’s model and numerous growth models and our experiences, a two dimensional framework is proposed. This framework 1) simplifies the six stages into two stages based on “shift concept” thus reducing the chaos caused by the efforts of many practitioners trying to fit their IS into six specific stages. 2) introduces a contingency concept “strategic choice” based on our experiences so that it explains better the organization’s strategic planning and controls. 3) provides easy-to-use and relatively reliable measures. Future research is required to verify the proposed framework. A reliable field study will increase the validity of this framework. The framework presented has two potential benefits. First, it can be a tool that can help managers better understand their current IS and develop the strategies for future growth. Second, it can serve as confounding variables in IS research design in the future.

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