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A Design Theory for Knowledge Transfer in Business Intelligence

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ABSTRACT (REQUIRED)

Information Systems (IS) have often been the mechanism by which Knowledge Transfer (KT) has been accomplished within organizations. However, in the case of Business Intelligence (BI) it is also often the source or the knowledge required to be transferred. While the IS profession has effectively studied explicit knowledge, the conversion of tacit to explicit knowledge (Champika et al. 2009; Parent et al. 2007; Swee 2002) or knowledge creation (Nambisan et al. 1999; Nonaka 1994) a gap remains in regards to knowledge adoption and application of transferred tacit knowledge. This paper will contribute a design theory to support future research for KT in BI.

Keywords (Required)

Knowledge transfer, business intelligence, tacit knowledge, absorptive capacity

1.0 INTRODUCTION

Knowledge Transfer (KT) has been recognized in the Information Systems field as a unique component of Knowledge Management (KM). While Information Systems (IS) have often been used as enabling technologies to facilitate KT (Goh 1998; Govindarajulu et al. 2000; Graham 2008a; Graham 2008b; Griffith et al. 2003), the field is often the source of information that needs to be transferred among individuals and organizations (Dong-Gil et al. 2005; Gupta et al. 2000; Huysman et al. 1998). While there has been significant research and contributing theories in KM and KT in the Information Systems domain most have focused on explicit knowledge, the conversion of tacit to explicit knowledge (Champika et al. 2009; Parent et al. 2007; Swee 2002) or knowledge creation (Nambisan et al. 1999; Nonaka 1994). The advances in this research have been significant; however a void still remains in regards to the adoption and application of transferred tacit knowledge.

This paper is motivated by the authors' professional experience in two fortune 500 companies and one healthcare organization. In each of these organizations Business Intelligence systems were employed, which are highly complex systems that seek to combine organizational tacit knowledge with technological solutions to access explicit data and information to enable faster and more effective decision making (Gorry et al. 1971). The complicated knowledge environment can be most closely aligned to Emergent Knowledge Processes (EKP) as described by Markus "In sum, then, knowledge-intensive emergent processes have *challenging information requirements.* They require knowledge and expertise in applying the knowledge. They require tacit and explicit knowledge, general and contextual knowledge. Because knowledge is distributed, they require knowledge sharing" (Markus et al. 2002). The field of BI in using EKP's relies heavily on the organizational tacit component of knowledge, and the resulting reliance on the human capital that supports such knowledge intensive analytic interpretations. Given these observed challenges it appears that in the professional venue there is recognized importance for continued research in tacit KT in the BI domain.

2.0 WHY A NEW DESIGN THEORY FOR TACIT KT FOR BI?

The design theory proposed looks to address the opportunity that exists in facilitating KT relating to the specific challenges faced in BI. While the author recognizes that significant research has gone into the field of KT resulting in advances in areas such as organizational characteristics(Cohen et al. 1990), motivation factors (Markus 2001) to technological support (Bolloju et al. 2002); those advances have not yet reached specific knowledge applications such as BI. Even the researchers themselves have continued to identify the need for improved KT and the implications to specific contexts (Alavi et al. 2001; O'Dell et al. 1998; Polanyi 1962; Walls et al. 1992; Walls et al. 2004). Surprisingly the

characteristics most frequently mentioned as areas of opportunity for future and further research are those pertinent to KT in BI. Specifically, many significant research contributions have identified issues in tacit KT both in achieving transfer and creating a knowledge basis for interpretation of explicit results, as well as the rapid pace of change resulting in large and unwieldy Knowledge Management Systems. For example:

- O'Dell and Grayson (O'Dell et al. 1998) identified "…the second biggest barrier to transfer is absorptive capacity of the recipient". The authors go on to identify a primary issue is "An over-reliance on transmitting 'explicit' rather than 'tacit' information. Most of the important information…cannot be codified or written down, it has to be shown to them"
- Polanyi (Polanyi 1962) describes how "tacit knowledge forms the background necessary for assigning structure to develop and interpret explicit knowledge" as is required in interpreting the context and recommended action of the output of BI.
- Alavi and Leidner (Alavi et al. 2001) recognized the challenge of KT in that it can result an "…information overload problem…when individuals are aware that the relevant knowledge exists in organizational memory, but are discouraged from searching by the sheer volume of available knowledge".

Therefore in this paper we will explore the need for a design theory for tacit KT in BI as a potential solution to the identified gap in the research domain. As these contributions have highlighted, there remains opportunity in KT, the characteristics of which align with the KT needs for BI users. It is with this in mind that we will discuss how a design theory for tacit knowledge conversion in BI is required. The remainder of the paper will talk about the development of the design theory following the Information Systems Design Theory process as described by Walls et al. in their 1992 work (Walls et al. 1992) and depicted in Figure 1 below.

Figure 1. Walls et al. Information Systems Design Theory(Walls et al. 1992)

Components of an Information System Design Theory (ISDT)

Design Product	
1. Meta-requirements	Describes the class of goals to which the theory applies.
2. Meta-design	Describes a class of artifacts hypothesized to meet the meta-requirements.
3. Kernel theories	Theories from natural or social sciences governing design requirements.
4. Testable design product hypotheses	Used to test whether the meta-design satisfies the meta-requirements.
Design Process	
1. Design method	A description of procedure(s) for artifact construction.
2. Kernel theories	Theories from natural or social sciences governing design process itself.
3. Testable design process hypotheses	Used to verify whether the design method results in an artifact which is consistent with the meta-design.

3.0 KERNEL THEORIES

Existing literature has proven KT and EKP for BI are challenging concepts that while seemingly straightforward have stumbled in implementation and relevancy in the professional environment. Therefore, this article proposes a design theory to be based on the kernel theories of Parents' Dynamic Knowledge Transfer Capacity Model (Parent et al. 2007) and Markus' design theory for systems that support EKP's (Markus et al. 2002). Each of these concepts and theories are explored in greater depth below. Prior to the discussion of these concepts the definition of tacit knowledge is explored as it relates to the authors motivations and contributions to the field of KT in BI.

3.1 Tacit Knowledge

In order to overtly define the domain of the proposed tacit KT framework, it is critical to first understand the definition of tacit knowledge as it applies to the framework. As such this paper focuses on the two dimensional view of

explicit and tacit knowledge proposed by Polanyi (Polanyi 1962) and refined by Nonaka (Nonaka 1994). However, the author recognizes that other theories for classification exist including individual and social dimensions, or declarative, procedural, causal, conditional and relational classification schemas (Zack 1998). For the purposes of this research the definition of tacit knowledge is derived from the work of Nonaka(Nonaka 1994) and Markus(Markus 2001). That being *tacit knowledge* is 'knowledge that resides in people's heads or "muscle memory" and may be destined to remain there' (Markus 2001). In further grounding in existing research *tacit knowledge* is also 'knowledge that is unarticulated and tied to the senses, movement skills, physical experiences, intuition, or implicit rules of thumb.'(Nonaka 1994) In combining these two foundational definitions of tacit knowledge, this research will define tacit knowledge as: *'knowledge that resides unarticulated within a person's brain as it ties to senses, movements, skills, physical experiences, intuitions or implicit rules of thumb'*. While tacit knowledge is sometimes further broken down into cognitive or technical knowledge, for the purposes of this framework such distinguishing characteristics were seen to provide unnecessary limitations to the applicability of the work.

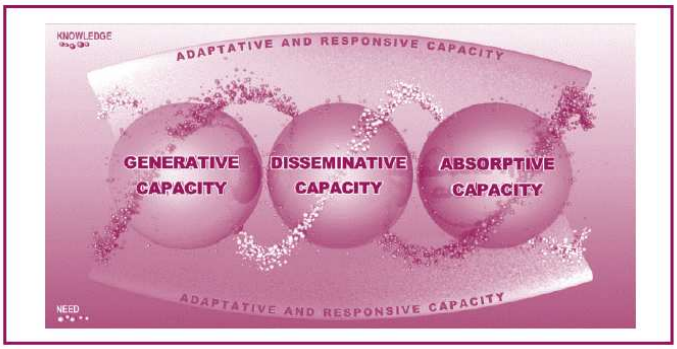
3.2 Knowledge Transfer Theory

The field of Knowledge Management has long existed in the organizational sciences. The competitive advantage realized by harnessing an organizations knowledge has been proven through multiple academic contributions measuring realized profits (O'Dell et al. 1998; Szulanski 1996), risk reduction(Dong-Gil et al. 2005; Gupta et al. 2000) or improved innovation (Cohen et al. 1990; Tsai 2001). As O'Dell et al. describe in their work "At Dow Chemical early efforts to manage intellectual capital brought an immediate kickback in the form of $40 million in savings" further describing "Chevron's network of 100 people…generated an initial $150 million in savings". The monetary and competitive significance of these research findings has created demand for increased adoption of KM strategies and spurred research into effective methods for KT.

The resulting research has been widely focused on knowledge creation (Holtham et al. 1998; Nonaka 1994; Nonaka et al. 2009) as the first step in KM. This research approach has been popular in recognizing that KT cannot take place without knowledge existing in a format or mechanism that enables transfer. As most researchers agree that tacit knowledge is the greatest source of potential competitive advantage, contributions have also focused primarily on this knowledge dimension primarily championing the codification and conversion of tacit to explicit knowledge to enable KT. The concept of knowledge conversion has met with significant controversy, leading to an further explanation and clarification of the explicit and tacit dimensions as a continuum by Nonaka in 2009 (Nonaka et al. 2009). It is in the shadow of this continued debate that the authors recognize opportunity for a KT design theory specific to BI. The author proposes that while knowledge conversion is certainly an interesting perspective for transferring knowledge it is not applicable to the tacit knowledge concepts that must be transferred in support of BI due to the transformational speed and emergent nature of the tacit knowledge that is both continually created and evolving. Rather, the focus of research in this dynamic environment requires better understanding of how the recipients' absorptive capacity can be increased through the incorporation of dynamic knowledge transfer and emergent knowledge processes.

Absorptive capacity was first conceptualized by Cohen and Levinthal in 1990 (Cohen et al. 1990). This capacity was focused on environments in which users have some prior knowledge which needs to be assimilated and combined with new knowledge to form innovative processes. Cohen and Levinthal described absorptive capacity "as broadening the firm's knowledge base to create critical overlap with new knowledge and providing it with the deeper understanding that is useful for exploiting new technical developments that build on rapidly advancing science and technology" (Cohen et al. 1990). They go on to say "…adoption, is affected by the degree to which an innovation is related to the pre-existing knowledge base of prospective users" (Cohen et al. 1990). This work is particularly relevant to BI, where base knowledge is built upon and leveraged constantly in solving new and dynamic problems. In the decades since Cohen and Levinthals' seminal work, updates to their proposed model have been proposed and validated. It is one such model that best captures the systemic view of KT that will serve as a kernel theory for the authors' framework. This updated model is referred to as the Dynamic Knowledge Transfer Capacity (DKTC) model.

Figure 2. Dynamic Knowledge Transfer Capacity model (Parent et al. 2007)



The Dynamic Knowledge Transfer Capacity (DKTC) model proposed by Parent et al. draws from the fields of experiential process in transferring theoretical knowledge to practical knowledge through the employment or real life settings, and the contemporary learning stemming from communities of practice. These knowledge transfer fields were considered in the context of systems thinking to develop the DKTC model to be employed as a methodology for the generation, dissemination and use of new knowledge. This model for KT demonstrates the three capabilities that users of a BI system require. Firstly, the model grounds itself in recognizing that "problem solving in its broadest sense is considered the primary reason for transferring knowledge". As BI are focused on continuously aiding the user community in solving problems it is apparent that transferring knowledge is important. The second key feature is that the model recognizes the continuum of capacities required for successful KT. This includes:

1) the generative capacity, or ability to create knowledge
2) the disseminative capacity, or the ability to put knowledge into context through formatting and translation
3) the absorptive capacity or the ability to recognize the value of the knowledge and apply it to relevant settings and
4) the adaptive and responsive capacity, or the ability to constantly learn and adapt.

While traditional KT models have focused on a linear model representing producers, translators and knowledge users the DKTC is more fluid in nature. This fluidity reflects the key feature of BI, which being its requirement for what is termed in the DKTC model adaptive and responsive capacity whereby the problem, information and data environment is in constant flux in order to solve new and challenging scenarios.

3.3 Emergent Knowledge Process Theory

The author recognizes that while KT theory alone may address some of the challenges of tacit KT in BI, it does not customize the KT concept to the unique challenges facing BI users. These challenges are very closely aligned to what defines an Emergent Knowledge Process (EKP) which can be defined as "Emergent knowledge processes are organizational activity patterns that exhibit three characteristics in combination: "deliberations" with no best structure or sequence; highly unpredictable potential users and work contexts; and information requirements that include general, specific, *and* tacit knowledge distributed across experts and non-experts.(Markus et al. 2002)" BI contain each of these three features in that users are deliberating solutions to a problem in which there is no given method or correct answer. A BI user can vary widely within an organization from a production line worker to an executive officer and as a result the work contexts vary widely. Thirdly, BI is the perfect marriage of general, specific and tacit knowledge in providing the technological power to capture significant volumes of general and specific knowledge often employed by analysts who are valued for their tacit knowledge contributions.

Therefore, the author proposes incorporating the relevant systems design methodologies proposed by Markus et al (Markus et al. 2002) in relation to EKP to transform existing KT theory to provide relevance in the BI domain. The work of Markus was tailored towards effective systems development through improved requirements gathering. In introducing the concept of embedded users, observation and a heightened focus on flexibility Markus was able to focus on relevancy and was able to demonstrate success in BI. In turn, this serves as a strong grounding for further application in the KT domain. It is suggested by the author that the incorporation of the system design and development principles applicable to EKP reflect the areas of opportunity in tailoring KT theory to BI. Therefore, the proposed framework described in the following sections will focus on describing how to extend existing KT and EKP theories to support tacit knowledge KT in BI.

Figure 3. Markus et al.'s EKP Design and Development Principles. (Markus et al. 2002)

EKP Support System Design and Development Principles

1. Design for customer engagement by seeking out naïve users
2. Design for knowledge translation through radical iteration with functional prototypes
3. Design for offline action
4. Integrate expert knowledge with local knowledge sharing
5. Design for implicit guidance through a dialectical development process
6. Componentize everything, including the knowledge-base

4.0 DESIGN THEORY FOR TACIT KNOWLEDGE TRANSFER IN BUSINESS INTELLIGENCE

The proposed design theory has 5 guiding principles. These guiding principles are discussed in a cumulative fashion in which each principle builds upon the previous to form a comprehensive solution to tacit KT in BI.

Principle #1: Design KT systems/activities for a wide and disparate user base that reflects rapidly evolving knowledge

The field of BI supports continuous EKP's where change is constant and self-created. In an organizational environment that often means a disparate user base. Therefore, in order to effectively transfer knowledge the content must be designed to be applicable to a targeted subset of users. Therefore the material available must have the ability to be tailored to, and/or reflective of the users' preferences, tool role and/or security privileges.

Principle #2: Design for componentized dissemination, focusing on maximization of absorptive capacity in incremental segments.

In expounding upon the kernel theories findings for improving absorptive capacity and the noted success of modular design for EKP's, an incremental componentized approach is suggested for KT in BI. This approach is envisioned by the authors to be similar to that of a college degree in which core courses are required to gain the foundational knowledge with electives and labs focusing on the specialized and immersive knowledge required by a specific user. Such tailored design dissemination is anticipated to be particularly useful in improving absorptive capacity through user based pacing of KT content.

Principle #3: Design for immersion of users/knowledge receivers in tacit knowledge through employment of functional prototypes

Given the dynamic tacit knowledge environment that describes BI the use of immersion is an opportunity for time-sensitive transfer with decreased burden on those sharing knowledge as well as knowledge recipients. Effectiveness of immersion is improved through the provision of tangible training materials such as a functional prototype. In BI, the creation of functional prototypes is neither time consuming or cost-prohibitive making their employment practical and purposeful.

Principle #4: Design for KT systems/activities to support continuous expert and local knowledge immersion in offline settings.

Numerous research papers have been published advocating the organic communities of practice concept in which employees form informal networks due to their like interests and as such support each other (Bourhis et al. 2010; Cabrera et al. 2006; Koliba et al. 2009; Wang et al. 2008). It is expected by the author that these communities of practice are particularly beneficial for the sharing of tacit knowledge in rapidly evolving information environments such as BI. Therefore, KT systems/activities should be designed so as to support continued expert and local knowledge immersion in unorganized, organic offline settings. It is anticipated that a well structured immersion training activity will enable expert and local knowledge workers the opportunity to build the organic relationships necessary to form and sustain a community of practice.

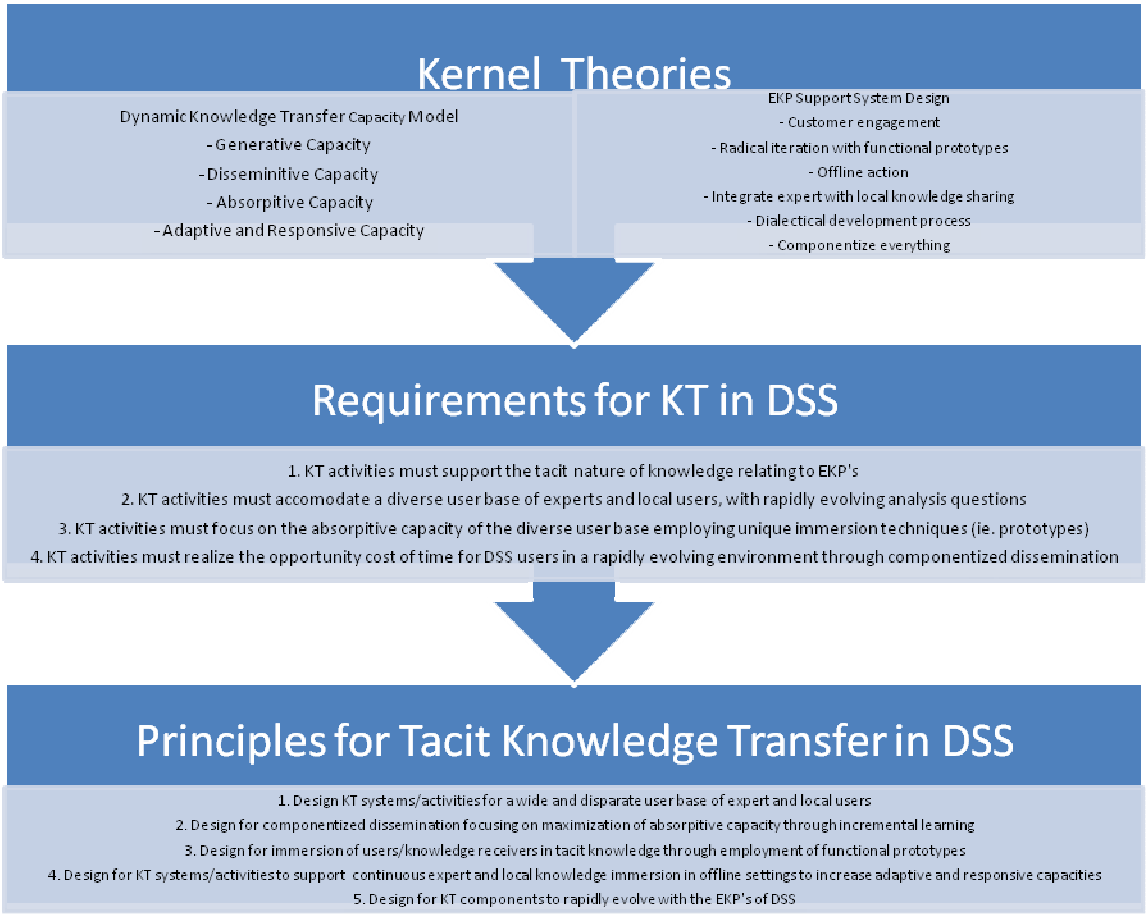
Principle #5: Design for KT components to rapidly evolve with the EKP's of BI

The field of BI provides challenges to KT due to its foundation in EKP's. In order for tacit knowledge to be meaningful to transfer it must still be relevant to the user base. Therefore, KT components and activities must be designed in

such a fashion that they enable and thrive on rapidly evolving knowledge. In going back to the example of a college degree program, it would be unlikely that a University would continue to offer a course that was no longer accredited or that no students were signing up for as it was no longer considered an elective for any major. In the same vein a KT activity for BI is no longer pertinent to the current information environment the KT system/activities should rapidly adjust to contain new and emerging knowledge. Preventing stale knowledge from bogging down KT is anticipated to also have the added benefit of improving absorptive capacity by lessening the severity of information overload.

These five principles together form a cohesive design theory for tacit KT in BI as illustrated in Figure 4. The cohesive integration of these principles with a focus on maximizing absorptive capacity addresses the meta-requirements and meta-design required in design theory.

Figure 4. A Design Theory for Tacit Knowledge Transfer in Business Intelligence



5.0 IMPLICATIONS FOR FUTURE RESEARCH

The ISDT approach has yielded a design theory for tacit knowledge transfer for Business Intelligence. This work has yet to be instantiated, and as such the proposed design theory is simply that; a design theory that requires validation. The author will continue research on this subject area, specifically in validating, and revising if necessary, the proposed framework. Validation questions include:

- Are KT systems/activities effective at transferring tacit knowledge in the context of a BI if designed in a componentized fashion?
- Does an organization benefit from increased absorptive capacity when KT activities related to BI use are performed as immersion activities through the use of functional prototypes?
- Does the employment of immersion activities result in expert and local knowledge sharing in offline settings such as communities of practice?

- Are KT systems/activities able to evolve as quickly as the EKP's they support relating to BI?

This work will contribute towards the work of the authors' dissertation, and will be substantiated at the authors' current employer in relation to the release of a new BI technology. The proposed validation of this design theory will provide legitimacy to the potential of successfully achieving tacit KT in the field of BI. The author encourages continued validation and expansion of the theory by fellow academics and practitioners in recognizing the potential impact and merit of this theory.

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