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MEASURING PROCESS-MODELLING SUCCESS

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ABSTRACT
Process-modelling has seen widespread acceptance, particularly on large IT-enabled Business Process Reengineering projects. It is applied, as a process design and management technique, across all life-cycle phases of a system. While there has been much research on aspects of process-modelling, little attention has focused on post-hoc evaluation of process-modelling success. This paper addresses this gap, and presents a process-modelling success measurement (PMS) framework, which includes the dimensions: process-model quality; model use; user satisfaction; and process modelling impact. Measurement items for each dimension are also suggested.

1. INTRODUCTION AND STUDY OBJECTIVES

Contemporary business concepts of Business Process Re-engineering (BPR) (Hammer and Champy, 1993) and Process Innovation (Davenport, 1993) emphasise the importance of a process orientation. Increasingly, organisations are structuring themselves around their business processes in order to improve responsiveness to business opportunities and threats, and adopting integrated software solutions that mirror and support the needs of their core business processes (Hammer and Champy, 1993; Davenport, 1993).

In support of these aims, organisations seek means of better understanding their business processes. “Process-modelling is an approach for visually depicting how businesses conduct their operations; defining and depicting business processes, including entities, activities, enablers and the relationships between them” (Gill, 1999, p.5). The benefits of process-modelling, particularly on large IT-enabled business process re-engineering projects such as Enterprise Systems implementations, have been widely recognised.

Practitioners and researchers have discussed extensively the various applications of process-modelling at different phases of an IS project (e.g. Curtis et al., 1992; Rosemann, 2000; Gulla and Brasethvik, 2000). Important contingent factors have been reported across various process-modelling contexts. However, little empirical evidence exists on how to conduct process-modelling successfully, and how to measure the success of a process-modelling initiative. This paper addresses the later part of this problem. Preliminary findings on candidate process-modelling success factors [modelling methodology; modelling language; modelling tool; modeller’s expertise; modelling team orientation; project management; communication; user competence; user participation; leadership; and top management support (Rosemann et al., 2001; Sedera et al., 2001)] have been reported previously. This paper presents a conceptual measurement model for process-modelling-success and discusses implications for practice and research.

Process-modelling is a technique for supporting system life-cycle management. Regardless of potential benefits, modelling is a resource intensive activity involving considerable costs (e.g. licenses for the modelling tool, third party modelling expertise, staff training in model development and maintenance). Organizations making these investments need to know if this intermediate procedure is worthwhile. A question often asked by both practitioners and researchers is “in what way(s) would the overall outcome have been different in the absence of modelling?” A valid, reliable and feasible process-modelling success measurement-model would aid in addressing this question.

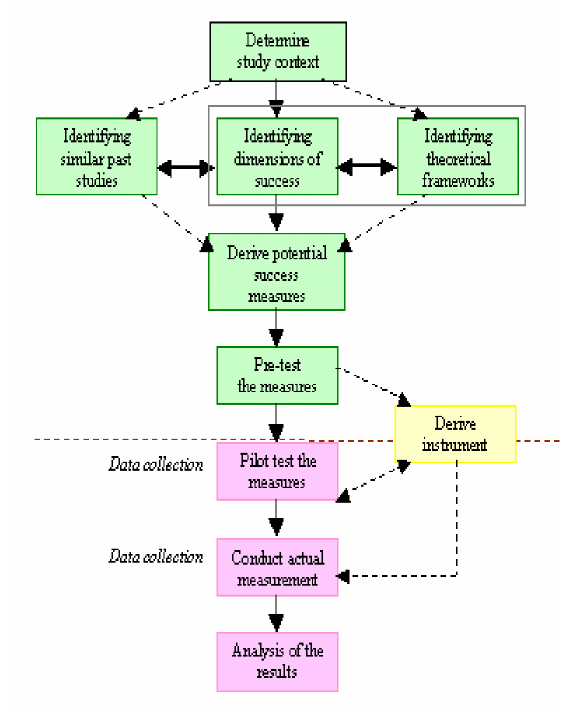

Figure 1: Measurement derivation process

Thus, a validated measurement-model of process-modelling success will benefit both practitioners and researchers. Practitioners may address the proposed success dimensions when justifying and/or evaluating their process-modelling initiatives. In research, such a model will be of value to studies seeking to predict or explain process-modelling success. Further, other research disciplines may also benefit from testing the value of the dimensions in analogous domains (i.e. data modelling, simulation). They may also apply the measurement derivation process, summarized in Figure 1 and explained in detail throughout this paper, as a guide to identifying measures of success specific to their own study contexts

Success is difficult to measure. It is often ill defined and there exists no standard measure that applies across all contexts (Larsen and Myers, 1998). This suggests the need to follow a clearly defined and planned process, when deriving success measures for any given context.

Figure 1 depicts the success measures derivation process that was developed and followed in this study. The paper chronicles the steps of the process up to the derivation of the success measurement instrument, (depicted by the horizontal dotted line in Figure 1). The paper proceeds as follows: the study context is described; similar studies are identified from the literature; potential dimensions for process-modelling success measurement are identified, justified and presented within a framework; and items (which have been face-validated) for measuring the process-modelling success dimensions are proposed. The paper concludes with discussion on further planned research.

2. DEFINING THE STUDY CONTEXT

The aim of this study is to derive a valid process-modelling success measurement-model. Before proceeding with specification of the model, four core contextual elements must be identified and clearly specified: (1) the unit of analysis, (2) the definition of process-modelling success, (3) the ‘view’ (stakeholder) on which the success evaluation is ultimately to be based, and (4) the ideal timing of views on success.

2.1. Unit of analysis

Process-modelling, as discussed earlier, supports system development and system lifecycle management. There is no output (i.e. an actual system) whose value to the organisation can be measured in isolation. Instead, it is mainly the impact and implications of process-modelling for the resulting system that is of interest. These implications can be difficult to identify, capture and measure. Consequently, a clear definition of the unit of analysis is crucial. This study unit of analysis is the process-modelling project, including both the evaluation of the *product* (the process-model), and the evaluation of the *process* of applying the model. This corresponds with the focus on product quality and process quality made in most quality management approaches.

2.2. Defining process-modelling success

In the quest for deriving the dependent variable(s), in this study context- 'process-modelling success', one must first clearly define what is intended to be measured. In the context of this study "the process-modelling project is a success if it is *efficient* and *effective*. *Process modelling effectiveness* can be described as the extent that it supports the fulfilment of the objectives that underlay the modelling project. *Process modelling efficiency* is to confirm to the resources (cost and time) assigned to the project.

2.3. Selecting the appropriate stakeholders' views for evaluation

Many success studies have shown the importance of properly identifying the correct 'stakeholder' or 'view' to collect data from. Looking at the context in which process-modelling is applied (*to support system development and system life cycle management)* and the unit of analysis of this study [*process-modelling projects, including the products (i.e. the models) and the process of applying the models]*, it is important that the evaluators have direct experience of and exposure to process-modelling.

A range of literature exits that summarise the key stakeholders in a IS success measurement context (i.e. Seddon et al, 1999). Different views provide different perceptions (sometimes contradictory) with past studies suggesting value in triangulation; by canvassing multiple stakeholders. We too encourage the elicitation of multiple perspectives when applicable and feasible. This study proposes the **Modellers'** (those who develop the process models) and the **Model Users** (the primary users of the process models; often likely to be process owners) perspectives as the most appropriate perspectives on process modelling success.

2.4. Determining the timing of measurement

The timing of evaluation (data collection) has a large impact on the actual result. Which time phase is most appropriate depends on the perspectives of measurement. As discussed earlier, two perspectives have been proposed for this study: the modeller (perceptions of the modelling process) and the model users (process owners – perceptions on the model applicability or use). The ideal time to gather the modellers' perspective is during the model design phase itself. The ideal time to gather the user perspective is after the process-modelling project has been completed and the application of the models has commenced, but is not totally complete; in other words, the phase in which the process-models are actually being applied to aid in the various phases of the system's life cycle. Figure 2 depicts this further.

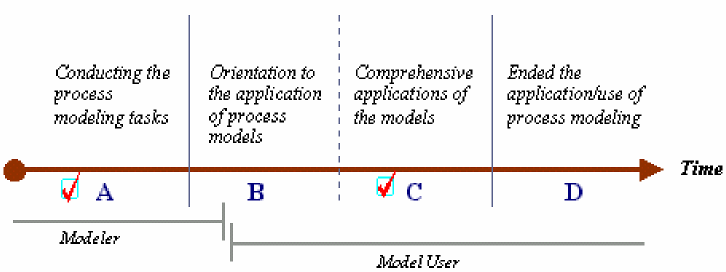

Figure 2: the ideal time for measuring process modelling success

Time period 'A' is the best time to gather data from the modeller perspective. The modellers would have recent experience in process modelling and will be able to provide more accurate perceptions. However, as the models are still being designed, there would be no models to apply and use, let alone to evaluate, from the model user perspective. Time period 'B' is not yet suitable for data gathering as the model users would not have had sufficient exposure to applying process-modelling, to be able to identify and appreciate its true implications (positive or negative). Time period 'C' is the ideal point to gather data from model users as the process-modelling project would be complete, and model users would have sufficient experience and exposure in applying the derived models. These value prepositions would be recent enough to obtain undistorted measures. As further time passes, external factors other than the true implications of process-modelling, will surface and influence stakeholder perceptions of process-modelling. People will tend to forget the true implications and show more or less weights to the constructs being measured and thus, falsely inflate or deflate the results.

3. RELATIONSHIP TO PRIOR WORK

Zmud and Boynton (1991, p.154) state that "*one should never develop an instrument from scratch when a well-developed, or fairly well-developed instrument that fits the level of analysis and level of detail required by a particular research model already exists. MIS researchers should develop their own measures only as a last resort, and only after comprehensive research and examination of existing instruments have been undertaken*". We have drawn upon the work on Information Systems (IS) success as the basis of this study. Information Systems success is a well-debated area of research and studies employing established measurement items have been widely published. However, prior to deriving process-modelling success measures from these study results, it is important to first establish a clear relationship between process-modelling and general Information Systems, and justify that the Information Systems success domain is suitably analogous with process-modelling success. The following section identifies core commonalities between process-modelling success and generic IS success.

Seddon et al. (1999) argue that IS success can be measured in various contexts, and state that 'any aspect of a system development methodology' also falls into the broader domain of Information Systems. Ishman (1998, p.68) states, "*In the theory of planned organizational change implementation, success is considered to be dependant on the quality of the implementation process*". Thus, the evaluation of the process of deriving an Information System is equally important and similar to evaluating the actual system. Ishman (1998), and other similar IS success studies (i.e. Garrity and Sanders, 1998; Bailey and Pearson, 1983) derive the same measures for both the process and product evaluation, based on similar assumptions. Since process-modelling is a system development technique, we modify this argument, to justify that IS product evaluation studies can be used as a foundation to derive measures for process-modelling success. Furthermore, process-modelling literatures describe in detail how process-modelling is applied extensively at the different system lifecycle phases (e.g. Curtis et al., 1992, Rosemann, 2000). This implies a "part-of" type relationship between process-modelling and IS developments. Process-modelling can be regarded as an integral part of the IS development and maintenance processes, thus further justifying the above arguments.

Based on these justifications, literature on IS success was extensively reviewed. Literature pertaining specifically to the field of process-modelling, especially conceptual model quality was also studied, with the goal of finding potential measurement dimensions for measuring process-modelling success.

4. PROCESS-MODELLING SUCCESS MEASUREMENT DIMENSIONS

Having the correct and complete number of success dimensions is important, as they become the foundation of preparing a measurement instrument (Garrity and Sanders, 1998, p. 31). The primary goal of this phase was to identify major IS success frameworks and related theories and to marry them with the study context to derive candidate process-modelling success dimensions. Table 1 provides a summary of the frameworks reviewed for this purpose. Figure 3 depicts the process-modelling success measurement dimensions framework (from here on referred to as the PMS framework). The goal of deriving this framework is not to test any causal relationships between selected dimensions, but rather, to ensure that the set of dependant variables is complete and has captured all relevant aspects/dimensions pertaining to the context of this study.

Table 1: Summary of IS success frameworks

SOURCE	CORE DIMENSIONS
De Lone and Mclean (1992)	Systems quality, Information quality, Use, User satisfaction, Individual impact, Organisational impact.
Garrity and Sanders (1998)	System use, User satisfaction (within User satisfaction: Task support satisfaction, Decision making satisfaction, Quality of work life satisfaction, Interface satisfaction), Individual impact, Organizational impact.
Ballantine et al. (1998)	*The framework is different in its nature. It mainly emphasizes a 'filtered effect' through the development→ deployment → delivery stages. They argue that the system has to be successful at the initial level to proceed successfully to the next.*
Ishman (1998)	Systems quality, Information quality, Use, User satisfaction, Individual impact, Group impact, Organisational impact.
Myres et al (1998)	Service quality, Systems quality, Information quality, Use, User satisfaction, Individual impact, Work group impact, Organisational impact.
Seddon (1997)*	Systems quality, Information quality, Perceived usefulness, User satisfaction, Impact on individuals, Impact on organisations and Impact on society.
Goodhue (1992)	Task system fit, Actual use.
Sarrinen (1996)	Development process, Use process, Quality of the IS product, Impact of the IS on the organisation.
De Lone (1988)	No actual framework but strongly argues for 'Actual use' and 'Impact on the business' as success measures.
Jennex et al (1998)	Systems quality, Information quality, User satisfaction, Amount of use, Individual impact, Organisational impact [All dimensions were modified to suit their study context - Organisational Memory Information Systems (OMIS)].

* Only the "IS success" part of this model was extracted

The De Lone and Mclean (1992) study is considered the landmark study in the IS success domain. This framework of IS success is by far the most popular. Many post De Lone and Mclean (1992) studies have been conducted to further explore and validate the dimensions introduced in this article. We too have used this framework as the basis, and analysed the contributions of other studies to derive the PMS Framework illustrated in Figure 3. A summary of how these dimensions were derived and their definitions are provided below.

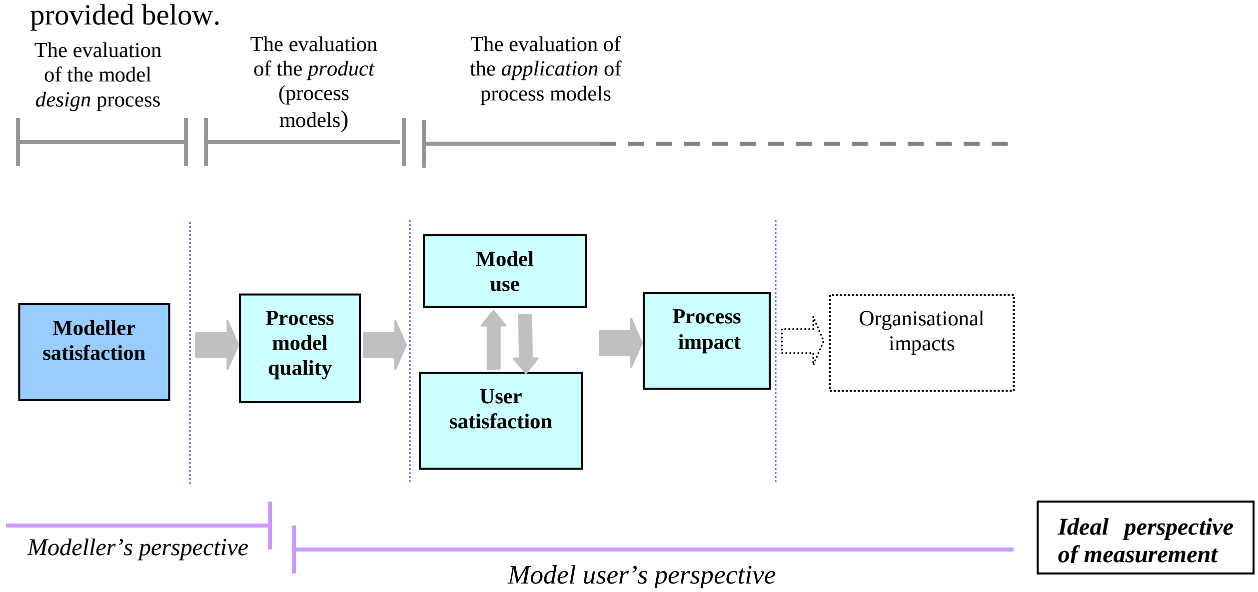

Figure 3: Process Modelling Success Measurement Framework (PMS framework)

The **modeller satisfaction** construct is unique to this success measurement framework. It refers to ***"****the extent to which the modellers (those who derive the process models) believe process modelling meets the fulfilment of the objectives that underlay the modelling project and the extent to which they believe that process modelling was enjoyable and efficient".* This was included in the framework to tap into the affective attitude of the modeller (analogous to the developer of a system). When applicable and feasible, analysing the developers' perspective on deriving the outcome (in this context – deriving the models) can be of value. A satisfied modeller would propose and support the idea of modelling more often, thus influence the Model use and User satisfaction constructs; and would also enhance the quality of the product, thus influence the Process model quality construct.

The system quality and information quality dimensions of the original IS success frameworks were dropped and the new dimension '**process-model quality'** defined as the *"extent to which all desirable properties of a model are fulfilled to satisfy the needs of the model users in an efficient way"*, has been proposed. In terms of system quality, within the context of this study, there is no actual system to measure as process-modelling acts only as a catalyst for the successful design and maintenance of a system rather than being a system in itself. Information quality often can be thought to relate to the quality of the output. But not much direct output or information is provided from the process-models; instead, one has to 'interpret' the models. The process-models are the only direct outputs of a process-modelling initiative and what influences the successful design and management of a system. Thus, the "process-model quality" in terms of semantic and syntactic correctness, economic efficiency (feasibility), clarity, comparability, and systemic design [following the Guidelines of Modelling (GoM) framework (Rosemann, 1998; Becker et al., 2000] is proposed in lieu of system and information quality. The GoM framework assures the quality of information models beyond the fulfilment of syntactic rules and has built upon other major information quality frameworks such as Lindland et al., 1994, Krogstie et al., 1995, Moody and Shanks, 1994.

'Use' has been identified as one of the most frequently reported measures of success of an IS (De Lone and Mclean, 1992, p. 66). This framework also proposes 'model use' to be an important dimension of success and defines it as "*the extent of comprehensive application of the models.*". The non-use of designed models is a failure and a waste of resources. Since success is the opposite of failure, it is often assumed that increased use is analogous to the success of the investment (Seddon, 1997, p. 242; Gelderman, 1998, p. 12). However, this may not always be true. First, the construct 'use', in itself is difficult to measure. Use must be voluntary and non-captive to be of any value as a surrogate measure of success. Actual use may often be different to reported use, due to noise from delayed data collection or other environmental issues. Different levels of use (or adoption) and different types of users make data collection even more complex. Furthermore, the availability of data that captures usage, and access to these data has been a critical problem for researchers attempting to employ this construct in evaluating systems (De Lone and Mclean, 1992, p. 66). Second, Seddon (1997, p. 242) argues that increased use is not an effective measure of success. "The critical factor for IS success measurement is not system use but the *net benefits* flown from use… A successful system will provide benefits such as helping the user do more or as much work in the same time, or take less time to achieve as much work of the same quality or more". Thus, use measured in terms of hours of interaction etc., is not effective.

Davis (1989) proposes two surrogate measures for use: 'perceived usefulness' and 'perceived ease of use' as a means of overcoming the difficulty of measuring use directly, and provides theoretical justification for these two constructs as predictors for IS use (p. 320-323). However, the applicability of these constructs within a success measurement context is questionable. Seddon (1997, p. 243) states that perceived usefulness and perceived ease of use "describe behavior, and do not measure success", and thus are not relevant in measuring success. Doll and Torkzadeh (1998) have proposed multidimensional measures of system use, based on performance related behaviour. Their findings have been applied as the foundation for this PMS framework's use dimension because: (a) the authors justify its applicability as a success measure (p. 173), (b) the concept of a multidimensional use construct resolves many measurement issues, and (c) the items proposed, fit the context of process-modelling fairly well.

Ives et al. (1983, p. 785) state that **user satisfaction** provides a meaningful "surrogate" for the critical but immeasurable result of an Information System. Melone (1990) notes similarities between user satisfaction and user attitudes, and draws upon attitude theories to justify the applicability of user satisfaction as a surrogate measure of IS success. However, care must be taken when adopting this dimension and related measures in the context of process-modelling. The first issue relates to the varying 'facets' of user satisfaction that have been discussed in past literature. Gelderman (1998, p.12) defines user satisfaction in a generic manner stating that it is "*The extent to which information requirements are met*". Ives et al. (1983, p. 785) use the term 'user information satisfaction' (with emphasis for the information aspect of the construct) and define it as "*The extent to which users believe the information system available to them meets their information requirements*". Doll and Torkzadeh (1988), on the other hand, differentiate generic user satisfaction from end-user satisfaction and define the 'end user satisfaction' construct as *"The affective attitude towards a specific computer application by someone who interrelates with the application directly"* (p. 261). For the context of this study, Doll and Torkzadeh's (1988) definition and the more generic view of user satisfaction are combined, and the construct is defined as "*the extent to which users believe process modelling meets the fulfilment of the objectives that underlay the modelling project"*. Secondly, Woodroof and Kasper (1998) discuss equity, expectance and need theory and argue that process satisfaction is different to outcome satisfaction, and that satisfaction and dissatisfaction are two different constructs. This indicates the difficulties for those researchers who intend to extract user satisfaction measures from past literature and/or derive new measure on their own.

Most of the success frameworks reviewed included an 'impact' section to capture either the individual, workgroup, organisational or social impacts of the information system. In relation to the context of this study, we have used "**process impact**" in lieu of the other impacts proposed in analogous literature. By definition, this dimension "*measures the effects of process modelling in the process' performance*". Here, the 'process' refers to the processes or functions that is applying modelling.

Stewart (2001, p. 38) argues that projects (like a process modelling initiative) are "mini" organisations", and that the Balanced Scorecard approach proposed by Kaplan and Norton (1992), can be applied to perform "health checks" throughout the project lifecycle. The Balanced Scorecard is an organisational performance evaluation technique that measures the performance from a qualitative and quantitative angle with its four core dimensions of; finance, customer, process, and learning and innovation. We support the adoptability of this concept for the context of this study, and propose to adopt the core perspectives of the Balanced Scorecard as sub-dimensions to tap into the proposed process impact dimension of this framework. The 'financial', 'learning and innovation' and 'effectiveness' dimensions have been proposed as sub-dimensions to measure process impact in this framework. The customer dimension overlaps significantly with the user satisfaction dimension and thus was not duplicated. 'Process impact' in itself is significantly similar to the Scorecard's quadrant of business process performance. Consequently, it was not directly included. Instead, 'effectiveness', which was deemed to be a more relevant feature of process improvement within a process-modelling context, was adopted.

Process impacts are a subsection of **organizational impacts**. Process modelling, when successful, should positively impact the process and reflect these impacts on the organization's performance. Due to the secondary and intermediary nature of process modelling in relation to generating organizational impacts, and the complexity of defining and measuring organizational impacts, this framework only acknowledges the existence of this dimension, but does not propose to measure it within a process modelling context.

5. THE PROCESS-MODELLING SUCCESS MEASURES

The proposed process-modelling success measurement dimensions were discussed in detail and confirmed with process-modelling experts. The next step was to identify potential measures pertaining to each dimension.

The stakeholder to be approached has a significant impact on the items employed, and the way they are phrased. The ideal stakeholder differs according to each dimension employed. Figure 3 depicts the model users as the ideal stakeholders to gather data on the aspects of applying the models, and the modellers as the ideal stakeholders to gather data on the aspects of designing the models. The model quality aspects are ideally evaluated by combining both the modeller and user perspectives. For example, syntactic quality of the models is best evaluated by the modeller, while semantic quality is best evaluated by the model users. A list of candidate measures, derived from the consolidation of IS success literature and the authors' process-modelling experience, was constructed and converted into measurement items. These items were then tested for face validity by researchers with experience and expertise with both process-modelling and survey design. The resulting items are presented in Appendix A. All items were designed on a five-point likert scale (very much-very little; occasionally the scale naming differed to suit the context of the posed question).

6. CONCLUSION AND OUTLOOK

This paper reported on a study that attempts to measure the success of process-modelling. All success instruments must ultimately commence with a conceptual justification of the dimensions, which comprise the measures. Hypothesized measurement-models are derived through these dimensional frameworks and empirically tested with data from a referent population. The results become standardized, only after the completion of confirmatory studies that empirically test the instrument against new data from the same reference population. This paper reported on the first phase of this process.

The paper presented the objectives and context of the study and established relationships with the process-modelling and the generic IS domain, from which knowledge to derive process-modelling success measures were drawn from. The core dimensions for measures of process-modelling success were derived and discussed via the process-modelling success measurement (PMS) framework presented. The final section of the paper provided measurement items that can be adopted for each dimension of the PMS framework. The next stage of the research is to empirically test the derived instrument as the process continues to the phase of data collection.

The instrument will be extended, with the inclusion of both the dependent (process-modelling success measures proposed in this paper) and independent (process modelling success factors) variables. 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 process modellers and users of a popular modelling tool.

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APPENDIX A: PROPOSED PROCESS-MODELLING SUCCESS MEASURES

Measures for Modeler satisfaction

1. How would you describe your relationship with the management?
2. How would you describe your relationship with the process owners?
3. How satisfied are you with the provided resources (i.e. facilities)?
4. Was the modeling tool easy to use?
5. Was the modeling language easy to follow?
6. Was the modeling methodology easy to conduct?
7. Did you have *sufficient* information to design the models?
8. Did you get the information you need in *time*?
9. How accurate was the information you received?
10. Do you perceive process modeling as a task that required intensive preparation?
11. Once the required information was gathered, how did you perceive the time it took to design process models?
12. Do you perceive process modeling as a complicated task?
13. How satisfied are you with the contributions that you were able to make to *this modeling project*?
14. How satisfied are you with the contribution that process modeling was able to provide *the organization with*?
15. Overall, is process modeling easy to conduct?
16. Do you enjoy process modeling?
17. Would you look forward to be involved in another process modeling project

Measures for Process-model quality

Semantic correctness: (how well the models describe the structure and behavior of the real world)

Syntactic correctness: (how consistent and compete the models are against the meta model)

Relevancy: (the degree to which the model includes all important elements and relationships of the real world)

Economic Efficiency: (how feasible the models are)

Clarity: (how ‘understandable’ the models are)

Comparability: (How comparable the models are to one another)

Systemic design: (The degree of interrelationships with models belonging to other views)

Interface quality: (The quality of the model output modes, in terms of accessibility, presentation and format)

Measures for Model Use (adopted and modified from Doll and Torkzadeh, 1998)

1. Do you use process modeling to make sense out of the process?
2. Do you use process modeling to analyze why problems occur?
3. Do you use process modeling to decide how to best approach a problem?
4. Do you use process modeling in order to improve process performance?
5. Do you use process modeling to help explain your decisions?
6. Do you use process modeling to help justify your decisions?
7. Do you use process modeling to communicate with other people in your work group?
8. Do you use process modeling to communicate with people who report to you?
9. Do you use process modeling to communicate with people you report to?

Measures for User Satisfaction (adopted and modified from Doll and Torkzadeh, 1988)

1. Are the models easily accessible?
2. Are the models easy to understand?
3. Do you think the models are reliable enough (i.e. they depict the underlying business processes close enough)?
4. Do you feel the models required any correction?
5. Do you perceive the models as sufficiently current?
6. Did you find elements in the model that were not useful?
7. Were all elements of the process important to you, depicted in the model?
8. Are you satisfied with the awareness of process modeling in your organization?
9. Do you enjoy using the process models?
10. Did you feel the models were used in a sufficient number of occasions?
11. Do you see further potential for using the models?
12. Did you feel the models were used inappropriately?
13. Are you satisfied with what you are able to achieve with process modeling?
14. Do you trust the interpretations derived by the models?

Measures for Process Impact

Financial:

1. Did process-modeling help you identify opportunities for *direct* cost savings (e.g. reduction of operational costs)?
2. Did process modeling help you identify opportunities for *indirect* cost savings (e.g. staff reduction)?
3. Did process modeling help you identify opportunities to *increase revenue?*

Learning and innovation:

4. Did process modelling increase the organization's *awareness* of the process?
5. Did process modelling increase the organization's *understanding* of the process?
6. Did process modelling help the organisation *generate* creative ideas for improvements?
7. Did process modelling help you *implement* improvements to the actual process?
8. Do you think process modelling inhibited opportunities for innovations?

Efficiency:

9. Did process modelling help to manage knowledge policy related to business processes?
10. Did process modelling help to implement continuos change management related to business processes?
11. Overall did process modelling contribute to achieve the objective that underlay the entire project?

Criterion Variable

Do you think process-modelling was successful?