Process Modelling for Enterprise Systems: Factors Critical to Success

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Abstract

A range of influences, both technical and organizational, has encouraged the widespread adoption of Enterprise Systems (ES). The integrated and process-oriented nature of Enterprise Systems has led organizations to use process modelling as a means of managing the complexity of these systems, and to aid in achieving business goals. Past research illustrates how process modelling is applied across different Enterprise Systems lifecycle phases. However, no empirical evidence exists to evaluate what factors are essential for a successful process modelling initiative, in general or in an ES context. This research-in-progress paper reports on an empirical investigation of the factors that influence process modelling success. It presents an a-priori process modelling critical-success-factors-model, describes its derivation, and concludes with an outlook to the next stages of the research.

Keywords

Process modelling, process management, Enterprise Systems, Information Systems success, critical success factors

INTRODUCTION

Leading contemporary concepts of Business Process Re-engineering (BPR) (Hammer and Champy, 1993) and Process Innovation (Davenport, 1993), emphasise the importance of process-oriented management concepts, as a businesses paradigm. As one result, organizations are increasingly adopting integrated software solutions, which entirely mirror and support the needs of the core business processes (Hammer and Champy, 1993; Davenport, 1993).

Enterprise Systems (ES) are packaged software solutions that encompass the complete range of business activities of an organization. They automate and integrate the core processes using state of the art technology such as Client/Server, workflow management and Web-based user interfaces (Bingi et al., 1999; Parr et al., 1999; Sumner, 1998). Though the ES market continuous to expand, recent research suggests a growing consensus that ES projects do not provide the anticipated benefits (*e.g.* Boston Consulting Group, 2000). Excessive focus on technical aspects to the detriment of business aspects has been identified as a leading factor for many ES failures (Sedera et al., 2001, Wreden, 1998; Forsberg et al. 2000). Mainly due to the complexity of these large integrated systems, many ES initiatives commence with a strong business perspective, but later shift to emphasize only the technical functionality. This creates a ‘gap’ between the implemented system and the way the organization works and thus, reduces the potential for achieving expected benefits from the Enterprise System investment. Process modelling is used within ES initiatives as an approach to cope with complexity and decrease the gap between the implemented system and organizational requirements (Becker et al., 2000; Rosemann, 2000; Forsberg et al., 2000; Gulla and Brasethvik, 2000).

Process-models are “abstract descriptions of an actual or proposed process, that represent selected process elements considered important to the purpose of the model and that can be enacted by a human or a machine” (Curtis et al., 1992, p.76). In other words, they are images of the logical and temporal order of functions performed on a process object (Becker et al., 1997, p.2). Process modelling in the context of Enterprise Systems covers all activities related to the design of models of the current business processes (as-is modelling), the model-based identification of weaknesses, the study of available ES-specific reference process-models, the design of a new business blueprint using process-models, and the use of process-models for the purposes of end-user training (Gulla and Brasethvik, 2000; Becker et al., 1997; Rosemann, 2000; Curtis et al., 1992; Bartholomew, 1999). This paper is structured as follows. First the study objectives and design are introduced, next the derivation of the a priori model is discussed in detail with results from a detailed literature review and initial insights from a pilot case study. The paper concludes with a brief discussion about the next steps of the research.

STUDY OBJECTIVES AND DESIGN

ES success factor studies explicitly and implicitly state the importance of process modelling and its contribution to overall ES success (*e.g*. Wreden, 1998; Gulla and Brasethvik, 2000). However, no empirical evidence exists on how to conduct process modelling successfully, in general, or in an ES context, and how to measure the success of a Process modelling initiative. This paper reports on a study that aims to address these two problems. The purpose of this paper is to address the first issue - "how to conduct process modelling successfully" - in other word to identify the antecedent factors that lead to a successful process modelling project.

The overall research design includes: (1) a literature review of potential process modelling critical success factors (CSFs) and success measures, (2) the specification of an a-priori model based on findings from the literature, (3) an in-depth pilot case study to coarsely validate (model building) the success factors and success dimensions of the a-priori model; (4) an exploratory / explanatory multiple case study across a minimum of 4 firms (each firm would have conducted process modelling at some phase of their ES initiative) to further build and test the study model, and finally, (5) a survey to derive and statistically test the final model. We have completed a comprehensive literature review, derived the a-priori model and are currently in the process of further specifying the model with case studies. This paper reports on these current research outcomes.

DERIVING THE A-PRIORI MODEL

An initial literature review was first conducted and 8 candidate process modelling CSFs were identified (Rosemann, Sedera, Gable, 2001). These factors were then evaluated within a pilot case study to gain initial insights and to further assess the appropriateness of the process modelling CSFs. Further analysis of the case study results and an intensified literature review, produced a process modelling CSFs a-priori model with 11 candidate factors. The following section describes the conduct of the literature review, and the derivation of the revised process modelling CSFs model in detail.

Literature Review

Selecting the Domain Areas

The study unit of analysis is the process modelling project. CSFs within the context of this research, can be defined as the key aspects (areas) where 'things must go right' in order for the process modelling initiative to flourish (following McNurlin and Sprague, 1989, p. 97). Due to the lack of theoretical and empirical evidence of process modelling CSFs, a review of relevant and analogous literature was conducted to extract those factors that were directly or indirectly mentioned as important. Thus, related domains were included in the review in order to obtain a list of candidate process modelling success factors that was as complete as possible. The main areas were (1) generic process modelling; (2) software engineering and conceptual modelling success; (3) information model quality features; (4) BPR and ES success; and (5) Information System success.

A historical analysis of the emergence of process modelling identifies its early roots within the software engineering community (Curtis et al., 1992; Scheer, 1998b). The close link that process modelling has with other conceptual modelling domains (such as data and object-oriented modelling) is evident, both within the literature and in the design of popular process modelling tools and practices (Scheer, 1998a, 1998b; Levin, 1996, Becker et al., 1997). Given the lack of theoretical or empirical evidence on process modelling CSFs, a review of relevant literature within the traditional domains of software engineering and conceptual modelling was conducted.

A review of literature that evaluated information models revealed that they often described 'quality' factors rather than CSFs. This can be explained with the specific focus of the community dealing with conceptual modelling. The typical focus here is in general the quality of the final product rather than the overall project success in terms of time or budget. For this research we assumed a strong correspondence of quality factors and CSFs. Literature describing 'information model quality' was studied in detail in order to identify and extract those factors (features) that would aid in obtaining a 'quality' modelling initiative. *Semantic* quality (pertains to how well the model depicts the structure and behaviour of the real world), s*yntactic quality* (relates to how consistent and complete the model is against the specified grammar rules) and *pragmatic* quality (captures the degree of 'relevance' and usefulness of the model to its users) were identified as the most widely stated "essential features" of 'good' information models (Moody and Shanks, 1994, 1996, 1997; Rosemann, 1998; Lindland et al, 1994; Krogstie et al., 1995a, 1995b). Means of achieving these model qualities (analogous to candidate process modelling success factors) were often described within these studies. These features were extracted and included with the overall literature findings.

Factors influencing the effectiveness of a system (system development and supporting methodology) are difficult to clearly separate from external factors surrounding its context (Kannellis et al. 1998; Smyth, 1999). Sarker and Lee (1999) further re-enforce this fact in relation to process modelling, stating that the impacts of Business Process Reengineering (BPR) tools are highly influential on their surrounding social phenomenon. Thus, (in addition to conceptual modelling domains) literature related to the specific *application areas* of process modelling was also studied with the objective of gaining insights into the external social factors influencing process modelling success. Literature that specifically described how process modelling is applied within Business Process Reengineering projects (*e.g.* Amoroso, 1998; Scheer, 1998a, 1998b), ES initiatives (*e.g.* Wreden, 1998; Rosemann, 1998; Gulla and Brasethvik, 2000) and general Information Systems projects (*e.g.* Curtis et al., 1992; Levin, 1996) were incorporated into this study. Furthermore, the domain areas of Business Process Reengineering success, ES success and IS success studies were addressed in this review. The relevance of general IS success studies to process-modelling success is further demonstrated by the study from Seddon et al. (1999). They argue that IS success can be measured in various contexts, and state that 'any aspect of a system development methodology' (process modelling is often used as a system development and analysis technique) will also fall into the broader domain of Information Systems.

Results from the preliminary literature review

A comprehensive literature review was conducted targeting leading MIS journals and conference proceedings. 20 leading MIS journals [extracted from an overall MIS journal ranking via the 'ISWorld NET' web site (available at: http://faculty-staff.ou.edu/S/Carol.S.Saunders-1/newjournal.htm#tpptable)] and proceedings of the past 10 years of key IS conferences (including; ICIS, AMCIS, ECIS, ACIS and PACIS), were reviewed in search of success or failure studies in the domains justified above. Important studies referred to within the original studies extracted from this search, were also included (using a snow-ball technique).

A preliminary analysis of the factors extracted from the literature pointed to 8 potential candidate success factors, which were clustered within the two groups of "modelling specific factors" and "context specific factors". The modelling specific factors are (1) Modelling methodology, (2) Modelling language, and (3) Modelling tool. The context specific factors are (4) Modeller's expertise, (5) Modelling team orientation, (6) Project management, (7) User participation and, (8) Top management support (Rosemann, Sedera and Gable, 2001). These 8 factors were then assessed in a pilot case study, the primary purpose of which was to specify the a-priori process modelling CSFs model.

Initial insights from pilot case study

Case study design

The main objective of the case study was to clarify the research questions and to aid in further specifying and operationalising the a-priori model. Yin (1994) argues for the relevance of a single case study when the researcher seeks to identify new and previously un-researched issues. He also states that multiple case designs are desirable when the intent of the researcher is to build and test a theory (Yin, 1994; Gable 1994). On this basis, a single pilot case study, and a multiple case study, have been incorporated into the overall research design to serve both exploratory and explanatory objectives of this research.

A case study protocol was designed, which consisted of two main phases. Phase 1, was designed primarily to understand the context in which the process modelling initiative was conducted within the case organization. Phase 2, was designed to measure those constructs believed to be potentially important variables for the success of the process modelling project within the organization (to test the existence and importance of the candidate process modelling success factors identified so far).

Corporate Services Agency (CSA) is the organization in which the preliminary data collection took place. CSA is a Queensland Government agency established in July 1996, which provides corporate services to both Department of Primary Industries (DPI) and Department of Natural Resources (DNR). Currently, CSA has 270 employees and a financial budget of AU $ 20 million. The main customers of CSA (DPI and DNR) have approximately 8,000 employees that utilise CSA's products and services. CSA is currently running a live SAP R/3 3.1h system. Its SAP R/3 Financial Accounting system has been live since 1998. The SAP Human Resource Management solution has been live since April 1999. CSA is currently assessing the feasibility of an upgrade to SAP v4.6. CSA conducts process modelling projects with the goals of: understanding and documenting current business processes; identifying short term improvements through process efficiencies; and as a means of requirements analysis for the planned upgrade.

Different stakeholders; including modellers, model users, process owners and project sponsors were approached for interviews in the second phase of the study (following the approach of Seddon et al., 1999), to capture the different perspectives of each stakeholder with regard to process modelling success. With the goal of receiving some initial insights into the a priori model, having documented and justified the process modelling initiative, each interviewee was:

i. asked to state *'how useful process modelling was to achieve the goals of the overall project'*,
ii. asked to list process modelling CSFs that they thought were important,

iii. given "cue-cards" with the candidate process modelling CSFs and were asked to rank them in order of importance.

Overview of case study analysis

Analysis of responses provided in the first few interviews of the pilot case, indicated a need to refine the existing candidate CSFs. Three new factors were identified; **User training** (*e.g. "It would be good if people at our end can maintain these models"*), **Project championship** (*e.g. "We would not have actively supported the project if not for the charismatic enthusiasm the general manager showed to this project"*), and **Communication** *(e.g. "structured communication and feedback between the analysis team and us, is one of the most important factors for success")* (per.com: CSA, 15/05/2001). These factors were incorporated into the later interviews of the study and the following was observed: (1) respondents indicated and agreed that the factors had different degrees of importance; (2) the relative importance of the factors differed mostly across the different stakeholder groups.

These initial insights suggest several issues. First, the a-priori model had to be refined to capture the new factors identified during the literature review. Second, the differing degrees of importance ascribed to the factors, suggested the importance of presenting the process modelling CSFs with a sense of their relative importance (see also, Rainer and Watson, 1995; Larsen and Myers, 1998). Third, the importance of defining and justifying 'whose perspective is being used' in the study (see also, Rainer and Watson, 1995; Seddon et al., 1999; Seddon 1997) is also implied. Action was next taken to address these issues in the remainder of the research design.

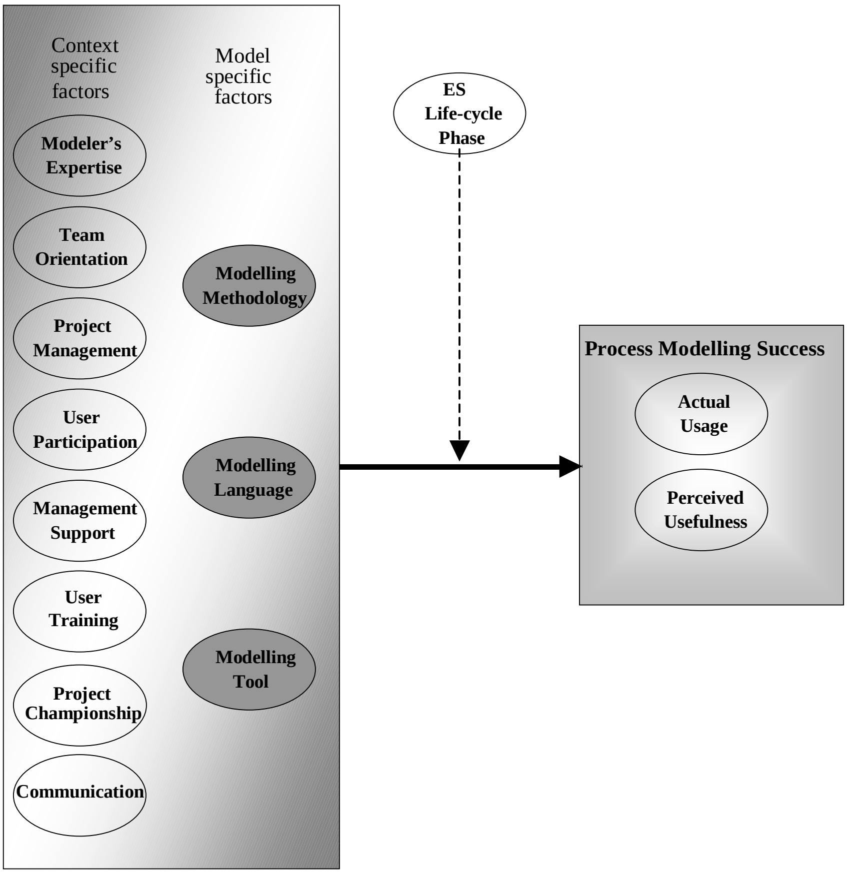

Figure 1: Process modelling critical success factors a priori model

Past IS success studies have shown the importance of properly identifying the correct 'stakeholders' or 'views' to collect data from. The assessment of IS is often based on the measurement of perceptions. Seddon (1999, p.248) argues that "IS success is a conceptualized value adjustment made by an individual, from the point of some stakeholder". Larsen and Myers (1998) further justify the importance of identifying the stakeholders, by describing how 'success' depends upon whom you talk to. Some show how different views provide different perceptions (sometimes even contradictory) and suggest a technique of triangulation; by approaching multiple stakeholder groups, when applicable within the context of the study. Seddon et al. (1999, p.6) classify potential IS evaluators (stakeholders) into five categories; independent observer, individual, group, managers or owners, and country. Looking at the context in which process modelling is applied **-** *to aid in system development and life cycle management* **-** it is extremely important that the evaluators have direct experience of and exposure to the application of the models. Thus, only the users' ('individual') perspectives on process modelling is deemed appropriate for the conduct of this study, as other stakeholders would not have the relevant insight and exposure.

Process modelling critical success factors a-priori model

Figure 1 depicts the current, consolidated a-priori process-modelling success factors model (from initial case insights and the revised literature review). It has 11 candidate success factors [(1) Modelling methodology, (2) Modelling language, (3) Modelling tool, (4) Modeller's expertise, (5) Modelling team orientation, (6) Project management, (7) User participation, (8) User training, (9) Top management support, (10) Project championship, and (11) Communication. Two dimensions of process modelling success are integrated at this point [(a) actual usage and (b) perceived usefulness].

Table 1 summarises findings of the literature review, indicating the specific studies where these factors were identified as critical to success (indicated with a '**X'**) and those studies that 'implied' the existence of the factors would benefit the process-modelling initiative (indicated with a '**X***').

Candidate Process Modelling Success Factors

The process **Modelling Methodology** is defined as a detailed set of instructions that describes and guides the process of modelling. It includes activities such as the definition of the model architecture, the modelling procedure, model lifecycle management and model quality assurance. For example, it should clearly define the modelling scope and the different levels of the model abstractions; and specify layout standards and naming conventions (*e.g.* Bancroft, 1998; Hammer and Champy, 1993; Rosemann, 1998).

Modelling Language is the grammar or the "syntactic rules" of the selected process modelling technique (e.g. Petri Nets, Event-driven Process Chains) (*e.g.* Lindland et al., 1994; Krogstie et al., 1995a, 1995b).

The **Modelling Tool** is the application that facilitates the design, maintenance and distribution of process-models (*e.g.* ARIS, ABC Flowcharter) (Davenport, 1993; Kettinger et al., 1997; Carr and Johannson, 1995). The importance of a tool for process modelling pertains to its ability to expedite expected levels of model quality. For example, automatic syntax checks, consistency checks, layout placements, animations and filtering features that most modelling tools offer, would aid to obtain syntactic and pragmatic quality more efficiently (Curtis et al., 1992, Lindland et al., 1994).

The **Modelers' Expertise** describes the experiences of the project member in terms of conceptual modelling in general and Enterprise Systems and process modelling in particular (Moody, 1996; Lindland et al., 1994; Sumner, 1998; Holland et al., 1999). Ideally the modellers should have *business knowledge* (understand the processes that are being modelled; *company-specific knowledge* (understand the individual issues pertaining to the process); *product knowledge* (understand the components and functionality of the tool being used); *technical knowledge* (understand how to apply the functionality of the selected tool within the existing system infrastructure and be able to interface with other systems), *project management knowledge* and *communication knowledge* (understand how to exchange ideas and communicate within the modelling team) (following Rosemann, 2000).

Study	Area / Domain	Model specific factors			Context specific factors							
		Methodology	Tool	Language	Modeler's expertise	Team orientation	Project management	User participation	Top management support	User training	Project championship	Communication
Bingi et al. (1999)	ES				X*	X*	X*		X	X		
Sumner (1998)	ES					X*			X	X		
Holland et al., (1999)	ES	X*				X	X	X	X			X
Stefanou (1999)	ES					X			X	X*	X	X
Raymond et al., (1995)	Business Process Reengineering	X*							X*			
Grover et al, (1995)	Business Process Reengineering		X*				X			X*		
Clemons, (1995)	Business Process Reengineering	X*	X*				X*	X*	X*			
Evans (1994)	Business Process Reengineering							X*				X
Larsen and Myers (1998)	Business Process Reengineering					X			X			X
Murphy and Staples (1998)	Business Process Reengineering	X*	X*				X		X			X
Davenport (1993)	Business Process Reengineering		X									
Kettinger and Teng (1997)	BPR		X									
Carr and Johanson (1995)	BPR		X									
Hammer and Champy (1993)	BPR	X				X	X					X
Amoroso (1998)	BPR											
Smyth (1999)	CASE		X*									
Burkhard (1990)	CASE	X					X	X	X	X		X
McClure (1979)	Software Engineering		X		X	X			X			
Brash (1999)	Enterprise Modelling							X				
Rosemann (1998)	Process modelling - quality		X*	X*			X*	X*				X
Moody and Shanks (1997)	Data modelling- quality						X*	X				X
Moody (1996)	Data modelling				X			X				X
Lindland et al. (1994)	Conceptual modelling - quality		X	X				X	X*			X
Green and Rosemann (2000)	Process modelling- ontological evaluation			X								
Batini et al. (1985)	Conceptual modelling-(Diagramming)			X*								
Krogstie et al (1995a, 1995b)	Requirements engineering -quality											
Delone and Mc Lean (1992)	Information Systems							X				
Bailey and Pearson (1983)	Information Systems							X				
Ginzberg (1981)	Information Systems							X				
Ives and Olson (1984)	Information Systems							X				
Lucas (1981)	Information Systems							X				
Lucas et al (1998)	Information Systems							X				
Raymond (1995)	Information Systems							X				
Fisher (2000)	Information Systems							X				
Davis (1989)	Information Systems							X				
Warne and Hart (1996)	Information Systems								X*			
Inchusta et al. (1998)	Information Systems		X*						X	X	X	
Srivihok (1999)	Information Systems - EIS							X		X*		X
Rainer and Watson (1995)	Information Systems - EIS							X				X
Chuang and Shaw (2000)	ES and Information Systems				X	X*	X*		X			

Table 1: Cross reference literature review of candidate process modelling CSFs

Modelling Team Orientation captures the 'infrastructure' that should exist in a successful process modelling team, such as an appropriate mix of internal and external members, representation of all core modelled processes, team leadership and vision (*e.g.* Sumner, 1998; Bancroft, 1998; Rosemann et al., 2000; Hammer and Champy, 1993).

Project Management refers to the formal definitions of the project scope, milestones, and plans (*e.g.* Rosemann et al., 2000; Grover et al., 1995; Murphy and Staples, 1999; Bancroft, 1998; Holland et al., 1999).

User Participation (*e.g.* De Lone and McLean, 1992) describes the degree of input from users. This input can be in terms of participation at modelling workshops or active process modelling. Users are here defined as those involved with a business process and consist of the process owners and the operational level employees.

User training describes how much knowledge was given to the users about the modelling tool and modelling procedures, so that they can understand the models, provide good interpretations and maintain the models after the project (*e.g.* Grover et al., 1999; Stefanou, 1999).

Management Support is the level of commitment by senior management in the organizations to the process modelling project, in terms of their own involvement and the willingness to allocate valuable organizational resources (*e.g.* Holland et al., 1999; Rosemann et al., 2000).

Project championship is the existence of a high level sponsor who has the power to steer the project, by setting goals and legitimate changes (*e.g.* Inchusta et al, 1998; Stefanou, 1999).

Communication describes exchange of information (feedback and reviews) amongst the project team members and the analysis of feedback from users. Achievement should be measured against project goals (*e.g.* Holland et al. 1999, Murphy and Staples, 1998).

Candidate Dependant Variables

'Success', of Information Systems, especially in the area of Enterprise Systems is very difficult to measure, as there is no established standard for evaluating it (Larsen and Myers, 1998; Seddon et al., 1999). Some argue that there is no single measure of success, but different perceptions influenced by 'context' (Kanellis, 1998; Seddon et al., 1999). Many IS related success studies have been conducted seeking to identify how to define and measure the success of IS. Based on these propositions from the IS/IT literature, **'actual usage'** (following Baroudi et al., 1986) and '**Perceived usefulness'** (following Davis, 1989) from the *model users'* perspectives, are proposed as the dependant variables to measure process modelling success in this study (see Figure 1). These two measurements seem to fit well within the research context, by (a) evaluating the initiative from an 'ideal' versus 'actual' state and (b) capturing not only the perceived degree of importance of each factor, but also the extent of their actual use in real life process modelling initiatives. Having the correct and complete number of dimensions is important as the dimensions become the foundation in preparing a measurement instrument (Garrity and Sanders, 1999, p.31). Thus, we have undertaken further research in identifying and justifying the dependent variable(s) of process modelling success (Sedera, Rosemann, Gable, upcoming).

CONCLUSION AND OUTLOOK

This paper introduced the context and the objectives of research on 'Success Factors of Process Modelling for Enterprise Systems'. It described the derivation of an a-priori process modelling success factors model, providing evidence from a comprehensive literature review and preliminary insights from an early case study.

The a-priori-model introduced in this paper will be further specified with multiple case studies. Literature will be revisited to identify potential theories that propose (a) any interrelationships between the different factors and (b) relationships between factors and the candidate process modelling success measurements. Past studies that have measured these constructs (factors and success dimensions) will be identified, and items for this study context will be extracted, modified and justified for the survey instrument derivation. The derived survey instrument will be pilot tested and any proposed revisions from this analysis will be conducted. Finally, a worldwide survey will be conducted targeting past and present Enterprise System process modelling users (as specified above). The overall goal of the survey is to (a) justify the process modelling success factors and their interrelationships (i.e. factor analysis, correlation analysis), (b) describe their relative contribution to process modelling success (i.e. regression analysis), (c) analyse how this may differ across various contingency factors, as the System life cycle phase in which the models are applied in (i.e. t-tests, Anova, Monova), and (d) essentially, to test the predictive power of the model posited [using partial least squares (PLS)].

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