DESIGN SCIENCE AND ACTOR NETWORK THEORY NEXUS

A Perspective of Content Development of a Critical Process for Enterprise Architecture Management

Theodora Ngosi
Innovation Value Institute, National University of Ireland, Maynooth, County Kildare, Ireland

Markus Helfert
School of Computing, Dublin City University, Glasnevin, Dublin 9, Ireland

Marian Carcary
Department of Management and Marketing, Kemmy Business School, University of Limerick, Limerick, Ireland

Eoin Whelan
Department of Management and Marketing, Kemmy Business School, University of Limerick, Limerick, Ireland

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Abstract: Design science in the Information Systems (IS) field is situated at the intersection of behavioural sciences, engineering and social sciences. However, little critical attention is paid to the behavioural aspects in a design process. Specifically, the role of the actors, group dynamics, consensus building and how results are achieved. This paper describes a design-oriented case study on the content development of the Enterprise Architecture Management, one of 32 critical processes (CP) of the Information Technology Capability Maturity Framework (IT-CMF). The case study methodology is an ethnographic exploratory approach tracing the content development of this CP from conception to maturity. We apply the combined principles of design science and Actor Network Theory (ANT). We develop a Translation Model that gives an integrative basis for using these combined principles in order to interpret the content development of this CP. The paper concludes with the validation of the Translation Model model to highlight its dominating qualities.

1 INTRODUCTION

Design science is often described as a problem-solving paradigm (Peffer et al., 2007; Robey, 2003). Several guidelines have been proposed that give a more systematic design process for the creation of useful artefacts and better problem solutions; a sound basis for developing arguments for the rigor and legitimacy of the artefacts and for defining testable propositions for their implementation (Gregor & Jones, 2007; Winter, 2008).

At present, design science is situated at the intersection of behavioural science concerned with knowledge of human behaviour; engineering of Information Technology (IT) artefacts; IS addressing theoretical development, application and management of artefacts in organisations; and, social sciences reflecting the respective approaches to rigour (cf. Stokes, 1997; Zmud, 1997). However, little critical attention is paid to the behavioural aspects in a design process regarding the role of the actors, group dynamics, consensus building and how results are achieved. Calls continue for the use of

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theory in design (Gregor, 2004, 2005), and theorising in design science (Nunamaker et al., 1991). These aspects have not been demonstrated through practical research.

This paper presents a case study on the content development of a single IT-Capability Maturity Framework (IT-CMF) critical process (CP), *Enterprise Architecture Management* (EAM). In the scope of design science, content development is a *scientific enquiry* focusing on a problem and the application of a scientific method to discover solutions to the problem. Groups of human actors collaborate in the content development activities. We argue that, examining the content development of the EAM CP that embodies group activities and scientific enquiry can present a holistic complement of factors.

In this paper we apply the combined principles of design science and Actor Network Theory (ANT) and develop a *Translation Model*. The paper makes two key contributions: (1) the proposed *Translation Model* linking design science and ANT is a key contribution. (2) The paper closes the gap in knowledge by introducing the IT-CMF that draws attention to the emerging emphasis in design science as a systematic approach to design activities and construction of artefacts with utility for practice (cf. Hevner et al. 2004).

This paper is structured as follows: Section 1 introduced the scope of this paper. Section 2 that follows next covers the literature review. Section 3 presents the IT-CMF and content development of EAM CP and case findings. Section 4 describes the *Translation Model* and case findings. Section 5 provides a discussion of the key items for implication for practice and concluding remarks.

2 LITERATURE REVIEW

This literature review is a scholarly response to close the gap in knowledge. It highlights understanding of EAM and some of the maturity models. Several competing frameworks have been developed to cope with the complexity of enterprise IS, and the level of detail required for EA designs and development of EAM function. The most widely cited is the Zachman classic EA framework (1987) that provisions essential building blocks in developing an IT-enabled enterprise, and organising the design artefacts that are significant to managing EA.

Other prominent EA frameworks such as Oracle (2009) and TOGAF (The Open Group, 2009) articulate a complex scope of elements related to the business or organisation, for example: data, functions, processes, products and services; stakeholders concerns of the architecture; and implementation scenarios.

In general, these frameworks do not indicate to the organisation the breadth and depth of EAM. Insights from IS/IT management (Khosrow-Pour, 1999; McNurlin et al., 2007) highlight that an organisation has continual tasks of adapting, validating, monitoring, evaluating and maintaining the rationale of its EA in order to optimise business and IS/IT elements. Further, an organisation's EAM function must be supported with objectives and practices as a basis for aligning IS/IT to business goals and making better decisions for integration (cf. Pereira and Sousa, 2005). According to Buckl et al. (2010) distinct EA states typically develop during EAM. Management includes defining the current EA state, and developing enterprise adaptations leading to a target state (Aire et al., 2009).

The lack of understanding of EAM has generated development of maturity models, each borrowing techniques from another. Models (such as US Department of Commerce IT Architecture Capability Maturity Model and IFEAD Extended Architecture Maturity Model) enable organisations to assess their EAM programs and design practices that improve the EAM function. However, the reviewed literatures lack explanation of how an organisation can apply the models to define an appropriate EAM function, capabilities, supportive standards, practices and success factors. Consequently, EAM remains an emerging area which is open for research debate.

3 OVERVIEW OF THE IT-CMF

In this section we summarise the IT-CMF and focus attention on the EAM CP we study as a case. The IT-CMF is designed as a systematic framework. It enables senior chief executives and business managers to assess their organisation's practices in order to understand opportunities for increasing maturity through incremental levels, over time. Taken as a holistic framework, IT-CMF complements the realisation of IT capabilities to deliver business value from IT investments and practices, and subsequent judgements of the organisation's effectiveness (cf. Curley 2004). The meta-elements of IT-CMF can be depicted in three interlinked layers, namely strategy, macro and micro.

[1] The strategy layer underpins the primary

elements of IT-CMF that support an approach to strategic thinking comprising: business context driven by the organisation's vision of its future; business strategy; IT capability; business operations; and, business value (Curley, 2004).

[2] The Macro layer consists of both the content and context of application of the IT-CMF. The content segments the activities of an organisation's IT function into four macro-processes (MPs) namely: Managing IT like a business, Managing the IT budget, Managing the IT capability and Managing IT for business value.

[3] The Micro-layer comprises 32 critical processes (CPs) assigned to the four individual MPs. Each CP adjuncts categories and capability building blocks (CBBs) allowing for analytic rigour to capture detailed content of the CPs. Each CBB has assumptions underpinning five incremental maturity levels, namely initial, basic, intermediate, advanced and optimised (Curley 2004).

4 CASE STUDY METHODOLOGY

We present, in this section, a single case on the content development of the EAM CP and the case study methodology.

The case study methodology is an ethnographic exploratory approach (Bruner, 1993; Meyer, 2001). The study involved two phases: The first phase, over two years, the authors had *first-hand experience* by participating in various WG activities. This experience involved facilitation of WG developing IT-CMF CPs, research to further develop the IT-CMF and literature reviews on the content development issues. We established the WG on EAM as the focus group of this case study. The role of the WG was to assess the meaning, relevance, and completeness of the instruments of the EAM CP in terms of: concept coverage of EAM in the context of the MP-'Managing the IT Capability'; applicability of EAM in an IT organisation; and, to attempt to bridge the gap in the area of EAM where no other frameworks exist.

The second phase is *data collection*. We trace the content development of the EAM CP across four predefined successive stages, over a two-year period. Qualitative data was collected on the sequence of activities performed and on the outcomes at each stage. Secondary data was collected from documented material of the EAM CP (such as inputs, outcomes), and real-world practices intended to improve the content of the CP.

In this second phase, collected qualitative data was analysed across the four stages of content development. Our data analysis goal was to identify general themes and features to understand how content development of the EAM CP was achieved. An interpretive stance was defined as the philosophical basis of the case study. Thus, in our data analysis, we were particularly interested to reflect upon the case findings in order to provide a comprehensive view of content development, emphasising the factors that are important to shape the criteria against which design science principles are applied. ANT as a lens grounded the theorising and reasoning of the case findings in order to interpret group dynamics, instead of a static checklist of activities. Following interpretive principles from Klein and Myers (1999) and Tesch (1990), data analysis and reflection guided how we developed our accountability to discover the substance of the evidence (Ngosi and Braganza, 2009).

5 DESIGN SCIENCE AND ANT NEXUS

In this section we have taken the key principles from design science and ANT to create the idea of a 'nexus' approach. This approach is particularly useful for framing general themes and features of content development from the case findings, and interpreting group dynamics concepts. In Table 1 we present the widely accepted underpinning guidelines (principles) for conducting design science research in the IS field and these are developed in Hevner et al. (2004). This Table also contains principles adapted from Callon and Latour's (1986) 'Social Translation' to describe the WG activities. Our nexus approach combining design science and ANT principles creates a *Translation Model* and this is illustrated in Figure 1. This model develops a process of theorising across the four successive stages of the content development of the EAM CP.

5.1 Summary of the Translation Model & Case Findings

This *Translation Model* is divided into seven interlinked segments in which we explain the meaning of the case findings. The segments are: CP projects, CP stages, ANT principles, design science principles, content development activities, salient

Table 1: Key Principles of Design Science and ANT.

Design Science	Actor Network Theory
1. Design Artefact	1. Actor(s)
2. Design Problem Relevance	2. Heterogeneous network
3. Design Cycle	3. Focal actor(s)
4. Design Research Rigor	4. Obligatory passage point
5. Design Artefact Evaluation	5. Social translation process (phases or moments)
6. Design Research Contributions	6. Articulation

instruments and key artefacts. From each segment we describe the dominating qualities of substance that help us to explicate how content development is achieved and which has important bearing on the meaning of design cycle as well as group activities shifting with time and context.

EAM CP Project

Our case findings show that the content development of EAM accords to a planned project that is purpose-oriented. A Technical Committee mandates the CP objective that bears on the ITCMF MP of reference, such as 'Managing IT. In addition, the TC specifies the stages of content development, CP review process, quality control constraints and deliverables (cf. Kerzner, 1998). The Bothe the TC and WG are responsible for establishing the facilitator role, required expertise, and stakeholders of the CP when published

EAM CP Stages Segment

The content development of the EAM CP goes through four successive stages, namely: Stages 1, 2, 3 and 4. Each stage is located in: time (e.g. stage time span of development); space (WG setting), and particular contexts (e.g. WG activities, collaboration, content development cycle, outcomes, TC reviews and so on.

ANT Principles Segment

In this segment, we draw attention to the ANT five principles in Table 1. There are four obligatory passage points connecting one stage to the next; to outcomes and, their reviews. In Callon and Latour's 'Social Translation' (1986) these passage points are defined as phases (or moments), namely: *problematisation, interessement, enrolment and mobilisation.*

Against this, in this Translation Model we apply the identities to differentiate the context of a content development stage, its passage point and outcomes. The interpretation of content development as a design-oriented process and group dynamics evolve from combining the principles of ANT and design science, hence.

Design Science Principles Segment

This segment applies the six design science principles in Table 1. It views content development of EAM CP in relation to each stage and passage points in order to emphasise the interpretation of group dynamics grounded in ANT as a lens.

- *Stage 1-Identify the problem and literature research [1].* Content development of the EAM CP opens up an array questions to be answered. A problem is identified ensuring that it has *relevance* (Benbasat and Zmud,1999; Hevner et al., 2004) to the underpinning EAM concepts to be examined. Literature Research [1] is conducted to gather real-world issues such as practices that have influence on the content of the EAM CP, together with theoretical underpinnings and the body of knowledge upon which to build its development.
- *Stages 2-Problem relevance, Design cycle [1].* We have considered that content development of EAM CP is intense, because of the complex nature of EAM practices. Thus, shaping the content development process relies heavily on understanding and defining the problem relevance expressed from the literature base of the CP. Problem relevance expresses a theoretical problem, hypothesis or input concepts for analysis (cf. Ngosi and Braganza, 2009). Thus, *problematisation* accords to the combined Stage 1 and Stage 2 activities leading to a definition of *outcome 1* such as the inputs, goals and scope of the CP, substance of each stage, and specific WG requirements.
- *Stage 3-CP hypothesis, Literature research [2] and Design cycle [2].* By defining the problem, a hypothesis to be tested is generated from the available CP knowledge base. Literature research [2] comprising up-to-date subject matters, methods, organisation practices and frameworks impacting on the EAM function ensures rigour in the development and refinement of the content of the CP. Design cycle [2] will include testable parameters of the hypothesis. The outcome is a formal master deck [1] for TC review 1.
- *Stage 4-Pilot assessments, Analysis & Evaluation of pilot results, and Contributions.* The testing of

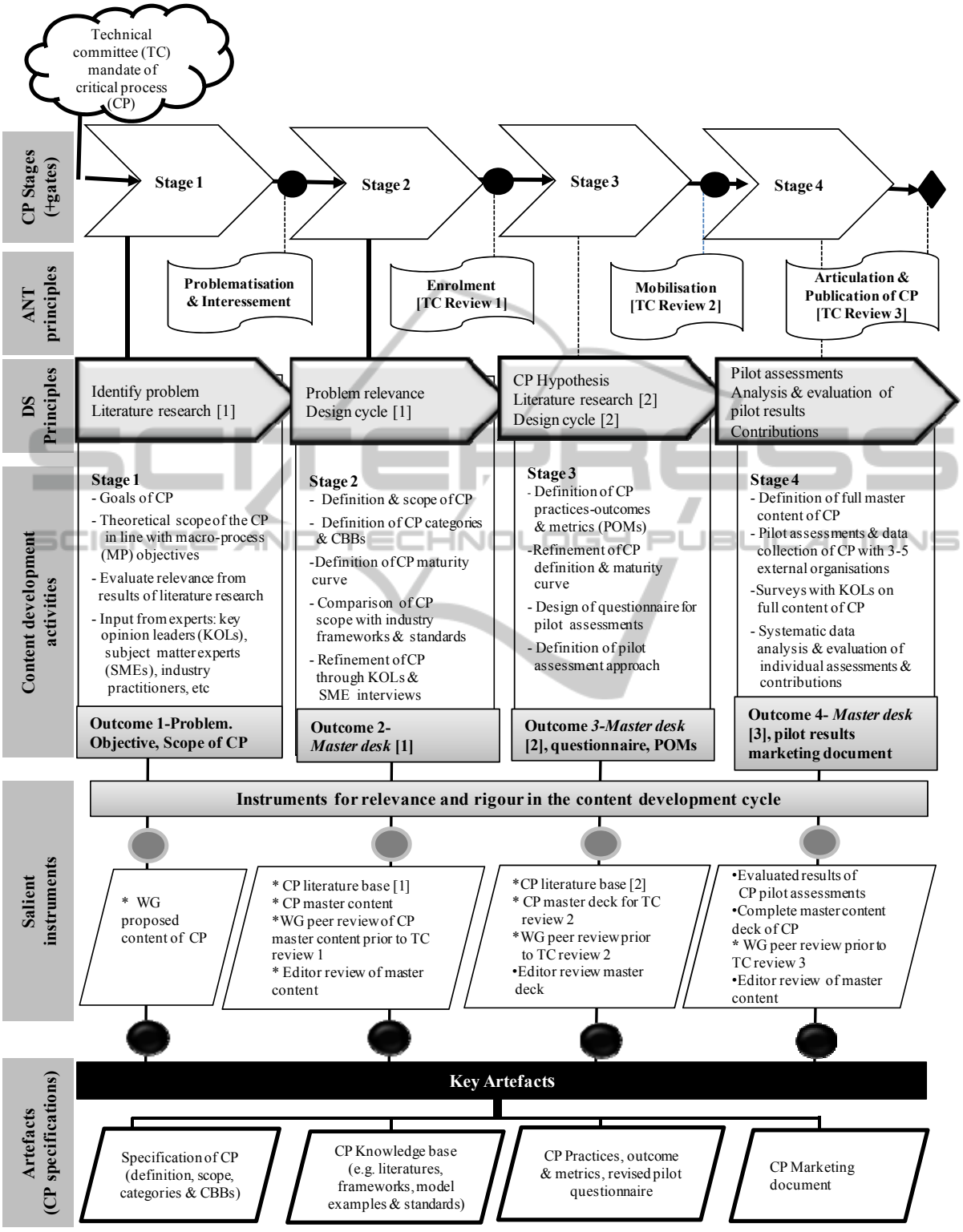

Figure 1: Translation Model.

the hypothesis is achieved through pilot assessments with a number of organisations (cf. Offermann et al., 2009; Venable, 2006). The pilot includes an initial assessment of the organisation

using IT-CMF maturity levels. This assessment captures a maturity posture: where the organisation is at a given point in time (cf. Curley, 2004; Braganza et al., 2009).

Pilot assessments can take up to four months to complete. This depends on the maturity of the pilot organisation in the EAM CP, priority improvement areas and human resource effort available to the pilot administration of data collection. Subsequent analysis and interpretation of pilot results produce full articulation of the EAM CP.

Salient Instruments Segment

This segment is for emphasising relevance and rigour in relation to the delineation of the content development of this CP. From Stages 1 to 4, the

Table 2a: Validation of the qualities of the Translation Model.

Stage	Milestones & stage gate	Key Activities	Group Dynamics Concepts
0	CONCEPTUALISATION	-WG objective of EAM CP -Conceptual guidelines to EAM	-Idea generation
	WG modus operandi	- WG focus group (10 members) -Key actor players: KOL & SMEs -WG facilitator role -WG stage & TC review schedules -WG meetings	-WG formation
1	PROBLEMATISATION	-Identification of EAM problem -Conceptual EAM capability areas	-Problem identity - Conflict resolution
	Problem relevance	- Conceptual CP content -Content of EAM	
	Design of CD cycle [1] & design of CP content	-Selection of input concepts of EAM -Definition of content of EAM CP - Definition of scope of EAM CP -Definition of categories and CBBS -Comparisons of EAM frameworks & standards	-Documentation of Master deck [1] -Editing of master deck -Peer reviews feedback - Group consensus -TC review[1] -TC review& decision-making
	INTERESSEMENt	-1:1 interviews with key opinion leaders & subject matter experts -Analysis of external practices	-Refinement of problem
	WG control assignments	- Analysis of external practices, outcomes & metrics (POMS)	
2	ENROLMENT	-WG external links	-Group CP pilot networking
	Design of CD cycle [2]	-Compilation of master deck [2] -Definition of CP hypothesis - Define pilot assessment instruments (e. g. questions, practices, metrics)	-Documentation of Master deck [2] -Edited master deck -Peer reviews feedback -Group conflict resolution in an actor-stakeholder network -Group consensus -TC review[2] -TC review & decision-making
	Literature research [2]	-Review of mew/emerging EAM literature (concepts, methods, processes) - Refinement of EAM frameworks & standards -Analysis of EAM measurement approaches	
	Pilot assessments planning	-Design of pilot assessment approach -Design of pilot questionnaire - Design of POMs -Selection pilot organisations	

Table 2b: Validation of the qualities of the Translation Model.

3	MOBILISATION	-WG networking with external pilot organisations	-Documentation of Master deck [3] -Editing master deck -Peer reviews feedback -Group conflict resolution in an actor-stakeholder network -Group consensus -TC review[3] - TC review & decision-making
	Pilot assessments	-Data collection of pilot results	
	Technical contextual factors of WG dynamics	-CP content evaluation against pilot results -Resolution of conflicting WG views -Harmonisation of practitioner & WG views	
	Social contextual of WG dynamics	-WG forming creativity -Constructive teamwork & learning -WG forms network relationships with pilot organisations (interests in CP, adoption intentions)	
4	ARTICULATION	-Specification of full content of completed CP	-Definition of artefacts -Publishing of full CP specification -TC review & decision-making
	Interpretation	-Analysis & evaluation of pilot results -Construction of CP specification based on evaluated pilot results	

content development of the EAM produces other connected activities. For example, creating the formal *master deck* is a continuous engaging activity of documenting all the material that the WG agrees to compile on the CP. Example salient instruments include: iterative improvement of the CP literature base and content of the CP; peer reviews of the formal master deck; and, TC reviews.

Artefacts (and CP Specifications) Segments

Each content development stage produces what we regard as sets of 'artefacts' that are designed to achieve their purpose of explaining the CP to intended users (cf. Hevner et al., 2004; Venable, 2006). The final specification of the EAM CP is a key artefact. It describes the concepts that are manifest in the IT-CMF language to which this CP is referenced (i.e. the MP-managing IT capability)'; CBBs and maturity profiles; EAM capabilities architecture management practices. These elements represent the best possible solution to the problem that pilot assessments present (cf. Venable, 2006).

6 DISCUSSION AND CONCLUSIONS

In this paper we have described a case on the content development of the EAM CP. Te problem we examines is the lack of empirical attention to how group dynamics have an impact on the design science process in producing results that can be artefacts such as living processes, methods, and instantiations (cf. Hevner et al., 2004).

In response, we have proposed a *Translation Model* that combines the principles of design science and ANT. By this combination we have expressed generalisable contexts in which the content development of EAM CP is achieved. In Table 2a and Table 2b we illustrate a summary of the features we identify as the epistemological justification of the credibility of this Model, given the treatment of the principles applied in the case.

The paper makes two key contributions. One, our *Translation Model* linking design science and ANT is a key contribution. Drawing on the dominating qualities of the *Translation Model*, the nexus approach has one implication for practice that theory and theorising are of great relevance in design science research, to ensure rigour that brings social realities and research practice into line. Our future work focuses on further refinement of this *Translation Model*.

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