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ABSTRACT

This paper develops a theoretical model to explain the relationships between knowledge management and business value in IT-enabled business projects. It draws upon a wide range of literatures including project management, management information systems, software engineering, organization and management theory, organizational behaviour and strategy.

The overall model comprises two sub-models. The first shows how the alignment of three project-based knowledges directly influences business value. The second shows how four knowledge-based concepts, knowledge management, knowledge stock, enabling environment, and knowledge practices, combine to create the project-based knowledges. Together these two sub-models provide an overall model of the causal system through which knowledge management influences business value.

This research makes contributions to the research into IT Projects by (1) integrating fragmented literatures which connect knowledge management and project success; and (2) proposing for discussion a predictive model in which knowledge management influences business value. It has the potential when further developed to clarify what project managers can do to manage knowledge in a systematic way.

KEYWORDS

Project management, knowledge management, business value, IT project

INTRODUCTION

Motivation

The traditional practitioner view of IT project management has seen the project manager's goal as delivering a pre-defined IT system to the business client. Consequently, the management task has been to plan, monitor and control a set of work packages in order to deliver the pre-defined system. Successful performance has traditionally been viewed as delivery to cost, schedule and scope/quality (Johnson 1995). Most research has accepted this view of projects as seen through the lens of action (or, as Bredillet (2007) calls it, the "optimization" perspective). It has similarly viewed performance in terms of variance against cost, schedule and scope/quality rather than in terms of business value achieved.

Today, executives focused on maximizing shareholder returns view IT projects as investments that must be seen to deliver business value. The project management tasks involved in timely and cost-efficient achievement of projects are not sufficient to guarantee value. Value is essentially the outcome not solely of action but of well-directed action. It is a function of knowledge of how IT can be used and how use can deliver value.

Recent research has begun to re-think the traditional framing of projects in two ways (Winter et al 2006a, Sauer & Reich forthcoming 2009). First, researchers and practitioners have recognised a variety of supplementary lenses including economic, social, emotional, and knowledge-based. Each lens adds to our understanding of projects and, when empirically explored, should add to our ability to predict performance. Second, the goal of projects has been re-framed to focus primarily on the delivery of business value. In this paper, we exploit these shifts in order to address the problem of managing projects for value. We take the knowledge lens, and explore how knowledge management can influence the business value delivered by projects. By combining a knowledge perspective with the attainment of business value, we aim to increase our ability to predict as well as deliver value.

Description

The purpose of this paper is to develop a theoretical model of the relationships between knowledge management and business value in IT projects. We use the term "IT project" as shorthand for "IT-enabled business projects" – those projects which combine information technology and business processes to impact business value. The proposed model is conceptual in nature. It is developed by drawing upon a wide range of literatures where relevant concepts and theoretical relationships have been investigated. These include project management, management information systems, software engineering, organization and management theory, organizational behaviour and strategy. We use these literatures to identify and define key knowledge concepts, such as Knowledge Stock, Enabling Environment, Knowledge Management, and Knowledge Practices. We combine these concepts into a model of the causal system through which knowledge management can positively influence business value. In particular, we step beyond the literature to propose that projects develop three distinctive sets of knowledge which when aligned will influence the ultimate achievement of business value. We claim that the model has face validity and that it will be susceptible to empirical validation once formal propositions have been developed in the next stage of the research.

Contribution

This research makes contributions to the research into IT Projects by (1) integrating fragmented literatures which connect knowledge management and project success; and (2) proposing for discussion a predictive model in which knowledge management influences business value. When further developed, it has the potential to clarify what project managers can do to manage knowledge in a systematic way.

Outline of the Paper

Our strategy in developing this paper is to start by examining prior research to set the context for the theoretical model. We then present the structure of our proposed model and a detailed explanation that grounds each element in specific aspects of relevant literatures. We make explicit certain assumptions, limitations, discuss the potential for practice, and point the way for future research.

CONTEXT FOR THE THEORETICAL MODEL

This section discusses the need and prospects for a model which connects knowledge management with business value in IT projects. It draws on a wide range of research literatures to support the core thesis embodied in our model – that knowledge management influences the business value of projects – and to identify concepts that can serve as building blocks for the model.

Need for the Model

There are three reasons why we need a new model to expand our perspectives on the factors that influence project success. The first concerns the problematic nature of IT projects. Empirical evidence shows that IT project managers find their task to be increasing in difficulty. Dimensions such as project size, complexity, novelty of technology, rate of business change, and number of stakeholders are all perceived to have become harder to deal with (Sauer & Cuthbertson 2003). In cases of high uncertainty or novelty, knowledge sharing and innovation are of critical importance.

The second reason that we need this model is that the concept of business value is under-theorized in IT project management. Practices such as value management and value engineering have concentrated on creating processes for solving traditional problems of project delivery rather than formulating a business-centered concept of value. Thus, while the importance of business value is beginning to be recognized (Winter et al 2006b, Sauer & Reich forthcoming 2009), surprisingly little literature focuses on what we mean by the term or how project managers can achieve it.

The third reason the model is needed relates to the important role of knowledge management in existing practice (Soderlund 2005). Project managers have always incorporated aspects of the management of knowledge and learning into their practice, for example through the management of expertise (Reich 2007). They have not typically referred to such activities as knowledge management, neither have they developed and managed a knowledge plan or strategy. More generally, there is not an explicit model of the role of knowledge in projects and no clear understanding of what project managers can and should do to secure and apply relevant knowledge to advance project outcomes. Thus focus on knowledge and knowledge management is desirable in terms of understanding these concepts as independent variables.

The linkage between knowledge and business value seems particularly relevant to IT projects because the task of building or implementing IT-enabled business systems is a knowledge-intensive activity. Where construction projects, for example,

involve the management and deployment of large quantities of materials, IT projects work with knowledge as their core material. Because the product or process represents an innovation, project tasks require sharing, creation, usage, and integration of knowledge among members of the project team and stakeholder groups including knowledge of business value, organization and technology. Also, because the project team is a temporary organization, team members may have no shared work or social history so the explicit management of knowledge becomes critical to develop shared understandings.

For these reasons, we argue that conceptualizing IT projects using a knowledge lens addresses a critical dimension and should add important insights to our ability to manage projects successfully.

Research into Knowledge in Related Disciplines

Project management, including IT project management, is inherently a multi-disciplinary domain. It is not realistic to expect a single unified theory of project management in the way in which we might aspire to a unified theory of strategic management (Sauer & Reich 2007). For any project management theory of more than modest scope, it is necessary to draw upon results from multiple disciplines.

Knowledge management, by contrast, is a conceptualization that has application in many different domains. Consequently, researchers in a range of management disciplines have examined aspects of knowledge and learning and their impact on various outcomes, including core capabilities (Kotnour 1999), team learning (Akgun et al. 2005), team satisfaction (Janz & Prasarnphanich 2003), and project success (Karlsen & Gottschalk 2003, 2004). In this paper, we synthesize concepts of knowledge management from the MIS, software engineering, project management, organizational theory, and organizational behaviour literatures. Each of these literatures is very briefly discussed below.

The MIS and software engineering literatures recognise the importance of knowledge management (Corbin et al. 2007, DeSouza et al. 2006, Aurum et al. 2008) and point to its limited application in practice (Aurum et al. 2008). Published studies make five positive contributions to the development of our theoretical model: (1) they provide empirical evidence that knowledge and knowledge management significantly affect project performance and project management performance, that is respectively outcomes such as business value, and delivery to budget and schedule (Faraj & Sproull 2000, Gemino et al. 2008, Tiwana 2004); (2) they highlight the importance of modelling at the level of specific knowledges (Tiwana 2004); (3) they provide relevant constructs such as project knowledge resources (Gemino et al. 2008) and expertise coordination (Faraj & Sproull 2000, He et al. 2007); (4) they introduce the idea of team-based knowledge (He et al. 2007); and (5) they introduce the concept of project alignment as a knowledge process (Jenkin & Chan 2006).

The project management literature has recently acknowledged the appropriateness of business value as a key project target (Winiter et al 2006b). It has relaxed some of its assumptions about the importance of control in favour of ideas about experimentation, innovation, knowledge management and learning (e.g. Akgun et al. 2005, Grant 2006, Reich & Wee 2006, Reich 2007, Sense 2003, Sauer & Reich forthcoming 2009) with some researchers connecting knowledge and learning with project performance (Reich et al forthcoming 2008).

The organizational and management theory literature includes two relevant theories that are based in knowledge concepts and have been applied to projects: organizational control theory (Ouchi 1977, 1979, 1980, Kirsch 1996, 1997, Choudhury & Sabherwal, 2003, Liu et al 2003) and information processing theory (Galbraith 1973, 1977, Winch 2002). At a more detailed level, empirical studies in this literature show a strong correlation between project management and knowledge management practices (Brown & Duguid, 1991; McElroy, 2000) and between good knowledge management practices and project performance (Leseure & Brookes 2004).

Research in organizational behaviour offers relevant insights into the knowledge practices of teams through concepts such as the shared or team mental models (Lee 2007, Cannon-Bowers et al. 1993, Rico et al. 2008), and transactive memory systems and the collective mind (Zhang et al. 2007, Yoo & Kanawattanachai 2001, Austin 2003).

We also draw on literature on learning on the basis that although it is a different research tradition, knowledge and learning are closely related concepts in that learning can be considered as a process of change in knowledge and a process of change in knowing which involve respectively changes in cognition and changes in behaviour (Bohn, 1994; Vera & Crossan 2003).

In summary, there is encouragement in existing literature for our core thesis – that the business value achieved by IT projects is influenced by knowledge management. From this literature, we draw the following key ideas for our model:

- project managers can actively manage knowledge through practices such as expertise coordination;
- a stock of knowledge has to be assembled;
- the enabling environment will be influential;
- multiple knowledges are required;
- these knowledges need to be aligned;
- the actual practices that teams apply to access, create and process knowledge will produce knowledge instrumental to the achievement of business value.

We now propose a structure for our model using these principal elements. We then describe the model more fully, drawing on the literatures cited in this section.

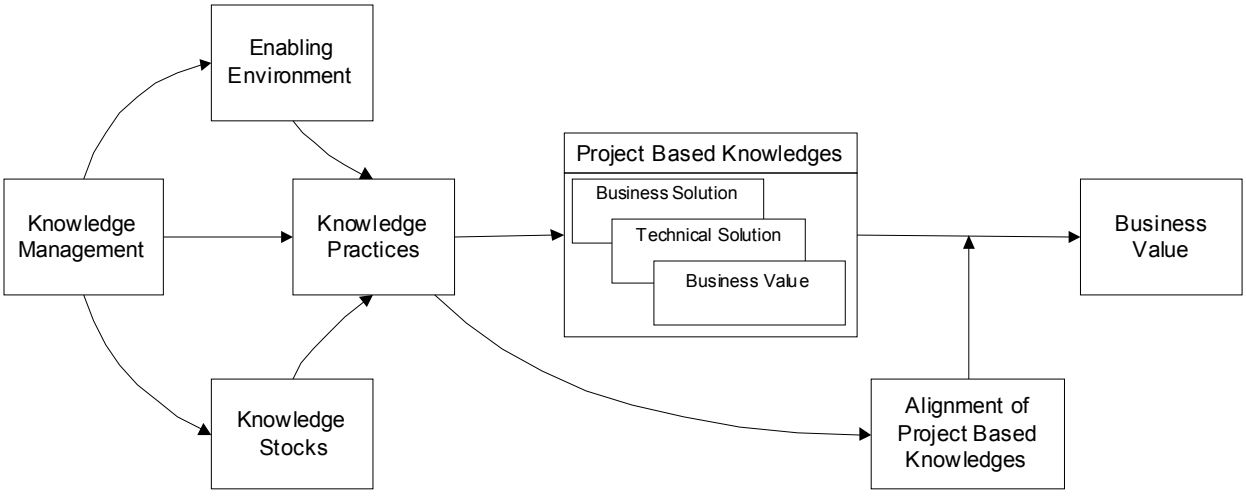
THE THEORETICAL MODEL

Structure of the Overall Model

The model (Figure 1) starts at Knowledge Management[6]. This term connotes the interventions that a project manager and her project management team make to improve the discovery and use of knowledge by the project team. It has as its end point the Business Value to be achieved by the application of the project's deliverables in its organizational setting. The model posits key intervening variables to explain how Knowledge Management influences the achievement of Business Value.

In speaking of a "project", we adopt a broad interpretation that includes organizational as well as technical change. We make no assumptions about limitations to the project manager's scope of responsibility. Rather, we conceptualize project management in terms of the project management team as comprising managers of both technical IT and line organizational units. The intention of this approach is to avoid our model being limited in its applicability by the contingent choices of businesses about how they divide project responsibilities.

Our model confines itself to proposing how knowledge and learning in an IT project can impact business value. We acknowledge that the traditional project management activities such as task and schedule management are still critical for completion of a project, but believe that knowledge management will add to a manager's ability to deliver business value. Issues of political support, emotional involvement or financial return are also valuable perspectives, but outside our current scope.



[6] From this point we capitalize the concepts in our model. When we employ the same words in their more general usage then we use lower case.

Figure 1: Theoretical Model of the Influence of Knowledge Management on Business Value

Overall, the model proposes that knowledge management results in an enabling environment, knowledge stocks, and knowledge practices. The knowledge practices lead to a set of project-based knowledges, which have a level of alignment. The alignment of the Project-Based Knowledges moderates their effect on the achievement of Business Value such that the stronger the Alignment the greater the Value achieved.

The model as depicted in Figure 1 is a simplification in that its arrows are unidirectional. We acknowledge that in practice there will be feedback loops. For example, knowledge practices that generate new knowledge will add to knowledge stocks. Nevertheless, the central thesis is that the manipulation (by Knowledge Practices) of available knowledge (Knowledge Stocks) will influence the development and alignment of the three project based knowledges. Unidirectional arrows highlight this.

In the following sections, we discuss the model in two parts (or sub-models) to provide a more detailed account of the individual elements and logic. The first sub-model discusses the relationship of Alignment among three Project-Based Knowledges with Business Value. The second demonstrates how Knowledge Management influences the creation of the Project-Based Knowledges and their Alignment. For each element of the sub-models, we draw upon the different reference literatures as needed. Our focus is on the concepts, so for now we leave aside issues of measurement and researchability.

Sub-Model 1: Business Value as a Function of Knowledge and Alignment

Sub-model 1 (Figure 2) includes three elements: Business Value, the three Project-Based Knowledges, and Alignment. Two propositions underlie this model. The first is that several types of knowledge are important in order to deliver business value – Knowledge of the Business Value, Knowledge of the Organizational Solution and Knowledge of the Technical Solution. IT systems (the technical solution) deliver Business Value primarily through organizational and business process change (the organizational solution) (Brynjolfsson & Hitt 2000, Brynjolfsson et al 2002). The second proposition is that since each knowledge may be developed by different stakeholders within a project, Alignment among them will be critical to the achievement of Business Value. Each element of the model is discussed below.

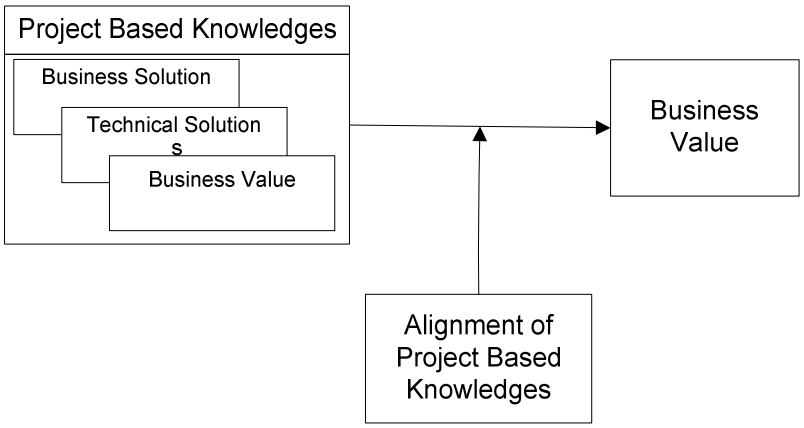


Figure 2: Sub-model 1 –Business Value as a Function of Knowledge and Alignment

Business Value

Currently, there is no consensus as to the definition of the business value of a project but there is growing recognition of its importance and its multi-faceted nature (Winter et al 2005a,b). Also, in most cases business value is not fully realizable by a project manager because the project is dependent upon others to harvest the benefits. In practice, however, project managers are increasingly focused on business value. So, what do we mean by business value and how do we reconcile these tensions?

The focus on business value is a relatively recent development as the world of projects has moved beyond the Optimization School (Bredillet 2008) in which business value was taken for granted as inherent in the project definition. Attention has now turned to what is actually delivered in terms of the product of the project activity, how it contributes to the larger task of the organization, and its financial return on investment.

Focus on the product of projects has given rise to the notion of Product Performance (Nidumolu 1996, Barki et al. 2001) as a description of what the project achieves by way of client satisfaction and/or business benefit. While Product Performance represents an improvement on Process Performance it does not encompass all the ingredients of value because it is possible for a client to be satisfied without value being attained and for benefits to be realized but either too few or at too high a cost or too late for value to accrue from the project.

More explicit measures of financial performance such as return on investment or cost-benefit analysis are typically limited in being unable to adequately recognize and measure intangible or non-financial dimensions. For example, the installation of an IT system that represents a competitive necessity may save a company from losing customers and going out of business. Its business value is high but the return on investment may not be measurable in objective and balanced terms (Hirschheim & Smithson 1988, Symons 1991, Willcocks & Lester 1999).

There are disciplines within the project world that explicitly focus on value – earned value, value management, and value engineering – yet none quite captures the notion of benefit to the client (Winter et al 2006b). Earned value reflects the value achieved by the project deliverer in terms of percentage completion of the full specification (Fleming & Koppelman 2005). Value engineering and value management concern the continual review of the project in terms of its desired functions (Kelly & Male 1993). Each potentially bears upon the issue of business value but none captures all aspects of what IT project managers mean when they say that their task is to contribute business value.

In the organizational and strategic management literature, the concept of shareholder value is widely employed (Rappaport 1986). Its advantage is that it captures the need for benefit to the enterprise. However, it is often a narrow financial goal (e.g. percentage increase in share price). It is not, by itself, broad enough to represent the multiplicity of goals that a project may be expected to achieve.

Our concept of Business Value fits between attainment of targets and shareholder value. We define it as "the achievement of a set of strategic objectives which may be long- or short-term, financial or non-financial". Consistent with the dynamic orientation of the model, these objectives may vary over time. They may vary across stakeholders. Indeed, the business value by which a project is justified and celebrated post hoc may never have been understood or clearly articulated by the business clients at the outset. For these reasons, Knowledge of Business Value is critical to its achievement and non-trivial as a condition for project success. We discuss this knowledge further in the next section.

Project-Based Knowledges

The model focuses on three areas of domain knowledge that are central to the delivery of business value: Knowledge of Business Value, Knowledge of the Organizational Solution, and Knowledge of the Technical Solution. We refer to the three as Project-Based Knowledges. We define each in turn, locating it within appropriate literature as justification for its inclusion in the model. We identify a set of shared characteristics that each knowledge should exhibit.

Knowledge of Business Value

Knowledge of the Business Value a project is to achieve is an extension and development of some less value-focused concepts. For example, the importance of a clear understanding and articulation of the principal objectives of IT projects is a long established success factor (Pinto & Slevin 1987) – the objectives may be but need not be value-based. Similarly, it has been argued that IT professionals should have business benefits in view when designing IT artefacts. The more recent benefits management literature has got closer to recognition of a concept of knowledge of business value. This work stresses the importance of a clear understanding of the desired value (Ward & Daniel 2005).

While the IT benefits management literature, like much earlier work on IT evaluation, has assumed that business value can be known from the outset, some writers on the dynamics of strategic IT have produced evidence of the emergent nature of business value (Ciborra 1991, Yetton et al. 1994). These researchers show that opportunities may emerge during a project through learning about the business application of the technology. In some cases they challenge the idea that it ever can be understood ahead of exploration, experimentation and improvisation – Ciborra's notion of bricolage. In effect, therefore, they

show that Knowledge of Business Value needs to be a dynamic concept such that it can grow and be modified throughout the project lifecycle.

We define *Knowledge of the Business Value as a "dynamic shared understanding of the business objectives that the project is expected to deliver and how the project will help achieve these business objectives"*. Thus we suggest that it is important to know what will constitute a business success and how the project will contribute to that success. The project must continually review whether what it is producing will lead to Business Value. This knowledge must be shared across a sufficiently wide constituency and it must be explicit and appropriately concrete.

Knowledge of the Organizational Solution

The IT project literature has increasingly recognized that benefits are only secured if a new system is accompanied by business process and organizational change (Markus 2004). Alignment models such as MIT90s embody the recognition that strategy, structure, process and people need to be aligned to core technology systems to achieve high performance (Scott Morton 1991). We use the term Knowledge of the Organizational Solution to reflect the need for understanding of what organizational change will be required. We use the idea of the Organizational Solution rather than the Business Solution both to explicitly include organizations such as non-profit and government organizations, and also to include solutions that run beyond the boundaries of a single business entity, for example by integrating a complex supply chain.

The literature on the dynamics of strategic IT (Ciborra 1991, Yetton et al 1994) also applies to the organizational solution. That is, knowledge of the organizational solution will emerge as a function of evolving understanding of the organizational issues both as the value becomes clearer but also as the organizational implications themselves become clearer.

We define Knowledge of the Organizational Solution as *"the dynamic shared understanding of the changes that need to be made in the organization and the ways in which these changes will be accomplished"* to exploit the IT system and attain the expected business value from the project (e.g. process change, training, hiring, and reorganizing).

Knowledge of the Technical Solution

Over the last fifteen years, industry has increasingly developed architect roles at the corporate and project levels. The task of the project technical architect is two-fold - to develop a satisfactory Technical Solution, and also to do so in a manner consistent with corporate architectural standards (Zachman 1999, Pearlson & Saunders 2006 p138). Not only must the project technical architect know what technology can do, how it works and what new technology is emerging, he/she must also understand the corporate architecture.

Again, technical knowledge is subject to dynamic change. It will develop and grow over time, particularly where a new technology is employed. It is also subject to a degree of volatility. New technologies can emerge and supersede old ones within the time frame of medium to large projects. Thus Knowledge of the Technical Solution may also be subject to fluctuation.

We define Knowledge of the Technical Solution as a *"dynamic, shared understanding of the architecture and infrastructure of the technical solution within the context of any wider architectural standards or infrastructure standards and constraints"*. This understanding comprises recognition of the ways in which the project solution architecture and infrastructure will be created and made to work.

Characteristics of Project-Based Knowledges

In order for the three Project-Based Knowledges to affect actual business value, they have to exhibit some common characteristics. In this model, each knowledge type is expected to be: negotiated and socially constructed, shared, externalized, actionable, dynamic and interrelated. Each of these characteristics is discussed below.

What counts as knowledge in the project context is typically negotiated. For example, the notion of Business Value may be an outcome negotiated among senior executives or their Board. Even technical knowledge is often a function of the process of negotiation through which specialists learn about and share their knowledge of a technology (Collins 1985, Strauss 1978). However, knowledge, for example that a given piece of software works in a certain way, will typically be treated by team members as if it were objective. We therefore treat knowledge as weakly socially constructed (Searle 1995).

Project-Based Knowledges need to be shared in the sense of understood by multiple members of the team, not contained in and restricted to a single individual. This is particularly important in highly uncertain environments. When specialists apply their own expertise, they need to have a shared understanding of the common objectives of their part of the project. This concept is often operationalized as shared mental models to explain how dispersed effort can pursue a common direction (Rico et al. 2008).

It follows that to be shared widely, particularly in the context of virtual project teams, the knowledges need to be externalized. In the context of IT projects where the knowledges are abstractions that stand for organizational and technological reality, to externalize means to render the knowledge explicit for example in a document, diagram, spreadsheet or discussion that is understandable by others. Staples and Webster (2008) show the particular importance of knowledge sharing for virtual team performance.

Projects inherently seek to create change within organizations and therefore knowledge needs to be actionable. For example, a statement of business value such as "this project will reduce unnecessary hospital deaths by reducing the variance in clinical diagnostic decisions" is more concrete and explicit than just "this project will improve hospital health outcomes".

We have already noted that knowledge is emergent and therefore dynamic. More generally, we can say that in most projects the three sets of knowledge will grow and develop continuously through the course of the project as a natural function of learning. Discontinuous changes may occur to affect each set of knowledge; for example, changes in the competitive environment may affect the potential business value; changes in the organization may affect the organizational solution; changes in technology may affect the technical solution.

The three knowledges are also interrelated, not discrete. For example, some business knowledge and technical knowledge will be needed to create Knowledge of the Organizational Solution – business knowledge informs as to the business value needed, technical knowledge informs as to how the technical solution might be developed. In effect, for knowledge of any one solution to be effectively applied it will need to be with awareness of the other two.

Alignment of Project-Based Knowledges

Sub-model 1 states that Business Value is influenced by the three knowledges and the level of alignment between them.

In the strategy literature, alignment commonly refers to the extent to which internal firm resources match the needs of the externally-focused competitive strategy (Leavitt & Whisler 1958, Scott Morton 1991). The Resource-Based View of the firm embodies the assumption that knowledge in the form of capabilities is a key internal resource (Collis & Montgomery 1995). In the IT literature it refers to the extent to which the IT function is organized to support the principal business lines (Henderson & Venkatraman 1992, Chan & Reich 2007).

Although a discussion of Alignment among knowledges is seemingly to introduce a new meaning for the term, there are existing concepts to guide us. It is implicit in our model that we see Alignment of knowledges as involving some degree of knowledge sharing across individuals. Thus concepts relating to team cognition may assist (He et al 2007) to signify overlap or coherence among individuals with potentially different expertises or knowledge bases. Empirical research has reported that shared mental models influence team performance positively (Levesque et al. 2001). Although the effects of shared mental models are not consistent across studies (Lee 2007), two characteristics that appear to influence performance are the similarity and accuracy of the mental models (Edwards et al. 2006, Lim & Klein 2006, Mathieu et al. 2000). For our theoretical model, similarity implies Alignment. Accuracy would imply that the knowledges are of a high quality were they representations of an objective reality. Rather, to the extent that the three Project-Based Knowledges are related, social constructions their quality may be better assessed in terms of their joint coherence. Related concepts include transactive memory (Akgun et al. 2005, Yoo & Kanawattanachai 2001) and integrative capability (Mitchell 2006). Research and experience indicates that free and frequent exchanges of knowledge across boundaries are key performance predictors.

In our context, Alignment can be defined as *"the level of congruence between the three Project-Based Knowledges"*. An image of knowledge alignment might be a set of three cogs, representing Knowledge of Business Value, Knowledge of the Organizational Solution, and Knowledge of the Technical Solution. If the knowledges are aligned, when one shifts, the others will also move. They are out of alignment when change in one knowledge fails to trigger an appropriate change in the other two. A simple example of the Alignment of knowledges might result from a change in organizational structure which separates two previously integrated functions. In terms of our model, if the implications of the structural change are recognized, we have a change in Knowledge of the Organizational Solution. If this results in recognition that we now need

two distinct sets of financial and management reports, then we have alignment between the Knowledge of the Technical Solution and the Knowledge of the Organizational Solution. Alignment therefore involves continuing feedback among the three Project-Based Knowledges. The process can be considered one of mutual adaptation.

In summary, this sub-model represents important conditions for knowledge in a project to contribute to business value. While we recognize that the business value achieved will be a function of the organization's ability to execute on its preferred solution, and that therefore our model represents necessary but not sufficient conditions, we expect that aligned knowledge of the solution will be correlated with the achievement of value.

Sub-Model 2: The Influence of Knowledge Management

Sub-model 2 (Figure 3) represents the knowledge management process - the process by which the three Project-Based Knowledges are generated and aligned. It proposes that knowledge is generated through a range of Knowledge Practices, using Knowledge Stock as input and operating within an Enabling Environment. Knowledge Management generates and maintains these three elements. We describe each component below.

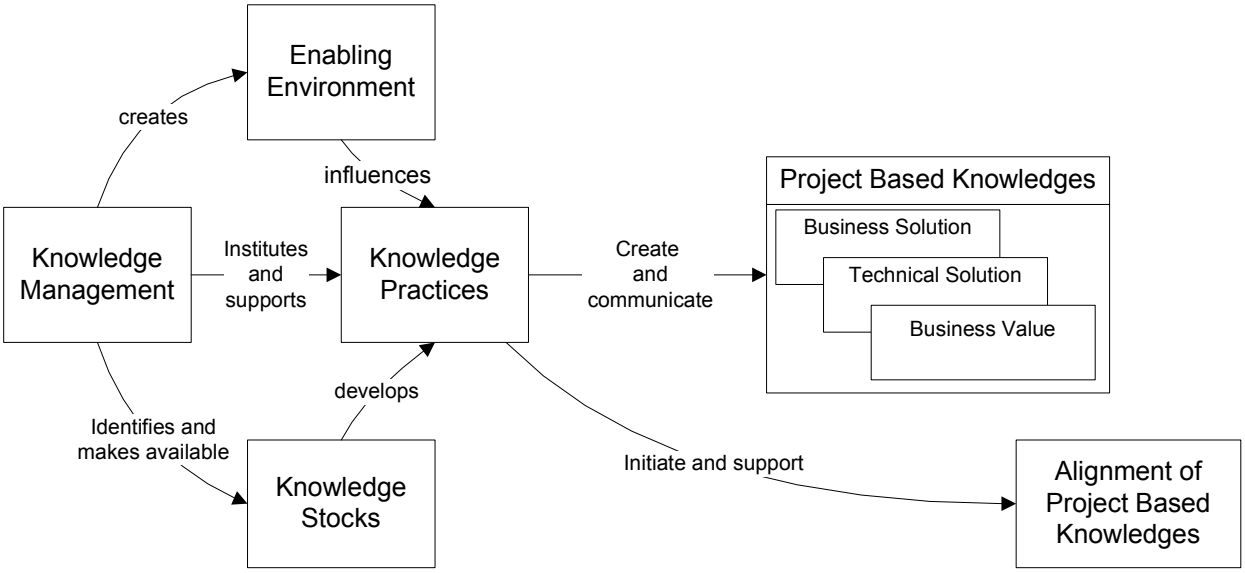


Figure 3: Sub-Model 2: Theoretical Model of the Influence of Knowledge Management

Knowledge Management

Past work has tended to incorporate all knowledge-related activities under the heading of Knowledge Management. In this paper, we draw out three distinct concepts: Knowledge Stock, Knowledge Practices and Enabling Environment. In this Sub-Model, therefore, we restrict the concept of Knowledge Management to the distinctive management practices involved in managing a project's Knowledge Practices, Knowledge Stock, and Enabling Environment. We define Knowledge Management as *the management activities required to source Knowledge Stock, create the Enabling Environment, and manage the Knowledge Practices* to result in an aligned set of project-based knowledges.

Creating the Enabling Environment includes identifying and establishing the knowledge channels (committees, networks etc) within and between the technical, business and organizational Knowledge Stock. It also involves creating the group memory process such as stage end meetings, and logs of decisions and lessons learned. It involves designing the technology infrastructure to support the channels. It also involves creating the right climate – for example, establishing incentives, shadow roles, learning plans and mentoring processes as well as role modelling appropriate behaviours.

Sourcing the Knowledge Stock (the knowledge acquisition process according to Jordan & Segelod 2006) includes generating knowledge requirements for each of the three Project-Based Knowledges, matching these against existing knowledge inventories, identifying the Knowledge Stock required, locating it using knowledge maps and knowledge networks, and obtaining it. Because research to date has not adopted a holistic knowledge management approach to projects, the notion of sourcing knowledge has not been fully defined.

Knowledge Management in this sub-model also comprises active management of the Knowledge Practices. This can be viewed as standard management with the difference that it is applied to knowledge. Basic elements include creating a knowledge plan for the project, identifying the processes needed to accomplish the knowledge plan, and monitoring achievement against the knowledge plan with modification of the plan as necessary

Knowledge Stock

The term Knowledge Stock represents the total cognitive capacity available to the project. This covers two facets: the store of knowledge that is possessed by members of the project, and the potential to increase that knowledge – a combination of existing knowledge and the capacity to learn. It can be defined as *"the sum of the actual knowledge of project team members together with their capacity to extend their knowledge and their access to other knowledge sources through their networks"*.

The importance of the Knowledge Stock has been recognised by the literature on knowledge loss and failure to learn (Schindler & Eppler 2003, Gable et al. 1998, Eskerod & Blichfeldt 2005, Parker & Skitmore 2005).

The literature discusses several aspects of a Knowledge Stock. The team selection literature (Walz et al.1993) notes the embodied nature of important aspects of a Knowledge Stock. The knowledge of individuals involved in governance is also recognised (Henry et al. 2003). The store of knowledge in a project includes both the tacit experiential knowledge embodied in individuals and the explicit knowledge represented in documents, models, designs, and other repositories (Arthur et al. 2001). These are part of the project's Knowledge Stock if they are known about or understood by someone within the project. A book in the project library describing a new technology that no-one in the team knows about is not part of the project's knowledge stock. Knowledge Stock also includes knowledge inherent in project processes and design methods. For example, established gateway review processes may embody knowledge about how to ensure project quality is being maintained. Together, there may be a collective knowledge of the team that is more than the sum of the individual stocks (Adenfelt & LagerstrÖm 2006).

Knowledge Stock also includes external expertise that is available to the project, such as that of vendors and consultants (Mitchell 2006, Owen et al 2004). It includes meta-knowledge such as knowledge inventories and knowledge maps within a project (Faraj & Sproull 2000). It includes latent knowledge, that is, knowledge that is implicit in the existing stocks ("capacity" in the terminology of Klimoski & Mohammed 1994).

The stock of knowledge includes three general classes of knowledge that mirror the three more specific project-based knowledges (see Reich 2007 for a discussion of types of knowledge). Thus, there is business knowledge necessary to develop Knowledge of Business Value, technical knowledge necessary to develop Knowledge of the Technical Solution, and organizational knowledge necessary to develop Knowledge of the Organizational Solution.

We also use the term Knowledge Stock to include the project's ability to increase its knowledge. This includes the project's learning capability. Including learning capability reflects some project managers' preference to hire team members more for their ability to learn than for their personal store of knowledge or expertise (Sauer & Reich forthcoming 2009). An important dimension of a project's ability to learn is its absorptive capacity. This captures the ability to absorb a diverse range of knowledges and make use of them (Cohen & Levinthal 1990, Szulanski 1996). The project's ability to increase its knowledge also includes the access that individuals have to sources of knowledge external to the project such as knowledge networks (Ancona and Caldwell 1992, Nagarajan & Mitchell 1998, Henderson 1994, Henderson & Cockburn 1994, Leonard-Barton, 1992). This represents the knowledge dimension of the project's social capital, or, more simply, it's not only what you know that counts, it's also who you know. Thus, there is scope for substitution of experts for networkers so long as there are good channels between the networkers and their alternative sources of knowledge (Szulanski 1996).

Enabling Environment

Numerous research studies have focused on the conditions that facilitate or hinder effective knowledge processing. These include the need for: appropriate resources including human and financial resources and IT infrastructure (Holm et al. 2006,

Carrillo et al. 2004, Lytras & Pouloudi 2003); standard processes and techniques including those for knowledge bases such as lessons learned databases, knowledge mapping including yellow page systems (Disterer 2002, Reich & Wee 2006), and HR processes including incentives for sharing knowledge, job rotation (Carrillo et al. 2004), and mentoring programs (Leseure and Brookes 2004); key knowledge roles such as project knowledge broker (Schindler and Eppler 2003); informal and semi-formal social groupings such as communities of practice and centers of excellence both inside and outside the project (Kodama 2005, Walker & Christenson 2005, Jewell and Walker 2005, Carrillo et al. 2004); and a culture of knowledge sharing and learning including the existence of an open and constructive atmosphere of intra-team trust, freedom, and safety (Disterer 2002, Janz & Prasnanphanich 2003).

Prior research has identified technological and social components of what we call the Enabling Environment. In particular, this refers to the technological and social aspects of a project that encourage or make it easier to create, process, and share knowledge. We therefore define the Enabling Environment as *those aspects of the infrastructure and climate of a project that facilitate Knowledge Practices*.

The technological component combines the physical resources such as IT infrastructure including the communications infrastructure, project websites, shared repositories and other similar elements of a technology-based knowledge management system (Earl 2001). This is particularly important for large and virtual or geographically dispersed projects (Espinosa et al. 2007).

The social component of the enabling infrastructure relates to the project organizational structures and processes and the project climate. The organizational structures and processes can be seen as defining the formal knowledge channels that support knowledge transfer and creation. Galbraith (1977) defines structures and processes for information (and knowledge) processing. These include arrangements such as committees, working groups, liaison groups, and conference calls that together help define who will be systematically involved in group-based Knowledge Practices and in what ways. In addition, there is a group memory process whose function is to ensure that learning that occurs during the project is not lost either as a function of time or turnover. It is both instrumental to ensuring continued clarity within the project team about project direction and to rapidly inducting new members into the project. It can also contribute to lessons learned processes both during and at the end of a project.

Climate is a social facet of the Enabling Environment. We use the term "climate" rather than "culture" to reflect the ephemeral nature of projects. *Climate* has been defined as the shared perceptions of employees concerning the practices, procedures, and kinds of behaviours that get rewarded and supported in a particular setting (Schneider, 1990: p384), or simply, the shared perceptions of "the ways things are around here" (Reichers & Schneider, 1990: p22). Therefore, climate involves employees' perceptions of what the organization is like, with a focus on the situation and its link to the perceptions, feelings and behaviour of employees (Ostroff et al. 2003). In our project context, a project manager can create a "climate for learning" or a "climate for collaboration" that may or may not be reflected in the permanent organizations that the team members belong to.

The Enabling Environment in Sub-Model 2 facilitates or inhibits the intensity and effectiveness with which Knowledge Practices employ the project's Knowledge Stock. Further, research suggests that its proposed impact on performance is well founded. In particular, the availability of channels that permit access to external sources of expertise is linked to higher performance (Ancona and Caldwell 1992, Nagarajan & Mitchell 1998, Henderson 1994, Henderson & Cockburn 1994, Leonard-Barton, 1992).

Knowledge Practices

Knowledge Practices are the activities that transform Knowledge Stock into an aligned set of Project-Based Knowledges. For example, a database design team translates its knowledge of a particular software product (a Knowledge Stock) into a specific design for a database (part of Knowledge of the Technical Solution). This part of the technical solution will become a knowledge input to be used by other colleagues, such as transaction designers.

We are unaware of any catalogue or taxonomy of Knowledge Practices for IT projects. Studies of the generation, integration and sharing of knowledge are numerous within the MIS research domain but do not build on each other. For example, Huang and Newell (2003) focus on team members' ability to manage social capital. Fernie et al. (2003) use the concept of social ties to explain levels of knowledge sharing and resultant innovation. Likewise Jackson and Klobas (2008) focus on knowledge sharing. Bresnen et al. (2003) are concerned with the capture and transfer of tacit information as a function of trust, social norms and shared values. Boh (2003) has created a model to predict whether personalization or codification is the best

strategy for knowledge sharing. Fong (2003) has developed a process model of knowledge creation, arguing that the first step must be role and disciplinary boundary spanning. Reich et al. (2008) refer to knowledge integration, coordination and transfer as influences on performance but they do not elaborate beyond reference to Faraj and Sproull's (2000) expertise coordination. This last is perhaps the best defined account of Knowledge Practices in the IT project context because it operationalizes expertise coordination for a survey. Even this, though, involves a conflation of Knowledge Practices – what the project team does – and Knowledge Management – what the project *management* team does.

The knowledge management literature offers high level models of Knowledge Practices using concepts such as socialization, internalization, combination and externalization (Nonaka & Takeuchi 1995). These concepts are applicable to projects in that at the start of a project socialization is necessary to enable knowledge sharing, externalization is necessary to make the knowledge manipulable by the team, and combination is necessary to create new knowledge from what is currently known.

We cannot talk about Knowledge Practices without talking about learning because they involve learning, both at the individual and organizational levels. This learning is particularly important for specialists to acquire knowledge of domains that are not their core expertise (Enberg et al. 2006, Eisenhardt & Tabrizi 1995). The management learning literature makes the distinction between exploitation of existing knowledge and exploration for new knowledge (March 1991). Exploitation involves the re-application of existing knowledge for a new purpose. Knowledge exploration by contrast is more creative and would involve activities such as innovate, invent, design, discover, experiment, prototype, and create (Tiwana and McLean 2005). Both exploitation and exploration involve different forms and levels of learning. As such they offer a relevant distinction among project Knowledge Practices but they do not offer a fine grained taxonomy.

For our current purposes, the definition of Knowledge Practices includes but is not restricted to certain basic practices recognised in the literature discussed above including the acquisition, creation, storage, diffusion and processing of knowledge with learning as a continuing reflexive process operating in parallel with specific Knowledge Practices. Beyond this basic set of practices, the model suggests one area in which we may discover distinctive Knowledge Practices – alignment practices. That is, if Alignment of Project-Based Knowledges is an important influence on Business Value, project teams should be expected to work to maintain Alignment among the three knowledges as they develop. In particular, to the extent that they are negotiated and socially constructed, we would expect explicit practices that develop coherence among them to be effective. However, more concrete descriptions of Knowledge Practices in the IT project context must await future research.

The Dependent Variables – Project-Based Knowledges and Alignment

Project-Based Knowledges and Alignment are the link between our two sub-models. In sub-model 1 they functioned as independent variables. In sub-model 2 they operate as dependent variables. Although alignment has been defined in other research both as a state and a process, in this work we envision it as requiring a dynamic process to achieve the state of alignment (described in sub-model 1) and describe this below.

It is quite possible for each of the three Project-Based Knowledges to develop independently and in the interests of efficiency it may be desirable that they do so. However, if little attention is paid to Alignment of the technical and organization solutions with the desired Business Value, that value is unlikely to be achieved. In order for mutual adaptation to occur, relevant aspects of each Project-Based Knowledge need to be explicitly represented, transferred across boundaries of knowledge categories, and integrated into another knowledge. Mutual adaptation not only addresses the orderly development of Project-Based Knowledge over time, it also permits responses to changes triggered by external dynamics (e.g. industry, technology, ideas) and internal dynamics (e.g. organizational structural change).

Prior research has shown that knowledge of project objectives (Pinto & Slevin 1987), and more generally goal clarity (Gibson & Earley 2007), is a critical influence on performance because it directs action in a coordinated way. Thus, a likely starting point of dynamic alignment is a Knowledge Practice which examines and clarifies the Business Value that the project might be expected to deliver. This generates some initial Knowledge of Business Value which becomes essential feedstock for Knowledge Practices which generate the initial Knowledge of Technical Solutions and Organizational Solutions. The expectation is that these knowledges will develop iteratively as the project progresses. As knowledge of the solutions becomes more detailed and more concrete, and as project-based learning occurs, each of the three knowledges will develop through Knowledge Practices that enable mutual adjustment. Further, these will themselves be supported by the Enabling Environment including conditions that support environment scanning, regular meetings, co-location, liaison roles, job swaps, and formal reviews among others.

SUMMARY AND ASSUMPTIONS OF THE THEORETICAL MODEL

The model we have proposed in this section depicts a systems view of how knowledge influences business value in IT projects. The underlying thesis is that knowledge has to be brought into a project and processed and that new knowledge may need to be developed. Business value is influenced through the quality of three Project-Based Knowledges developed during a project and the degree to which the three are aligned. Knowledge Management within a project directly influences the Knowledge Practices by which solutions are developed and the processes by which they are aligned with desired Business Value. It also influences them indirectly via the sourcing of Knowledge Stock and the creation and maintenance of the Enabling Environment. If a project manager can ensure that the Project-Based Knowledges are aligned, this will have a substantial influence on the actual achievement of Business Value notwithstanding any deficiencies in project implementation capability.

This model is mid-level inasmuch as it employs project and team level concepts without being able to fully translate them into atomic components of specific items of knowledge and specific knowledge practices. It therefore assumes that if we understand and execute Knowledge Management even without fully understanding the underlying structure and composition of knowledge, that nevertheless the achievement of Business Value will be positively influenced.

The model makes no assumption about the Project Manager's area of formal responsibility. However, it considers it desirable that the project manager is (1) brought in early enough to facilitate the development of Knowledge of Business Value; (2) willing and able to actively influence the creation of the Knowledge of the Organizational Solution even though she may not have formal jurisdiction over the Solution or implementation of the Solution; and (3) organizationally responsible for the Knowledge Practices designed to create the Knowledge of the Technical Solution.

The model does assume that projects start with a felt business need – a problem or opportunity that needs to be addressed – however difficult it may be to articulate. It does not purport to describe make-work projects for which there is no business value to be uncovered and therefore none to be achieved. It does assume that it will be most applicable and most predictive in projects where the uncertainties surrounding the project are great. In these circumstances, the impact of the management of knowledge and learning is likely to be at its highest.

DISCUSSION

In this section we discuss the limitations of our theoretical model, its contribution to practice, and directions for future research.

Limitations

The proposed model is focused on the influence that Knowledge Management exerts on the Business Value generated from IT Projects. It does not attempt to explain all factors which might impact Business Value. It also does not purport to model all the results of a knowledge approach – for example it does not include the individual and organizational learning that may result from Knowledge Practices. It also does not include any intermediate impacts on process effectiveness or emotional health of a project that may result from Knowledge Management. This model is focused on improving our ability to predict attainment of Business Value.

We argue that the influence of explicit Knowledge Management on Business Value is more likely to be apparent in strategic or transformational projects. This is not to say that it will not contribute to more tactical or operational-improvement focused projects, but in such cases the evidence of Business Value may be impossible to surface so it would not be possible to validate the model in this regard.

The mid-level nature of this model means that we have not identified cross-project outcomes, nor have we gone deeply into understanding the mechanisms of knowledge and learning. Similarly, we have a limited conceptualization of Knowledge Practices – we have neither a complete inventory of such practices nor have we offered a precise logical structure that differentiates terms such as knowledge transfer from knowledge diffusion, knowledge integration from knowledge application and others. Nor do we suggest which Knowledge Practices might be most salient. We are therefore only able to provide a conceptual overview of the Knowledge Practices that may require management, not a toolkit or a set of practices.

We have not articulated the connections with all the other relevant perspectives that may affect the achievement of Business Value. We note that the achievement of Business Value will be in part dependent on organizational implementation

capability, but have not clearly identified a connection between the knowledge perspective and the action perspective. Similarly, we have not linked the knowledge perspective to the economic perspective of a project. These limitations are consistent with our objective to examine one influence on Business Value, viz Knowledge Management, and not to attempt to model the full set of determinants of Business Value.

Application to Practice

Although this model is largely a product for researchers to evolve and test, we believe it has potential for developing more specific guidance for project managers. The term "knowledge management" often seems elusive to practitioners – it can signify everything that happens on a project or just a tiny fraction of it, such as a project website or the "lessons learned" session. In our model, knowledge management is a set of practices carried out by the project governance team – which may include roles such as the project sponsor and client manager as well as the project manager. Knowledge management includes three separate processes: creating an enabling environment, selecting and developing the knowledge stock, and managing the knowledge practices. With careful operationalization of the concepts, each of these processes can be subdivided into project tasks and managed accordingly. The aim of knowledge management is to generate three project-based knowledges that are of high quality individually and are aligned collectively.

If project managers, when faced with a project in which uncertainty or complexity are high, take the time to develop appropriate knowledge management practices, their projects will deliver higher levels of business value than if they acted as if task and schedule were the only appropriate areas of interest. This involves managing what often cannot be measured or seen, but will be reflected in the team members' shared understanding of their tasks and vision.

Directions for Future Research

As researchers, we see much promise in a knowledge-based view of the project. We believe that adopting Knowledge Management can improve the chances of success in innovative or complex projects and the empirical research supports this assumption. However, digging into this black box to uncover "how" and "when" to adopt Knowledge Management will require a concerted research effort.

The model is intended to provide a structure for testing the influence of Knowledge Management on the Business Value of IT projects. The fact that in the full model (Fig 1) Knowledge Management directly influences three elements of the model and indirectly the other two strongly suggests that it would be worthwhile to empirically test just the relationship between Knowledge Management and Business Value. However, testing either Sub-Model 1 or 2 should generate stronger findings and help to shed light on the relationships among the elements of the overall model. Either way, the development of formal propositions of the theory will be required. They have not been included in this paper because of complexities associated with the iterative nature of knowledge processes over the course of a project and the as yet incomplete description of constructs such as Knowledge Practices.

Testing will be challenging for empirical researchers for a number of reasons. Measuring many of the concepts will require innovation. For example, how exactly do we quantify the stock of a given knowledge? Is there an objective measure or will we need to rely on perceptions? It may be necessary to measure the application of Knowledge Management rather than try to quantify their outcome.

The challenges of quantitatively validating the model and the incompleteness of existing knowledge about some of our proposed constructs represent an opportunity for qualitative research. For example, because project managers have not explicitly identified their Knowledge Management practices, there is much scope for qualitative investigation. One useful direction would be to explore the actual practice of Knowledge Management within projects through case studies, participant observation or ethno-methodology. Another direction would be to employ action research to develop and test new knowledge-based project management practices because existing training courses and textbooks offer little guidance on this topic.

One further direction for research is to investigate the dynamic nature of the model. Here longitudinal research both qualitative and quantitative should be helpful. For example, is learning linear or punctuated? In particular, quantitative research should enable us to chart levels of growth in knowledge and thus velocity of learning. This would itself be a new concept for the model.

SUMMARY

Our intention with this research is to model how knowledge management can impact the attainment of business value in IT projects. Ultimately, we hope to operationalize each construct, test the model and better understand the causes of variance in project performance.

We have identified four elements of the knowledge-based perspective of IT Projects – Knowledge Management, Knowledge Stock, Enabling Environment, and Knowledge Practices. These elements interact to create three Project-Based Knowledges which influence the attainment of Business Value – Knowledge of Business Value, Knowledge of the Organizational Solution and Knowledge of the Technical Solution. The Alignment of these knowledges is critical to the achievement of Business Value. For innovative projects, these outputs (knowledges and their alignment) will need continual management, since they are both dynamic and emergent.

We hope that this preliminary work will lead to a productive researchers dialogue as we work together to uncover the secrets of IT project success and failure.

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