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IDENTIFYING CAPABILITES FOR THE IT FUNCTION TO CREATE AGILITY IN INFORMATION SYSTEMS

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Abstract

In this paper, we identify the necessary capabilities of the IT function to create agility in existing information systems. Agility is the ability to quickly sense and respond to environment perturbations. We contrast the agility perspective from a widely used industry framework with research perspectives on agility in the IS literature. We suggest Beer's Viable System Model (VSM) is a useful meta-level theory to house agility elements from IS research literature, and apply VSM principles to identify the capabilities required of the IT function. Indeed, by means of a survey of 34 organisations, we confirm that the meta-level theory better correlates with reported agility measures than existing practice measures do on their own. From a research perspective, the incorporation of the VSM mechanism helps to explain 'why' the IT function is capable of creating agility. From a practical perspective of 'how', the findings point to a new set of capabilities of the IT function for future versions of the industry frameworks to enable agility.

Keywords: Agility, IT function, Viable System Model, COBIT

1 INTRODUCTION

IS practice appears to be subscribing to a common concept of agility. The concept consists of: recognition of a business environment that fluctuates quicker than conventional planning cycles; the need to sense environmental fluctuations; the need to respond using existing information systems; and organisational readiness to effect the sensing and response (Luftman & McLean, 2004). Gartner defines agility "as an organization's ability to sense environmental change and respond efficiently and effectively to that change" (Newman & Logan, 2006 p 3).

Agility in information systems is a topic of recent interest in IT practice. Strategic agility was ranked first in a survey of 28 senior IT executives presented with a list of 53 issues (Ives & Mandviwalla, 2004). Agility was ranked fifth amongst 22 management concerns in a survey of 128 respondents from the Society of Information Management, representing a broad IT practitioner body (Luftman & McLean, 2004). The survey's authors noted that a faster business pace demands IT organisations respond quickly and effectively. IT activities once measured in years now required in months, and the ability to sense and respond has become critical.

This paper extends the theory on agility in information systems, where the IS literature currently focuses on "what" agility is, and "does" the IT function enable the capability. The paper questions "why" the IT function can enable agility in existing information systems. In doing so, the paper contributes to the practice perspective of "how" to enable agility. This contribution is the result of providing a testable theory of agility that both explains and predicts (Gregor, 2006). The information systems in question are IT-conducted business initiatives, and composed of implemented electronic processes and networks (Weill et al., 2002). The IT function is the IT personnel and their work processes that complement the information systems.

The paper will first review the IS theoretical literature and the practice perspectives on agility. The claimed best practice of Control Objectives for Information and related Technologies (COBIT) provided a practice perspective. Gaps between the IS theoretical and practice perspectives are identified. Next, the conceptual study is explained, and a Viable System Model approach to extend the IS theoretical perspective justified. A description follows of a mailed survey to test empirically the research propositions and an analysis of the findings. Last is a discussion of the anticipated research contribution is to extend best practice frameworks to enable agility.

2 REVIEW OF THEORETICAL AND PRACTICE PERSPECTIVES

This section reviews the current theoretical and practice perspectives on agility in information systems. First, the IS literature on agility is reviewed and classified into a taxonomy of theory to assess how far the theoretical perspective extends. Second, the current IS practice perspective to design and action the IT function for agility is derived from a claimed best practice framework. This section concludes by identifying the gaps between theoretical and practice perspectives on agility.

2.1 Theoretical perspectives on agility in information systems

Agility of information systems and its effect on organisational performance has recently received much attention in IS research (Piccoli & Ives, 2005; Sambamurthy et al., 2003; Weill et al., 2002). IS research discusses a new era where a firm's performance depends on the IS capability to effect agility, and less on identifying strategic IT-enabled initiatives (Peppard & Ward, 2004; Galliers, 2006). This IS capability has inter-related competencies, that forms a basic model for agility in information systems (see Figure 1). First, the IT function fuses business and technical knowledge to sense the environment. Second is a competency to sense the current use of information systems. Third, generate a portfolio of digital options to adapt existing information systems to forecasted needs (Sambamurthy et al., 2003). Last, if a forecasted need materialises, exercise a digital option that enables an agile response. The response is agile as it adapts existing information system quicker than conventional planning cycles, due to the initial IT investment in the exercised digital option. This is a process of the IT function to monitor and improve the value realized from the existing systems (Overby et al., 2006).

The implication of Sambamurthy et al. (2003) is that digital options enables agility in information systems by responding to an opportunity in less time than making a full IT investment at the time of the opportunity's arrival. The cost is that if the anticipated opportunity fails to arrive, the initial IT investment in the digital option is foregone. A goal of a portfolio of digital options is that the value of opportunities captured from exercised options outweighs the other options that are never exercised.

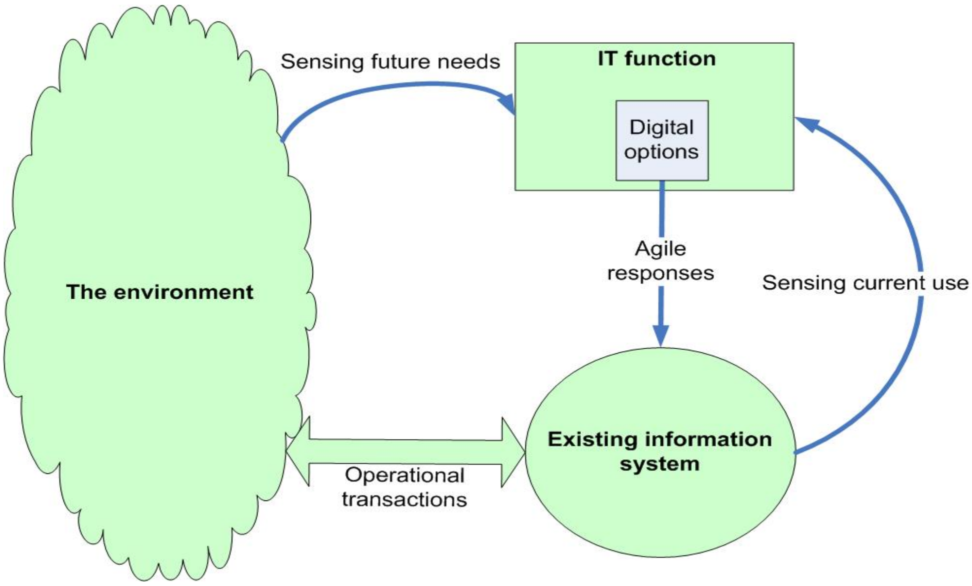

Figure 1. A basic model of the IS theoretical perspective of agility

Gregor (2006) provides a taxonomy of five IS theory types. This taxonomy is used to reconcile the contributions from the IS theoretical and practice perspectives on agility. The first type is theory for analysing, which does not extend beyond analysis and description. Analytic theory does not specify causal relationships and makes no predictions. The second type is theory for explaining, which does not intend to predict with any accuracy and has no testable propositions. Third is theory for predicting that provides testable propositions but do not have well-justified causal explanations. The fourth type is theory for explaining and predicting that has testable propositions and causal explanations. Last is theory for design and action that have explicit prescriptions for constructing an IT artefact.

Gregor (2006) draws interrelationships on how these theory types inform each other. She notes that theories for analysing are required to develop the other theory types by providing clear definition of constructs. Gregor states that a theory for design and action can be developed without a theory for explaining and predicting, based on what has worked in practice.

A survey of the IS literature concerned with agility and the IT function suggests most of the contributions have been theories for analysing for defining concepts, or theories for explaining with no intent to predict with any accuracy. Theories for analysing on agility in the IS literature include the following. Agarwal and Sambamurthy (2002) state that IT now plays a more prominent role in corporate agility. Lyytinen and Rose (2006) view an agility outcome of the IT function from an organisational learning perspective, and considers exploration and exploitation of innovative processes. Osborn (1998) analyses an agility paradox to be resolved by strategy, control and systems. Peppard and Ward (2004) present attributes of an IS capability for agility. Weill et al. (2002) correlate strategic agility and IT-infrastructure capability. Arguably, some of these papers might be typed as theories for explaining, based on varying claims of moderate predictive accuracy.

Theories for explaining occur in the IS literature on agility. Galliers (2006) suggests a strategizing framework for agile information systems. Overby et al. (2006) define enterprise agility and explore the underlying capabilities, explain the enabling role of IT, and propose scoring agility based on unspecified measures of sensing and responding. Sambamurthy et al. (2003) define IT competencies to enable digital options which afford agility. Van Oosterhout et al. (2006) define the change factors requiring agility, and identify IT as both an enabler and inhibitor of agility. These papers have no testable propositions, and none can claim as theories for explaining and predicting.

A theory of predicting occurs in Fink and Neumann (2007) e-mail survey, which positively correlate IT personnel capabilities and IT infrastructure capability, and IT infrastructure capability and IT-dependent organisational agility. The paper does not offer an explanative mechanism.

What is missing from the IS theoretical perspective on agility is a theory for explaining and predicting that has testable propositions and causal explanations. Such theories have a strong interrelation with theory for design and action required by the IS practice perspective (Gregor, 2006).

2.2 Practice perspectives on agility in information systems

The IS practice perspective on how the IT function can enable agility has been deduced from a claimed 'best practice' framework. COBIT is arguably the most appropriate control framework available to align information systems and business goals, and is increasingly being used by a diverse range of organisations throughout the world (Ridley et al., 2004). COBIT practices represent the consensus of experts (IT Governance Institute, 2007 p 5), and the framework this study deduced as the dominant design and action theory for agility from the IS practitioner perspective. This deduction recognizes that a design and action theory can build on idiographic studies of what worked in the past, or known predictive relationships that are not fully understood (Gregor, 2006).

Within the COBIT framework is a goal of *Create IT agility* linked to four measurable control objectives. The linked control objectives are: *Define the information architecture; Define the IT processes, organization and relationships; Manage IT human resources;* and *Acquire and maintain technology infrastructure* (IT Governance Institute 2007). COBIT defines agility as responding to changing business requirements from the customer perspective, and managing business change from an internal perspective. This definition reflects COBIT dependence on business requirements and strategy received by the IT function from business stakeholders.

2.3 Gaps between IS theoretical and practice perspectives on agility

Comparing the IS theoretical perspective on agility, gleaned from the research literature, with the IS practice perspective on how to create agility, deduced from COBIT best practice, has highlighted four noteworthy gaps.

The first gap between the IS theoretical and practice perspectives is differences in the concept of agility itself. The COBIT definition of agility is narrower than the IS theoretical perspective, as it is based on the IT function responding to received business requirements and strategy. The IS theoretical perspective observes that deliberate alignment of information systems with a stated business strategy has had limited success (Galliers, 2006). The IS theoretical perspective on agility has information systems being subject to less long-term planning strategies, and more to constant adaptation (Desouza, 2006; Peppard & Ward, 2004). The COBIT definition of agility is also narrower than some other IS practice perspectives (Newman & Logan, 2006; Luftman & McLean, 2004), which include the IT function sensing and responding directly to the business environment.

The second gap is the capability for the IT function to sense future needs directly from the environment. The IS theoretical perspective emphasizes this forecasting capability (Sambamurthy et al., 2003; Overby et al., 2006; Desouza, 2006). In the IS practice perspective, the capability to sense environmental change is noted by Gartner (Newman & Logan, 2006 p 3), but the COBIT goal of *Create IT agility* is not linked to any measurable process for this capability. That COBIT is silent on the IT function directly sensing future needs from the environment, is probably the result of the COBIT concept of agility being based on responding to a received business strategy.

The third gap between the IS perspectives is concerned with maintaining digital options that can be readily implemented. Digital options are a portfolio of initial investments without an obligation for full investment. Informed by strategic foresight and systemic insight, the IT function makes an initial IT investment, which remains open until an opportunity arrives, at which time the IT function makes the remaining IT investment to capture the opportunity. This capability is put forward in the IS research literature on agility (Weill et al., 2002; Sambamurthy et al., 2003; Overby et al., 2006). The IS practice perspective, deduced from the COBIT factors to create agility, is silent on this capability.

Last, the IT function sensing current use of the information systems is not included in the IS practice perspective on agility. There are several references to this capability in IS theoretical literature which discusses systemic insight (Sambamurthy et al., 2003), effective use processes (Peppard & Ward, 2004); and the assessment of unexpected consequences that were experienced in existing activity (Galliers, 2006). The stated COBIT enablers for creating agility are silent on this capability.

The IS research literature discusses the extent that *information system agility* enables *enterprise agility*. The IS literature also discusses whether the IT function enables information systems agility. Based on the assumption that the IT function does enable agility, the theoretical development is why the IT function enables agility in existing information systems.

3 THEORY DEVELOPMENT

The review of the IS theoretical and practice perspectives on agility has identified gaps in the concept of agility, and a lack of any explanation of a mechanism to sense and respond to environmental fluctuations. This section first discusses a control mechanism for sensing and responding from the cybernetic framework of Beer's Viable System Model (VSM) (Beer, 1970). The VSM was conceptually found to apply to the IT function, and used to extend the IS theoretical perspectives on agility to practice by prescribing capabilities. A description of the testing of the hypothesis with a mailed survey of organizations follows this theory building section.

3.1 Cybernetic approach

The research approach was to draw theoretical parallels between the IS research into agility in information systems, and the VSM. The cybernetic model is justified for a number of reasons.

First, the business issue of agility for sensing and responding to perturbations in the environment (Overby et al., 2006) is the fundamental problem of adaptation addressed by cybernetics (Ashby, 1956). Second, is the concept that agility of information systems requires a requisite knowledge base to manage information received from the environment, and to enable adaptations of existing IT and work processes (Desouza, 2006). This concept is consistent with the cybernetic theorem of managing environmental perturbations by maintaining a model of operations. The model can be less complex than the operating process, but must be of requisite variety to control the process (Conant & Ashby, 1970). Last, the IS competencies for agility of externally-focused future planning, and an internally-focused effective use process (Peppard & Ward, 2004; Desouza, 2006; Galliers, 2006) equates to the dynamic that is addressed by the sub-systems of the Viable System Model (Beer, 1970).

The validity of a cybernetic framework for an explaining and predicting theory, to reconcile the IS theoretical and practice perspectives, is supported by Gregor (2006). Gregor states a commonality of cybernetics with general system theory. General system theory provides a high-level way of thinking about information systems. Systems are in a continuous state of exchange with their environment and other systems, and modelled with concepts of input, throughput, output, feedback, boundary and environment. Gregor suggests cybernetics as a grand theory for explaining and predicting.

3.2 The VSM applied to the IT function

This section describes the Viable System Model (Beer, 1970), and equates the IT function to the meta-system of the model. The VSM provides a mechanism for sensing and responding to environmental fluctuations, and answers the research question: why can the IT function enable agility in existing information systems?

The VSM proposes that any viable system consists of five necessary and sufficient subsystems, which are interactively involved in maintaining the system's identity within a fluctuating environment. Viability is the property of a system to maintain its identity separate from others, despite the components of the system adapting in basic structure and function over time. This research used the terms *Policy, Intelligence, Control, Coordination* and *Operations* to describe the five subsystems of the VSM for a focus on information systems. Beer originally named the subsystems System FIVE to System ONE, respectively. The adoption of these terms for Beer's subsystems is a liberty often taken by interpreters of the VSM.

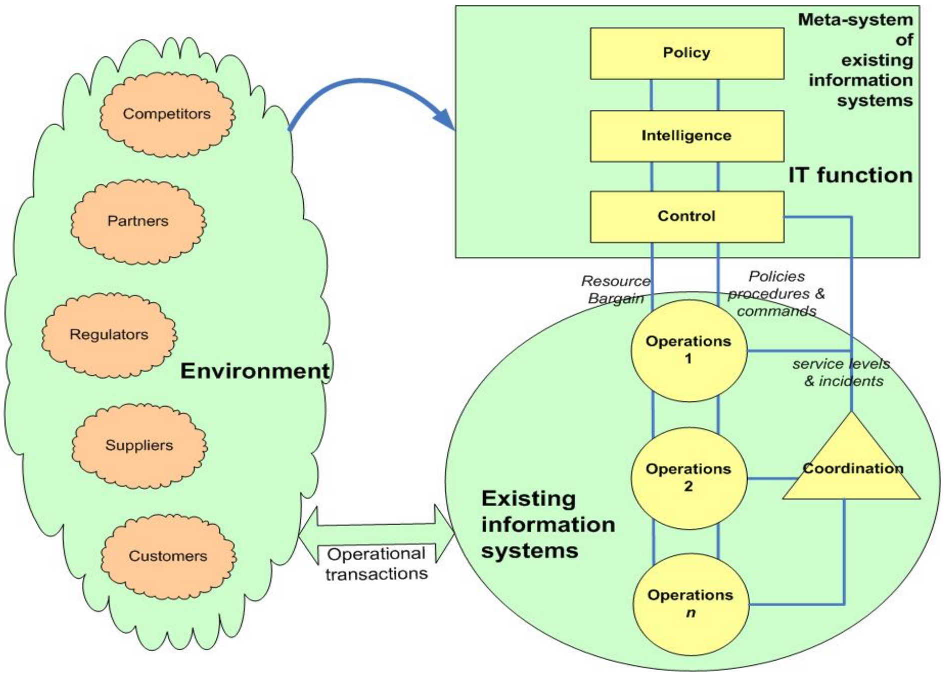

Figure 2. The VSM applied to the IT function and existing information systems

A description of the VSM follows, using the IT function and information systems as an example. Within any viable system are the subsystems of *Operations* and *Coordination*, which as a whole compose the function of the viable system. The meta-system is the *Policy*, *Intelligence* and *Control* subsystems. The meta-system does not exist for itself, but is a necessary redundancy to adapt the viable system for perturbations from the environment.

Operations occur in many instances in a viable system. Each *Operation* is an independent system, and their coordinated behaviour composes the identity of the viable system. These instantiations of electronic processes and networks enable business initiatives. The instantiations of the IT can be a portfolio of ERP packages or bespoke/legacy systems. *Operations* benefit from resources from organisations in return for performing at prescribed service levels, within the legal obligations and corporate rules.

The function of *Coordination* is to dampen oscillations that will arise amongst the instances of *Operations* in the viable system. This can be instantiations of System Integration software to stabilize applications and the transduction of code-sets. Examples of integration software include Data Warehousing and Enterprise Applications Integration (Markus, 2000). An IT support group is often involved to dampen fluctuations not handled electronically. *Operations* and *Coordination* compose the information systems, which is subject to the meta-system of the IT function.

The *Policy*, *Intelligence* and *Control* meta-system of the information systems is conceptualised as the IT function. *Policy* sets the overall goals of the system, and constrains the possibilities of adaptive behaviour provided when coupling *Intelligence* and *Control*. In many enterprises, this role is that of a steering committee, with representation by the IT function. The aim is to encourage desirable behaviours in the use of IT (Weill, 2004).

Control is responsible for the direct "inside and now" control of *Operations* and *Coordination*. In the IT function context, *Control* is often the accountability of the Application Management Office, which includes a disciplined approach to delivering IT-enabled business initiatives beyond project completion; a single point of application support; and a single contact for operational support.

Intelligence spends most of its time looking outside the system and to the future. *Intelligence* is necessary for the viable system to anticipate change and adjust *Operations* to fit a dynamic environment. In the IT function of many organisations, this is the accountability of the Strategy and Enterprise Architecture office. The accountabilities of the office include to align business and IT strategies; monitor benefit realisation; translate strategy to operational programs; prioritize initiatives for delivery; and one-stop communication for strategy stakeholders. Deliverables of the office include identified IT trends and opportunities; current and target enterprise architectures; and transition roadmaps. The *Intelligence* attribute of building probabilistic models to forecast events and how *Operations* will react to those events, is consistent with discussion of the IS agility as a portfolio of digital options that are readily implemented (Weill et al., 2002; Overby et al., 2006).

The theory development suggests the hypothesis: *The more mature the coupled capabilities of the Policy, Intelligence and Control of the IT function (POLINTCON), the more frequently digital options are exercised (D-OPTIONS).*

POLINTCON is a hierarchical construct and used, in preference to the subordinate constructs of *Policy Intelligence* and *Control,* as it occurs at the same level of analysis as D-OPTION, i.e. the IT function (Wetzels et al., 2009). The subordinate constructs belong to a lower level of analysis of the offices within the IT function, such as the Application Management Office for *Control*.

POLINTCON and D-OPTION are ontologically different. POLINTCON is a structure of rules and non-human resources persistent in time. In contrast, D-OPTION is a sporadic activity of human agency enabled by POLINTCON. Exercising digital options is a necessary activity for agile responses to adapt existing information systems. Applying the VSM to the IT function, in the context of the basic model of the IS theoretical perspective of agility (Figure 1), suggested the causal relationship between POLINTCON and D-OPTION.

4 METHODOLOGY

To test the hypothesis, the research conducted a mailed survey. The survey tested the correlation of latent constructs of the capability maturity of the IT function, and agility outcomes measured by the frequency of exercised digital options. The theory development proposed causality between these latent constructs. The level of analysis is the IT function of organisations.

The survey's target population is the client base of organisations of ConsultCo, a pseudonym for an IT and business services consultancy. ConsultCo has over 1,300 employees and offices in four Australian cities. Its client organisations range from major banks to small "not for profit" bodies.

The research instrument was a covering letter and a questionnaire of 48 Likert items. The instrument was letter-headed by ConsultCo and the University of Melbourne, but made clear that ConsultCo has no access to the individual responses. The mailing addressees were contacts known to ConsultCo, and included an IT manager and a business stakeholder in each client organisation in most cases. The contacts had three weeks to complete the questionnaire, after which non-respondents were mailed a follow-up letter and another copy of the questionnaire. The only incentive for respondents to complete the questionnaire is to receive a summary of the findings. The six-page, research instrument is available from the authors on request.

4.1 Constructs and their measurement

The following define the measures for the exogenous construct (POLINTCON) and the endogenous construct (D-OPTIONS) of the hypothesis. Each measure is a Likert item on the questionnaire.

Table 1 lists the maturity measures for POLINTCON, and maps their genesis from the VSM (Beer, 1970) and IS theory on agility (from section 2.1). The first three measures equate with the VSM attributes of *Policy*. *Policy* governs the behaviour of the total system (MAT37); monitors the *Control* and *Intelligence* couple; supervises their behaviour and mediates conflicts (MAT38); and thinks about what is being produced and why (MAT39). The next five measures equate with the VSM attributes of *Intelligence* to build probabilistic models to react to forecasted events (MAT34 MAT36); gather data from the environment (MAT40); and indicate structural changes that lead to a different configuration of *Operations* and *Coordination* (MAT43 MAT44). The last four measures equate with the VSM attributes of *Control*. *Control* sources the plans, programs and schedules to adapt *Operations* (MAT35 and MAT45); monitors the behaviour of *Operations* resulting from the regulatory action of *Coordination* (MAT46); and monitors *Coordination* (MAT47).

Based on your experience, which maturity level best describes the following processes of the IT function ***(non-existent; initial; repeatable; defined; managed; optimized)***	**Informed by the VSM subsystem**	**Supports concepts from IS theory on agility**
MAT37 To develop and maintain a set of policies to support IT strategy? This includes policy intent, roles and responsibilities.	***Policy***	***Decision to exercise a digital option***
MAT38 To establish and maintain an optimal co-ordination, communication and liaison structure within the IT function?		
MAT39 To create a strategic plan that defines how IT goals will contribute to the company's strategic objectives?		
MAT34 To maintain a set of high-level designs for IT-enabled capabilities, which are options for forecasted business initiatives?	***Intelligence***	***Sensing future needs directly from environment***
MAT36 To assess any unexpected operational consequences, arising from existing information systems, to forecast business initiatives?		
MAT40 To monitor the business sector, industry, technology, infrastructure, legal & regulatory environment trends?		
MAT43 To analyse existing & emerging technologies, & plan which technological direction to realise the IT strategy?		***Creating a portfolio of digital options***
MAT44 To develop a feasibility study that examines the possibility of implementing the requirements & alternative courses of action?		
MAT35 To implement a set of IT-enabled capabilities, which are readily configurable for forecasted business initiatives?	***Control***	***Sensing current use of existing IS***
MAT45 To acquire and maintain applications in line with IT strategy and IT architecture?		
MAT46 To continuously monitor specified service level performance, and report in a format that is meaningful to the stakeholders?		***Delivers an agile response for an exercised digital option***
MAT47 To report service desk activity to enable management to measure service performance and to identify trends?		

Table 1. Measures for POLINTCON

The questionnaire included the COBIT definitions of the six maturity levels (IT Governance Institute, 2007). The use of COBIT maturity levels allows the operationalisation of the construct in terms recognisable to the survey respondents. All but three measures (MAT34 MAT35 MAT36) reused existing COBIT control objectives, none of which link to the COBIT goal of *Create IT agility*.

Based on your experience, how often does your company ***(Very frequently; Somewhat frequently; Occasionally; Rarely; Never)***
FRQ07 Have existing information systems that are readily configurable for a new business initiative?
FRQ08 Have existing detailed designs for IT that can be used, partially or wholly, for a new business initiative?
FRQ09 Have existing, high-level designs for IT that can be used, partially or wholly, for a new business initiative?
FRQ10 Have alternative target IT architectures and road-maps for new business models?

Table 2. Measures for D-OPTIONS

The activity measures for the D-OPTIONS are in Table 2. This construct is suggested by the concept of digital options in IS literature on agility (Sambamurthy et al., 2003), where the IT function maintains a portfolio of digital options. If the forecast need arises, the exercising of a digital option becomes the agile response to adapt existing information systems. The frequency of exercising digital options observed by the survey respondents is the operationalisation of the concept.

4.2 Data collected

The survey mailing to 506 IT professionals and business stakeholders occurred in September 2008. These potential respondents represent the 257 client organisations of ConsultCo. Insufficient addressing, or the contact no longer at the address, caused 169 surveys to return undelivered. This left a possible 204 organisations with at least one deliverable survey. Thirty-six completed surveys returned from 34 organisations gave an organisational response rate of 16.75%.

The activities of the responding organisations were: education (2); electricity, gas and water supply (5); financial and insurance (5); manufacturing (3); mining (2); telecommunications (1); rental, hiring and real estate services (3); retail trade (2); scientific and technical services (2); public administration (4); transport (1); other community, social and personal services (3); and unidentified (1). All were large enterprises of 250 or more employees, with a mean of 10,504 and a deviation of 27,326.

Respondent individuals classified themselves as business managers (2), senior business managers (10), IT professionals (1), IT managers (5) and senior IT managers (18). The median experience of the respondents is one to five years of employment in the organisations. A workforce-hire firm and a fire service each returned two questionnaires, completed by different individuals in the organisations.

5 DATA ANALYSIS

This section begins with an analysis of the collected data to test the research hypothesis. The section next analyses the data against an existing practice model for comparison with the research model. The responses of 34 organisations were analysed using Partial-Least-Squares (PLS) modelling in support of confirmatory research (Marcoulides & Saunders, 2006). The software used was SmartPLS version 2.0.M3 (Ringle et al., 2005). Measurement standardisation catered for the different ordinal scales. Ordinal measures, such as maturity levels, have been used for regression analysis in previous IS research (e.g. Sledgianowski et al., 2006).

5.1 Research model

The PLS analysis of the completed surveys is show in Figure 3. The analysis found a large positive correlation between the constructs (0.730), which does not falsifying the hypothesis. The measure of fit of the structural equation is the R-square of the endogenous construct (0.534).

	Cronbach's Alpha	Composite Reliability	AVE (square root)
POLINTCON	0.948	0.955	0.639 (0.799)
D-OPTIONS	0.882	0.881	0.650 (0.806)

Table 3. Benchmarks for construct validity and reliability

When an individual construct uses multiple measures, the measures must demonstrate reliability and validity. A Cronbach's Alpha of 0.7 is a benchmark for 'modest' convergent validity (Hulland, 1999). The composite construct reliabilities are recommended above a 0.70 threshold, indicating that the specified items sufficiently represented their respective constructs (Fink & Neumann, 2007). The benchmarks in Table 3, from the research model in Figure 3, show more than modest convergent validity and composite reliability.

Discriminant validity of the model is sufficient, as the square root of the Average Variance Extracted (AVE) for both the constructs is greater than their correlation (0.730) (Hulland, 1999). For significance testing, the SmartPLS bootstrap procedure was used and the two-tailed, t-values of all measurement weights and the variable correlation were significant at $p < 0.0001$ for Type I errors.

The PLS modelling achieved a level of statistical power of 0.80, considered by most researchers as acceptable to reject a false null hypothesis, i.e. Type II errors (Marcoulides & Saunders, 2006). A calculation of post-hoc statistical power for multiple regression, using the R-square of 0.534 and the *p*-value of 0.0001, returned a strong statistical power of 0.947 for the sample size of 34 (Soper, 2009).

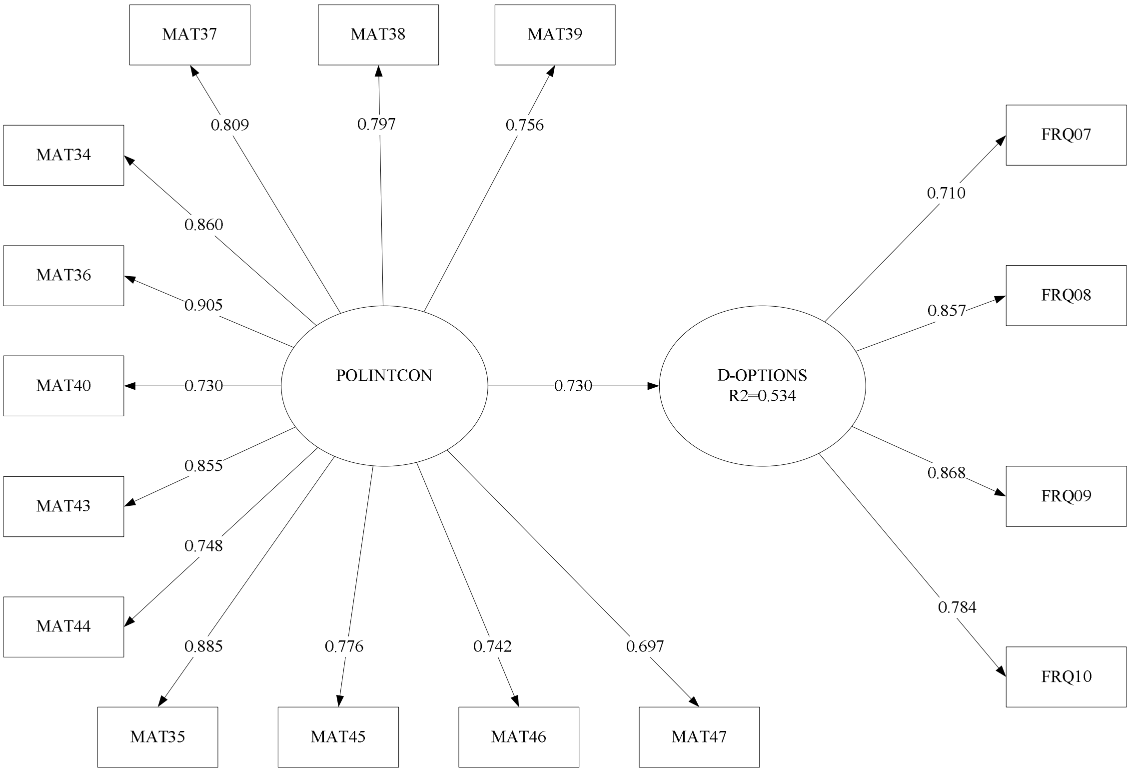

Figure 3. Research model for the IT function to create agility in existing information systems

5.2 Existing practice model

The survey data was also analysed against the existing practice perspective of agility, for the purpose of comparison with the research model. The goal of *Create IT agility* is explicitly linked in COBIT to four measurable control objectives (see section 2.2). The mailed questionnaire surveyed the maturity of the four control objectives, linked as reflective measures to an exogenous construct, and positively correlated with D-OPTIONS (0.667). The objective of PLS is to maximize the variance explained in the endogenous construct. The R-square of D-OPTIONS in the existing practice model (0.458) was weaker than that of the research model (0.534). The results are significant at $p < 0.0001$

6 DISCUSSION

The purpose of this study was to identify the capabilities of the IT function to create agility in existing information systems. A contribution is to extend what is known in the IS literature to inform IS practice, by suggesting improvements to a widely used industry framework.

The perspective gaps in section 2.3 illustrate that the IS practice, based on existing COBIT control objectives, is uninformed by the IS theoretical perspective. Further informed by VSM principles (i.e. the VSM meta-system to the IT function) and concepts from the IS literature, we can derive a new set of objectives that explain more than half of the variance of agility in the survey responses (Figure 1). The survey analysis suggests the meta-level theory, applied to the IT function, better correlates with reported agility outcomes than the existing COBIT linked measures do on their own. What are missing in COBIT are control objectives to create agility that relate to *Policy*, *Intelligence* and *Control* capabilities of the IT function. To reflect those control objectives, this research suggests new measures (MAT34 MAT35 MAT36); and recognises COBIT measures not previously linked to agility. The study recommends the identified measures for future versions of industry 'best practices'.

Of course, one could argue that adding measures to the existing COBIT-based model is an obvious improvement. The question becomes whether the additional measures are necessary, is the new set of measures sufficient, and how can this be justified theoretically? Using the VSM, we offer a pathway to answering these fundamental questions, and in so doing point towards a more comprehensive and defensible theory on agility.

6.1 Limitations

This section notes a number of biases that may affect the validity of the mailed survey. The first bias is that the responses of the questionnaire are perceptions of the respondents, and not formative measurements of the constructs that make up the hypothesis. Second, the survey results were subject to mailing errors and did not allow all members of the client base of ConsultCo to have an equal chance of participating. Third, the generalisation of the survey results to other organisations is subject to any bias in the profile of the client base of ConsultCo. Last, a bias may occur where non-respondents hide a significant capability for agility. Given the high ranking of agility as an issue amongst senior IT executives (Luftman & McLean, 2004), it is unlikely that non-respondents have a high capability of agility.

A research limitation is the reliance on COBIT as a representative industry framework. The alternative frameworks of ITIL and TOGAF are not explicit in creating agility as a goal. Regardless, the reliance of COBIT for the IS practice perspective may not reflect the reality of design and action.

7 CONCLUSION

We demonstrated in this paper that the IS theoretical perspectives on agility can extend to practice. By applying the VSM mechanism to the problem area, we address the "why" behind the IS theoretical perspective that the IT function "does" enable agility. Conceptualising the IT function as a VSM meta-system of the existing information systems addressed the "why" question. In doing so, we provided a testable theory that informs IS practice, with measurable capabilities, "how" to enable the IT function to create agility. The data analysis of the mailed survey suggested that the identified capabilities in the IT function are a strong determinant of agile responses to adapt information systems.

The research fills two gaps identified in IS literature. First, Fink and Neumann (2007) suggest future research to identify the mechanisms underlying IT personnel and infrastructure capabilities that afford agility. The theory for agility in information systems extended by this study identifies the VSM as a plausible mechanism. Second, the identified measures for the IT function to enable agility addresses the need for an index of sensing and responding suggested by Overby et al. (2006). A final anticipated contribution, of applying the VSM meta-system to the IT function, is insights gained from known viable system pathologies that pose further IS research.

References

Agarwal, R. and Sambamurthy, V. (2002) Principles and models for organizing the IT function. *MIS Quarterly Executive* 1 (1), 1-16.

Ashby, W. R. (1956) *An Introduction to Cybernetics.* Chapman & Hall, London.

Beer, S. (1970) *The Heart of Enterprise.* Wiley, Chichester.

Chin, W. W., Marcolin, B. L. and Newsted, P. R. (2003) A Partial Least Squares Latent Variable Modeling Approach for Measuring Interaction Effects: Results from a Monte Carlo Simulation Study and an Electronic-Mail Emotion/Adoption Study. *Information Systems Research* 14 (2), 189-217.

Conant, R. C. and Ashby, W. R. (1970) Every good regulator of a system must be a model of that system. *International Journal of Systems Science* 1 (2), 89-97.
Desouza, K. C. (2006) *Agile Information Systems: Conceptualization, Construction, and Management.* Butterworth Heinemann, Oxford.
Fink, L. and Neumann, S. (2007) Gaining Agility through IT Personnel Capabilities: The Mediating Role of IT Infrastructure Capabilities. *Journal of the Association for Information Systems* 8 (8), 440-462.
Galliers, R. D. (2006) Strategizing for Agility: Confronting Information Systems Inflexibility. In *Agile Information Systems: Conceptualization, Construction, and Management* (Desouza, K. C., Ed), Butterworth Heinemann, Oxford.
Gregor, S. (2006) The nature of theory in information systems. *MIS Quarterly* 30 (3), 611-642.
Hulland, J. (1999) Use of Partial Least Squares (PLS) in Strategic Management Research: A Review of Four Recent Studies. *Strategic Management Journal* 20 (2), 195-204.
IT Governance Institute (2007) COBIT 4.1: Framework, Control Objectives, Management Guidelines, Maturity Models. IT Governance Institute, Rolling Meadows IL.
Ives, B. and Mandviwalla, M. (2004) Key Issues for IT Management in 2004. Temple University.
Luftman, J. and McLean, E. (2004) Key Issues for IT Executives. *MIS Quarterly Executive* 3 (2), 89-104.
Lyytinen, K. and Rose, G. M. (2006) Information system development agility as organizational learning. *European Journal of Information Systems* 15 (2), 183-199.
Marcoulides, G. A. and Saunders, C. (2006) PLS: A Silver Bullet? *MIS Quarterly* 30 (2), iii-ix.
Markus, M. (2000) Paradigm Shifts-E-Business and Business/Systems Integration. *Communications of the Association for Information Systems* 4 (10), 1-44.
Newman, D. and Logan, D. (2006) Achieving Agility: How Enterprise Information Management Overcomes Information Silos. Gartner.
Osborn, C. S. (1998) Systems for Sustainable Organizations: Emergent Strategies, Interactive Controls and Semi-formal Information. *Journal of Management Studies* 35 (4), 481-509.
Overby, E., Bharadwaj, A. and Sambamurthy, V. (2006) Enterprise agility and the enabling role of information technology. *European Journal of Information Systems* 15 (2), 120-131.
Peppard, J. and Ward, J. (2004) Beyond strategic information systems: towards an IS capability. *Journal of Strategic Information Systems* 13 (2), 167-194.
Ridley, G., Young, J. and Carroll, P. (2004) COBIT and its utilization: a framework from the literature. In *37th Annual Hawaii International Conference on System Sciences*, p 8.
Ringle, C. M., Wende, S. and Will, A. (2005) SmartPLS. University of Hamburg, Hamburg, Germany.
Sambamurthy, V., Bharadwaj, A. and Grover, V. (2003) Shaping Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms. *MIS Quarterly* 27 (2), 237-263.
Sledgianowski, D., Luftman, J. and Reilly, R. (2006) Development and Validation of an Instrument to Measure Maturity of IT Business Strategic Alignment Mechanisms. *Information Resources Management Journal* 19 (3), 3-18.
Soper, D. S. (2009) Post-hoc Statistical Power for Multiple Regression. *The Free Statistics Calculators Website* www.DanielSoper.com, Online software.
van Oosterhout, M., Waarts, E. and van Hillegersberg, J. (2006) Change factors requiring agility and implications for IT. *European Journal of Information Systems* 15 (2), 132-145.
Weill, P. (2004) Don't Just Lead, Govern: How Top-Performing Firms Govern IT. *MIS Quarterly Executive* 3 (1), 1-17.
Weill, P., Subramani, M. and Broadbent, M. (2002) Building IT Infrastructure for Strategic Agility. *MIT Sloan Management Review* 44 (1), 57-65.
Wetzels, M., Odekerken-Schroder, G. and van Oppen, C. (2009) Using PLS Path Modeling for Assessing Hierarchical Construct Models: Guidelines and Empirical Illustration. *MIS Quarterly* 33 (1), 177-195.