

NOLAN'S STAGE LEVEL MEASUREMENT OF INFORMATION AND COMMUNICATION TECHNOLOGY IN MODERN ORGANIZATIONS

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ABSTRACT

The purpose of this academic research was to measure and analyze the stage level of the ICT/IS initiatives in modern organizations, based on the Stages of Growth Theory and Nolan's studies regarding stages of growth models. The rigor in use of theoretical concepts and methodological rules was the focus of this study, to understand, clarify and integrate all the pieces of a huge puzzle, which got its start about 40 years ago. As a theoretical contribution, the framework creation to this study and the development of a scale instrument with the purpose of making the measurement of the ICT/IS initiatives stage level in modern organizations, adapted for the evaluation of emerging technologies in modern society, can be considered a very useful working tool for academicians who study this thematic, as well as to practitioners seeking answers to their practical actions in organizations where they work.

INTRODUCTION

In the academic field of Information Systems (IS), Nolan's Stages of Growth Theory (NSGT) first appeared in 1973 as probably the most well-known and widespread theoretical framework to the development of Management Information Systems (MIS) for the assimilation of Information and Communication Technology (ICT) in business organizations in business organizations (Nolan *et al.*, 1993; Mutsaers *et al.*, 1998; Mattia, 2011). Nolan was the first researcher to introduce a structured scheme for explaining the growth of computing in organizations (King & Kraemer, 1984, p. 474), making statements regarding technical and organizational consequences about this subject. Nolan's theory provides many insights in the ways in which technologies have evolved and continue to be evolve in organizations (Mutsaers *et al.*, 1998). The literature related to stages of growth models and the context of MIS study field, provide the conceptual bases for this research (Nolan, 1973; Gibson & Nolan 1974; Nolan 1979, King & Teo, 1997).

The arrival of newer technologies and platforms, quite different from those existing in the 70s, calls for a fresh and updated approach of Nolan's model in terms of their implementation and management. The purpose of this academic research was to measure and analyze the stage level of the ICT/IS initiatives in modern organizations, based on the Stages of Growth Theory and Nolan's studies regarding stages of growth models. As a theoretical contribution, it is proposed a framework to illustrate this broad understanding and to guide to the development of a scale instrument. A development of scales is motivated when you want to measure a type of phenomenon that is believed to exist due to the theoretical understanding of the world, but which cannot be directly evaluated by an already existing measure.

Stages of Growth Theory and Management Information Systems

The root of the studies regarding SGT/MIS comes from the research conducted at Harvard Business School by Professor Neil C. Churchill, James L. McKenney, F. Warren McFarlan and Richard L. Nolan, in the 1970s (Nolan & Croson, 1995). The original concept behind the NSGT was proposed by Richard L. Nolan in 1973 by the article “Managing the Computer Resource: A Stage Hypothesis”, published in Communications of ACM journal (Nolan, 1973; Mutsaers *et al.*, 1998; Mattia, 2011), where a descriptive stage hypothesis was presented, based on the study of expenditures for Data Processing (DP). In his first version of the Stage of Growth Model (SGM) presented in 1973, Nolan suggested a descriptive model where the planning, organization and control of organizational activities associated with the assimilation of computer technologies (now ICT/IS initiatives), would change in feature over a period of time, and could evolve in patterns roughly correlated to four stages, I-Initiation, II-Contagion, III-Control, IV-Integration, of the computer budget growth (now ICT/IS expenditures) (Nolan, 1973, p. 401). In the later version of Nolan’s Stages of Growth Model (NSGM) initially presented in 1975, the stage III was divided to include two other stages, thus totalizing six stages (Nolan, 1975, 1979): I-Initiation, II-Contagion (also known as ‘Expansion’), III-Control (also known as ‘Formalization’), IV-Integration, V-Data Administration, and VI-Maturity, as has emerged the stages based on organizational learning (Gibson & Nolan, 1974; Nolan, 1979, 2001). Guidelines for action were established to make change a proactive managed process, instead of a reactive environmental process (Nolan, 1979; Nolan & Koot, 1992; Mutsaers *et al.*, 1998).

Studies published in academic literature regarding Nolan’s Stages of Growth Model

Academic literature of the last decades mentions the great struggle of many researchers to develop models of growth stages (Nolan, 1979; Burn, 1994; King & Teo, 2000; Ditlev-Simonsen & Gottschalk, 2011), which are both theoretically founded and empirically validated. As described in Table 1, many researchers have made efforts to access the Nolan model's validity and plausibility (Lucas & Sutton, 1977; Benbasat, *et al.*, 1984; Huff *et al.*, 1988), one of the best-known, debated and controversial frameworks for describing the typical developmental patterns of ICT/IS initiatives in organizations (King & Kraemer, 1984; Benbasat *et al.*, 1984; Lyytinen, 1991; Mattia, 2011), with a high level of interest and acceptance among practitioners (Sääksjärvi, 1985), as a valuable empirically-based theory and accepted description of managing technological change over time (Mahmood & Becker, 1985).

Table 1: *Studies published in academic literature regarding Nolan’s Stages of Growth Model*

Researchers and Publications	Sample Size	Methodology	Number of Stages evaluated	Issue Examined / Finding / Results
Nolan (1973)	3 firms	case study	4	proposed the theory of stages in MIS without empirical test;
Lucas & Sutton (1977)	29 firms	questionnaire and interview	4	“S” shaped budget curve not confirmed; did not invalidate the stages of growth;

Nolan (1979)	35 firms + a large number of IBM costumers	case study	6	analyzed the technology expenditures applied in various industries in terms of stages; emphasizes the importance of data management; report 5 guidelines for managing the IT growth successfully; no empirical test;
Drury (1983)	144 firms	questionnaire	6	application of benchmarks variables not confirmed; Usage of planning and control partially confirmed;
Sääkjärvi (1985)	130 firms	questionnaire (in 3 firms case study)	6	variables had to be adapted; only partially confirmed; suggested that the model is confined in its limits, but it has many attractive and useful measures;
Mahmood & Becker (1985)	59 firms + 118 managers	questionnaire	6	suggested to find a new set of maturity variables; modify Nolan's stage model to make it more efficient;
Li <i>et al.</i> (1994)	123 firms	questionnaire	6	the questionnaire seems to be reliable and valid; about 20 years ago; brings questions with a single indicator to measure the stage position of the organization; does not address emerging technologies;

Source: Compiled by the authors

Table 1 illustrates several studies published in academic literature regarding the NSGM, emphasizing that it has not been completely confirmed through statistical testing (Leem *et al.*, 2008), and this might be due to the lack of adequacy of the questionnaires used in capturing the essence of the stages model (Benbasat, *et al.*, 1984, p. 485; Li *et al.*, 1994, p.5), or because of the failure to perform reliability and validity tests on measuring instruments (Mahmood & Becker, 1986, p. 42). The empirical bases of the model are questionable (King & Kraemer, 1984, p. 474), and the model has been testing poorly because it is underspecified (Friedman, 1994, p. 139), since Nolan had not explicitly defined his own operationalization of the model, remaining proprietary, other researchers were forced to apply their own perception for the maturity measures (Benbasat, *et al.*, 1984, p. 485). The arrival of newer technologies, quite different from those existing in the 70s, such as those based on the Internet, calls for fresh approaches of Nolan's model in terms of their implementation and management (Damsgaard & Scheepers, 2000, p.10).

METHODOLOGY

The rigor in use of theoretical concepts and methodological rules was the focus of this study, to understand, clarify and integrate all the pieces of a huge puzzle, which got its start about

40 years ago. The methodological procedure started with an intense search for scientific papers located in databases for academic use. The following bases were used for location: Ebsco, JStor, ScienceDirect, ACM Digital Library, AISNET, HBS, HBR, Wiley, Emerald, etc. and other academic sources to complement this task, such as: Thomson Reuters Web of Science and Journal Citation Reports (JCR), Google Scholar, Microsoft Academic and Research Gate, i.e., to identify the connections between the researchers and what were those most relevant articles considered by the choices of academicians, being cited in the references of their works.

Another procedure well exploited were the reading of the reference lists of selected major papers (many of the most cited), identifying how were formed the 'connections' of discussion of the subjects among the papers. This helped to understand the contemporary "networks of conversations" between the authors of this paradigm, and how the subject could still be exploited in certain gaps that were not yet clear.

A proposed framework has been created in order to help the next step: development of the scale instrument. After completing the preparation of the scale with maximum possible theoretical refinement (content validity), was possible to perform a pretest with a group of experts (both academic and practitioners), contributing to the face validity. After getting the views and comments from these experts, the scale received additional enhancements and new validations. From the full approval of the scale, it was part of a questionnaire survey hosted through a form available online on the Internet. In addition to providing the collection instrument itself (online form), which was developed based on the rigor and relevance of academic theory and scientific methodology, this questionnaire survey also served to a secondary function, but probably of great practical use to the organizations that participate in the research. After concluding their responses and confirming the data submission, the respondents were redirected to a page (automatically generated in real time by the on-line database software) to display a summary report and diagnostic about the stage level alignment of the organization ICT/IS initiatives.

RESULTS

Based on the last Nolan's six stages model (Nolan, 1975, 1979), on literature review (Nolan & Koot, 1992; Grégoire & Lustman, 1993; Nolan, 1993, 2001; Mutsaers *et al.*, 1998; Pranantro *et al.*, 2003; Mattia, 2011), and the new demands of ICT/IS due to the current times (modernity) (Nolan & Croson, 1995; Nolan & Bennis, 2002; Derksen, 2013; Meirelles, 2014; Favaretto, 2015), the authors have suggested some updates regarding the descriptions of the stages definitions and its coverage limits in the model, as mentioned in Table 2.

Table 2: *Revisited definitions of the six stages of growth of Nolan's model*

Stage Number	Stage Name	Stage Definition	References
I	Initiation	Characterized by limited investment and contained experimentation for proving the value of the technology in the organization. ICT/IS personnel are learning regarding the new technology. There is no clear direction for the organization's ICT/IS initiatives. The organization directs efforts to functional applications.	Nolan, 1975, 1979, 1993, 2001; Nolan & Koot, 1992; Mutsaers <i>et al.</i> , 1998; Pranantro <i>et al.</i> , 2003

II	Contagion	Also known as "Expansion" stage. A period of high learning in the organization whereby the technology proliferated in a relatively uncontrolled manner. ICT/IS initiatives are increasingly considered to be an important component of the organization's business. With no proper planning, high slack and low control, the use of ICT/IS is growing rapidly, but in an inefficient manner. There is a lack of direction for ICT/IS development and implementation.	Nolan, 1975, 1979, 1993, 2001; Prananthro <i>et al.</i> , 2003
III	Control	Also known as "Formalization" stage. Management reacts to impose controls on the ICT/IS initiatives and to discipline related costs. Due to the growing use of automation activities, they are considered an important component of the organization's business. Uncontrolled growth eventually led to inefficiency, which created a demand for controls that slowed the growth to a more manageable rate. There is a clear direction for the development of ICT/IS initiatives within the organization. However, ICT/IS is still focused much on technology-centric perspective and not influenced by business needs.	Nolan, 1975, 1979, 1993, 2001; Nolan & Koot, 1992; Grégoire & Lustman, 1993; Mutsaers <i>et al.</i> , 1998; Prananthro <i>et al.</i> , 2003
IV	Integration	The accumulated learning led to a balance of managed controls and growth. Organizations dominate certain current technologies, providing a foundation to introduce the next order of magnitude of progress that would be the next S-curve Era seeking new improvements. ICT/IS adoption and development is becoming more business-focused. There is a move towards integration and greater coordination between the ICT/IS processes and the organization's business processes.	Nolan, 1975, 1979, 1993, 2001; Prananthro <i>et al.</i> , 2003
V	Data Administration	Integration between traditional business processes and activities and ICT/IS initiatives, creates seamless communication and flow of processes within the organization. ICT/IS initiatives aim to provide strategic benefits by building strategic systems.	Nolan, 1975, 1979, 1993, 2001; Prananthro <i>et al.</i> , 2003; Mattia, 2011
VI	Maturity	ICT/IS initiatives is deeply embedded throughout every aspect of the organization. There is a strong integration between the ICT/IS processes and business processes within the organization as well as with those of its suppliers and business partners. ICT/IS initiatives are aimed to create and maintain our organization's strategic advantage.	Nolan, 1975, 1979, 1993, 2001; Nolan & Koot, 1992; Prananthro <i>et al.</i> , 2003

Source: Adapted by the Authors from Nolan (1975, 1979, 1993, 2001) and other academic contributions

Table 2 describes some suggested adaptations to the Nolan's model – descriptions of each stages definition was revisited and updated by the authors, based on academic literature and

the perception that, it is necessary to adjust the contemporaneity of ICT/IS initiatives that are found in modern organizational environments.

Operationalizing the measurement of the Nolan’s Stages of Growth Model

With the intention to measure the evolution of the stages of growth of IT in the organization, Nolan defined two levels of analysis variables in which he called the "benchmark variables" (Nolan, 1973, 1975, 1979; Gibson & Nolan, 1974). In the first level of analysis, he assessed the expenditures and investments of the organization for the implementation of their ICT/IS initiatives (called in those times “budget for computing”), and he was seeking to correlate the amount of sales or other 'links' with the financial results of the company, to investigate the percentage participation in the use of applied technologies and utilized by organizations throughout the stages of growth (for example: X% batch processing; Y% remote job entry processing; Z% time-sharing processing; K% data base processing, etc.). This level of measurement has not demonstrated effectiveness in other empirical studies by various authors (Lucas & Sutton, 1977; Drury, 1983; Sääkjärvi, 1985; Mahmood & Becker, 1985; Li *et al.*, 1994), and was unable to confirm it completely or validate it with a good level of correlation. In the second level of measurement, Nolan has proposed the measurement of so-called "growth processes" – because they evolve, or “grow” with use of IT over time (Cash *et al.*, 1994, p.260) – to comprehensively describe IT activity and the dynamics of computer organizational learning in an organization (Nolan, 1993, p.2), assigned into four main dimensions: Applications Portfolio, Resources (technology and personnel), Management (organization, planning and control) and User Awareness/Community (Nolan, 1979, p. 117, p. 121; Nolan, 1984, p. 197) – he has considered these four growth processes “more useful” to make this measurement.

Table 3: *The five growth processes to the assessment of ICT/IS initiatives stage level alignment*

Growth processes	Definitions	References
Applications Portfolio (AP)	The existing base of information systems that support the business functions. The set of applications which the information systems must support in the business organization. For example: financial planning, order processing, on-line customer enquiries.	Cash <i>et al.</i> , 1994; Nolan & Koot, 1992; Mutsaers <i>et al.</i> , 1998; Krishna & Barman, 2011
ICT/IS Resources (IR)	The resources (staff/people and technology) providing the organization with the ways to use and apply ICT/IS in the business. Involves the position of the ICT/IS unit in the organizational chart, its areas of activities (technical services, database research, maintenance, etc.).	Grégoire & Lustman, 1993; Cash <i>et al.</i> , 1994; Nolan & Koot, 1992; Mutsaers <i>et al.</i> , 1998; Krishna & Barman, 2011
ICT/IS Management (IM)	The instruments, techniques, tools and controls that ICT/IS management uses to facilitate effective and efficient use and provision of ICT/IS (i.e, practices). For example: degree of control, formalization of	Cash <i>et al.</i> , 1994; Nolan & Koot, 1992; Mutsaers <i>et al.</i> , 1998; Krishna & Barman, 2011

	planning process, management of projects, and extent of strategic plans. The objective of management is to strike an appropriate balance between tight and loose controls for each stage of technology adoption.	
User Community (UC)	This process represents the amplitude to which users (people in the organization using ICT/IS; users skills) develop an understanding and awareness of the opportunities and limitations of ICT/IS initiatives. The ability of users to effectively apply IT to their work.	Benbasat <i>et al.</i> , 1980, p. 23; Cash <i>et al.</i> , 1994, p. 260; Nolan & Koot, 1992; Mutsaers <i>et al.</i> , 1998
Emerging ICT/IS (EG)	New and emerging ICT/IS influencers that will introduce, induce and promote organizational discontinuity regarding the new "Big Data Era". Connection full time, instantaneous information, information transparency, on-line databases, real-time messaging and transactions, data warehousing, cloud computing services, mobile technologies, Internet of things, etc.	Nolan & Koot, 1992; Nolan, 1993, 2001; Christensen, 1997; Mutsaers <i>et al.</i> , 1998, Nolan & Bennis, 2002; Mattia, 2011; Chen <i>et al.</i> , 2012; Davenport & Patil, 2012; McAfee & Brynjolfsson, 2012; Derksen, 2013; Meirelles, 2014; Goes, 2014; Favaretto, 2015

Source: Adapted by the Authors from Nolan & Koot (1992, p.3), Mutsaers *et al.* (1998, p.120) and other contributions

By the Table 3 it is possible to notice the five processes described to allow the assessment of ICT/IS initiatives stage level alignment, four of them based on the stages of growth Nolan's model (Nolan, 1979) – Applications Portfolio (AP), ICT/IS Resources (IR), ICT/IS Management practices (IM), User Community (UC) – and a new process, Emerging ICT/IS (EG), based on studies of academic literature and the necessity to update the model to contemplate the present times.

Proposed research framework to the assessment of ICT/IS initiatives stage level alignment in organizations

In order to integrate the literature review and several approaches of stage models examined in this study, it is proposed the framework shown in Figure 1, to illustrate this broad understanding and to guide to the next steps of this research.

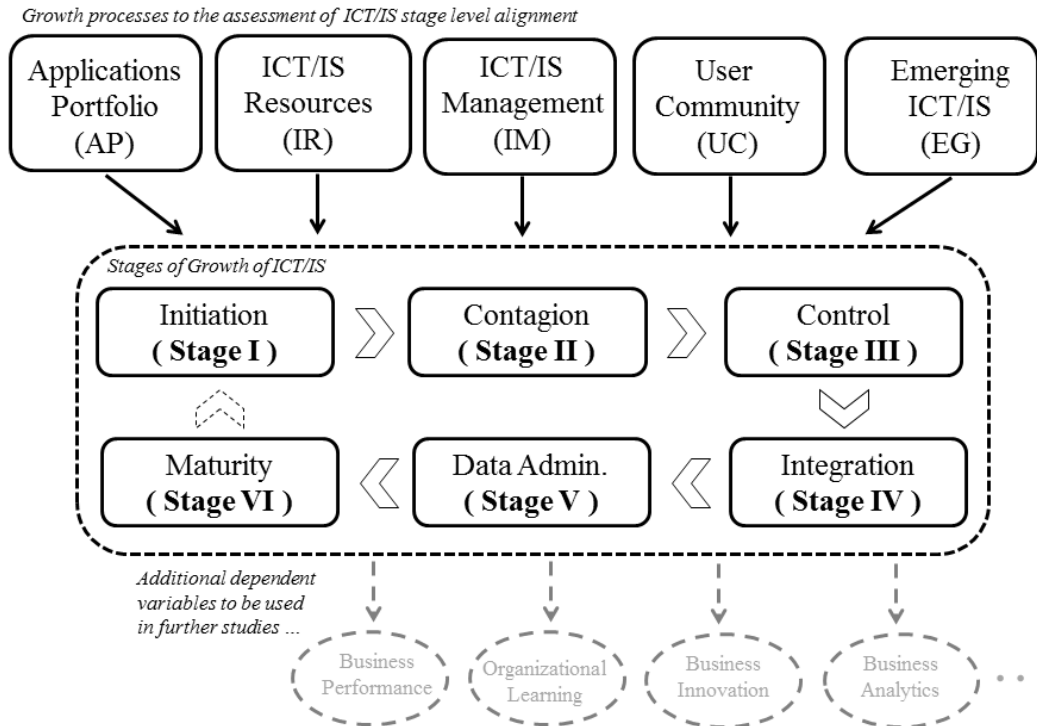


Figure 1: Proposed research framework to the assessment of ICT/IS initiatives stage level alignment in organizations

Source: Created by the authors based on Nolan’s stages model and new contributions

The framework proposed in Figure 1 is a tentative to continue to adapt the theory of stages of growth to the current ICT/IS environment present in the organizational structures, and expect to be useful to academic and practitioner studies. This model indicates that the five growth processes – AP, IR, IM, UC e EG (independent variables) – influence the evaluation of each of the six stages (Stage I, II, III, IV, V and VI). When evaluating specifically the level of alignment of all processes in each of the respective stages, the mean value obtained from the five growth processes in the respective stage, is the appropriate level of alignment of ICT/IS regarding that stage. Further studies are feasible and may use the data collected from the questionnaire developed in this research to explore the relationships between ICT/IS initiatives stage level alignment, in additional with other organizational variables (dependent variables), such as, Business Performance, Organizational Learning, Business Innovation, Business Analytics, etc.

DISCUSSION AND CONCLUSIONS

Modern organizations are evolved in an environment which constantly requests evaluation of competitive effects of new technologies and must ever more be focused on maximizing ICT performance, in order to be more competitive in their industries. They have been forced to continuously and organically re-organize and re-profile themselves, considering ICT as an important factor to help these changes. The framework creation to this study and the development of a scale with the purpose of making the measurement of the ICT/IS initiatives stage level in modern organizations, with academic/scientific rigor and adapted for the evaluation of emerging technologies in modern society, can be considered a very useful working tool for academicians who study this thematic, as well as to practitioners seeking

answers to their practical actions in organizations where they work. The scale should accommodate the needs of different organizations sizes (small, medium and large), but, when comparing the results obtained, it was recommended that consistent groupings might be used with respect to size and sector / industry, to avoid possible comparison bias. It is also important to mention that, the five grown processes need to be developed in balance by the organization, in order to allow the organically progression of its activities of ICT/IS from stage to stage. For example, if an organization is able to offer sophisticated ICT/IS applications, but the community of its users does not have the skills to take advantage of all its features and usefulness, there will be an unbalance between the AP (Applications Portfolio) processes and UC (User Community) processes. Another relevant situation was the observation of the temporal variable – i.e., a time dependency when the questionnaire was answered. As the questionnaire answers could receive the impact of some managerial requisites (the structure of the organization, the economic, political, market time, etc.) or technological issues (early use of a technology, obsolescence of technology, exchange of technical staff, untrained operators, etc.), the report and diagnosis of the stage level alignment of the organization ICT/IS initiatives could be compromised.

“References are available upon request from Jose Favaretto.”

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