Knowledge Creation: Definition and Measurement

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ABSTRACT

This paper examines the operationalisation of the construct knowledge creation. Given the importance of knowledge creation for national and corporate wealth, assessing its measurement is a valuable exercise, however, current research utilises a range of definitions and measures and this lack of agreed construct operationalisation is a barrier to robust empirical investigation. This paper reviews current definitions and measures of knowledge creation and constructs a taxonomy of knowledge creation measures linked to existing definitions. This hierarchical taxonomy, in which movement up the hierarchy provides broader conceptual classification and movement down the hierarchy provides conceptual refinement, is a useful basis for making decisions about measurement. The measurement taxonomy developed in this paper facilitates knowledge creation operationalisation by categorising measures in a way that facilitates assessment against existing comparable definitions.

(128 words)

Keywords: Knowledge creation, organisational knowledge
The creation of knowledge contributes to competitive advantage by providing organisations with a resource that is rare, valuable and inimitable. Unlike knowledge, which is often rare for a limited period (Peteraf & Barney, 2003), as organisations develop and implement routines to create new knowledge their expertise becomes increasingly rare, socially complex and causally ambiguous (Coff, Lippman & Rumelt, 1982). Since the recognition of the importance of knowledge to firm competitive advantage, several studies have been undertaken investigating knowledge management, yet while the effects of knowledge on competitive advantage (Eisenhardt & Santos, 2002; Grant, 1996), and on knowledge sharing and transfer has been researched widely, there remains a dearth of information regarding knowledge creation processes (McFadyen & Cannella Jr., 2004; Un & Cuervo-Cazurra, 2004). One of the explanations for this is the notable definitional and measurement problems that have plagued knowledge research (Droge, Calycomb, & Germain, 2003; Madhavan & Grover, 1998).

In this study, we attempt to advance the research on knowledge creation by responding to calls to develop a clearer conceptualisation of knowledge creation and to build consistency in its operationalisation (Lever, 2002; Malecki, 1997; Marjaro, 1988). Given the importance of knowledge creation for national and corporate wealth, assessing its measurement is a valuable exercise (Lever, 2002; Malecki, 1997; Marjaro, 1988). Agreed conceptualisation and accurate measurement facilitates robust empirical investigations and enables comparative analyses, and ultimately the legitimacy of research in this field is dependent upon the ability of the researcher to adequately define and measure knowledge creation (Schoenfeldt, 1984). Current research utilises a range of definitions and measures (Almeida & Phene, 2004; Bryant, 2005; Hoegl & Schulze, 2005). This lack of agreed construct operationalisation leads to empirical difficulties, as research results may vary depending on the measure utilised and limit comparison between and generalisability across organisations (Droge et al., 2003; Madhavan & Grover, 1998; Schriesheim, Powers, Scandura, Gardiner, & Lankau, 1993).

This paper’s objective is to classify the methods utilised in knowledge creation research. This objective is achieved by reviewing the diverse literature regarding the conceptualisation and operationalisation of knowledge creation and developing a taxonomy for measures of knowledge creation. While a range of different measures for knowledge creation have been developed and utilised, we do not have a taxonomy that categorises the array of extant measures and specifies distinctions among them. The explosion in, and eclecticism of knowledge creation research, the acknowledged role of taxonomies in the advancement of science, indicates the need for a comprehensive taxonomy of knowledge creation measures.

This paper is organised into three main sections. The first section reviews the construct of knowledge creation in an attempt to investigate consistencies and dissimilarities, and potential agreements in its conceptualisation. The following section outlines the process used to investigate extant measures of knowledge creation and describes the taxonomic framework that is developed through this investigation. The final section provides a more detailed discussion of the nested categories of knowledge creation measure, differentiated on the basis of three defined attributes.
CONSTRUCT OPERATIONALISATION AND KNOWLEDGE CREATION

Knowledge and knowledge creation are both constructs, in that they are abstract theoretical variables that are ‘invented’ to explain phenomena (Schriesheim et al., 1993). Among the key concerns about construct measurement is that of validity. In order to be judged as adequate, a measure must reflect the theoretical content domain of the construct (content validity) (Nunnally & Bernstein, 1994). In order to assess content validity, the construct is theoretically defined, incorporating clear specification of the total content universe that is relevant, and a representative measure is drawn from the content domain, which is operationalised to reflect the meaning of each chosen dimension (Carmines & Zeller, 1979). Therefore, the initial step towards establishing the content validity of knowledge creation measures is to review the theoretical definitions of knowledge creation used in current research and to undertake an assessment of their success in clearly specifying relevant content.

Literature on knowledge and its creation is replete with ongoing and unreconciled debate surrounding the definition and nature of knowledge (Argote & Ingram, 2000; Garavelli, Gorgoglione, & Scozzi, 2002; Gourlay, 2006; Kakhara & Sorensen, 2002). Because much research into knowledge creation is developed from a conceptualisation of knowledge (Droge et al., 2003; Madhavan & Grover, 1998), we would expect to find a similar discussion, categorisation and debate of its definition and operationalisation. Yet, while the conceptualisation of knowledge creation has been subject to varying investigative approaches (Bryant, 2005; McFadyen & Cannella Jr., 2004; Un & Cuervo-Cazurra, 2004), this has not been accompanied by attempts to categorise or debate different conceptualisations and methods (Droge et al., 2003; Madhavan & Grover, 1998), and much relevant theoretical and empirical research into knowledge creation is developed either without a construct definition (Droge et al., 2003; Kess & Haapasalo, 2002; Lee & Cole, 2003; Madhavan & Grover, 1998; Matusik & Heeley, 2005; Smith, Collins, & Clark, 2005). Those that do define knowledge creation depict a process, output or outcome.

Knowledge creation as a process refers to the initiatives and activities undertaken towards the generation of new ideas or objects, for example, Styhre and Roth et al (2002) describe knowledge creation as the utilisation of complex and discontinuous events and phenomena to deal with collectively defined problems. As a process, knowledge creation is defined in terms of the method or means through which knowledge is generated and can be differentiated from the end result, or output. Knowledge creation as an output refers to the development of new ideas that reflect a significant elaboration or enrichment of existing knowing (Parent & Gallupe, 2000), for example, Johnson (2002) describes knowledge creation as the difference between what is known and what must be known for project success. As an output, knowledge creation is defined in terms of an immediate product the knowledge creation process, such as the representation of an idea, and can be differentiated from its impact on the organisational system, or outcome. Knowledge creation as an outcome means that new knowledge is diffused, adopted and embedded as new products, services and systems (Argyris & Schon, 1996;
Nonaka, 1994; Phan & Peridis, 2000), for example, the assimilation from the outside of new codes and routines (Phan & Peridis, 2000). Knowledge creation as an outcome is defined in terms of a value-adding object.

We posit that knowledge creation outputs are antecedent to knowledge creation outcomes, and that processes are antecedent to outputs, which leads to a simple integrative knowledge creation conceptualisation with three layered components. As a process, knowledge creation reflects the initiatives and activities undertaken towards the generation of knowledge outputs, new ideas or objects. As an output, knowledge creation is the constructive change in subjective knowing, assessed as significantly different from extant knowledge, which provides a conceptual basis for knowledge creation outcomes. As an outcome, knowledge creation is the generation of value-adding objects such as routines, products, publications or services.

The following section analyses the methods that have been used in empirical investigations into knowledge creation and develops a taxonomy that can be utilised to classify the range of measures and their fit against the knowledge creation conceptualisation developed above. By identifying the broad array of measure types used in current research and key dimensions that distinguish them, this taxonomy lends some clarity to the conceptualisation and operationalisation of knowledge creation.

METHOD

Fleishman and Mumford (1991) describe four steps required to generate a classification: specification of the domain of objects to be classified; definition of the essential properties of objects lying in this domain; appraisal of the relative similarity of these objects to each other on the basis of the properties identified and specification of processes for determining assignment to a category.

The domain of objects to be classified in this research is methods used to measure knowledge creation. In order to generate information on the essential properties of measurement methods, we reviewed the relevant empirical research and performed a content analysis on the resultant measures. The literature review included key-term searches on bibliographic databases: Emerald Library, ABI Inform, Business Source Premier, JSTOR, ScienceDirect, PsychINFO and Wiley Interscience. The two main criteria for selection were first, that the research study specifically describe knowledge creation as a key issue for investigation and second, that the research study incorporate the description and utilisation of a method to operationalise intra- or inter-organisational knowledge creation. Decisions were made to omit conceptual papers, methods that were not clearly specified, as well as those that fell outside the area of interest, such as those defined as measuring creativity.

Our sample consisted of 63 empirical studies investigating knowledge creation. Research grounded solely in one type of journal was perceived as a threat to the generalisability of our findings and therefore our sample was taken from empirical research reported in publications from diverse management streams. With this heterogeneous sample, we hoped to identify a wide array of knowledge creation measures. A total of at least eighteen different knowledge creation measurement types were
identified. Both of the authors independently classified these measures based on three different attributes: orientation, data source and frame of reference (Figure 1).

**Insert Figure 1 about here**

The attribute of orientation differentiates measures on the basis of the targeted knowledge creation component: process, output or outcome. Measures oriented to capture knowledge creation as a process assess the steps or activities undertaken in pursuit of new knowledge, such as, for example, the use of metaphors to externalise knowledge (Teerajetgul & Chaoenngam, 2006). Measures oriented to capture knowledge creation as an output assess the immediate product of knowledge creation efforts such as, for example, a spoken idea (Beech, MacIntosh, Maclean, Shepard, & Stokes, 2002). Measures oriented to capture knowledge creation as an outcome assess the manifestation of an object, such as a changed routine or product prototype (Malhotra & Majchrzak, 2004). A comparative assessment indicates no correlation between a process-based definition of knowledge creation and the utilisation of process-based measures. Similarly, no connection is evident between output- or outcome-based definitions and methods of assessment.

Data source, as an attribute, differentiates measures based on whether the source of data used to determine knowledge creation is actor perception or a substantive object or change. Perceptual measures assess knowledge creation on the basis of individual or group perception of, for example, the generation of knowledge in the form of ideas (Un & Cuervo-Cazurra, 2004). Operational measures assess knowledge creation on the basis of the existence of a tangible or verifiable object or change such as a new product or a new routine (Hoegl & Schulze, 2005).

Frame of reference, as an attribute, differentiates measures based on whether knowledge creation is determined with reference to criteria external or internal to the organisation, or a subjective or objective judgment. Externally-referenced measures assess knowledge creation on the basis of criteria external to the knowledge creating organisation, such as patent citations. Internally-referenced measures assess knowledge creation on the basis of an internal organisational assessment of knowledge created. Measures using a subjective frame of reference assess knowledge creation based on the determination of participants involved in the knowledge creation process. Measures using an objective frame of reference assess knowledge creation based on the determination of actors not involved in the knowledge creation process (often research and hypothesis-blind).

These three attributes are characteristics by which different knowledge creation measures can be compared against another, allowing similarities and differences between measures to be identified (Rich, 1992). The orientation attribute was identified a priori on the basis of the existing conceptualisation of knowledge creation. The attributes additional to orientation emerged a posteriori on the basis of analysis of the data generated through the literature review, which is a valid method for constructing typologies (Rich, 1992). On the basis of these attributes, the authors established the dimensions of a working taxonomic framework.
Once the taxonomy was established, two coders independently assigned each of the knowledge creation measures to a taxonomic category. The authors trained the two independent coders – doctoral student in international business and academic administrator – in the nature and use of the knowledge creation measures classification scheme. The coders worked separately and categorised each measure according to each dimension of the taxonomy. To check for coding reliability, the measures were split into two groups. Agreement between the two coders was assessed for the first 24 measures and then for the remaining 39 measures. Agreement between the two authors for coding of the first group was 83% and for the second group, 90%.

**TAXONOMY OF KNOWLEDGE CREATION MEASURES**

The taxonomy incorporates measurement classifications nested under three hierarchical levels (Table 1). An illustrative sample of knowledge creation measures categorised according to these classifications is presented in Table 2.

Insert Table 1 about here

Insert Table 2 about here

The following description of taxonomic classification is organised initially on the basis of orientation: process, output and outcome. Process-oriented measures are perceptual in terms of data source and are subdivided on the basis of reference frame: subjective and objective. Output-oriented measures are also perceptual in terms of data source and subdivided on the basis of reference frame: subjective and objective. Outcome-oriented measures are operational in terms of data source and are subdivided on the basis of frame of reference: external and internal reference.

Process-oriented measures are based on an assessment of engagement in defined knowledge creating processes. They are classified as perceptual in terms of data source and utilise subjective or objective perception as the basis of categorisation. Subjective measurement is through participants’ subjective determination of their involvement in knowledge creating activities, for example, Nonaka (1994) utilised thirty-eight items to measure managerial self-reported involvement in processes of knowledge creation incorporating socialisation, externalisation, combination and internalisation. Objective measurement of knowledge creation processes is through non-participant investigators’ objective determination of actor involvement in knowledge creating activities, for example, Nonaka and Takeuchi’s (1995) observation of bread-maker’s failure to externalise tacit knowledge.

Output-oriented measures assess the immediate end result of knowledge creation process and are classified as perceptual in terms of data source (Bryant, 2005; Cross, Parker, Prusak, & Borgatti, 2001; Styhre et al., 2002). Perceptual measures of knowledge creation output either utilise subjective or objective perception as the basis of their categorisation. Subjective perception-based measures include, for example, Fong et al’s (2007) investigation into design options for the refurbishment of a reservoir, which assessed participants’ perceptions of enriched, unique ideas. Similarly, Paul’s (2006) assessment of telemedicine consultation as knowledge transfer, knowledge discovery or knowledge creation
involved coding data from transcribed interviews with multiple key informants who participated in the consultations as either clinicians, administrators or IT professionals. Other studies attempt to objectify perceptual assessment, for example, Parent and Gallupe’s (2000) experimental study into focus groups used the number of enriched ideas generated as the measure of knowledge creation. Enriched ideas were coded by experienced, research- and hypothesis-blind researchers, who were not involved in the consultations and judged as capable of providing an objective assessment.

Outcome-oriented measures assess the value-adding objects or changes resultant from knowledge creation and are classified as operational in terms of data source. Operational measures determine knowledge creation either on the basis of internal, organisational criteria or external criteria. The former category use the development of new products, services and routines to assess knowledge created, for example, new product prototypes and new supply chain management services (Arnulf, Dreyer, & Grenness, 2005; Cardinal & Hatfield, 2000; Kodama, 2007; Salisbury, 2001). The second category of operational measures employs an external frame of reference and determines knowledge creation based on criteria that are often also argued to provide a foundation for assessing the value of knowledge created. For example, McFadyen (2004) utilised journal impact factor as a measure of the quality of knowledge created in scientific journal publications, arguing that frequent citations reflect the value of a publication to the scientific community, which can be extrapolated to reflect the quality or level of knowledge created (McFadyen & Cannella Jr., 2004). Similarly, patent citation rate has been used as a proxy for knowledge creation in a number of studies in which it is argued that successful patent applications ensure the knowledge is deemed valuable by qualified assessors (Ibert, 2006; Robertson, Scarbrough, & Swan, 2003; Sigurdson, 2000).

**IMPLICATIONS, CONCLUSIONS AND FUTURE RESEARCH**

In this paper, we provide a review of recent efforts to conceptualise and operationalise knowledge creation. The first contribution of this paper is the review and analysis of extant definitions of knowledge creation. We develop and present a simple knowledge creation model in which knowledge creation processes lead to the creation of immediate outputs, representations of subjective knowing, such as spoken ideas, which provide the basis for value-added outcomes, such as routines or new products. We note that future research into knowledge creation should be anchored by a clear construct definition, and specify whether the process, output or outcome of knowledge creation (or a combination) is the subject of empirical investigation. A clear conceptualisation of the knowledge creation construct is a first step in accurate operationalisation and delineates the parameters which guide measurement decisions.

A second contribution of this paper is the development of a hierarchical taxonomy of knowledge creation measures. Coupled with an explicit definition, a hierarchical taxonomy, in which movement up the hierarchy provides broader conceptual classification and movement down the hierarchy provides conceptual refinement, is a useful basis for making decisions about appropriate
measurement approaches. The measurement taxonomy developed in this paper facilitates knowledge creation operationalisation by categorising measures in a way that facilitates assessment against existing comparable definitions. Using an output-oriented definition of knowledge creation provides a sound underpinning for an empirical investigation measuring enriched new ideas. Similarly, measurement of new products, for example, should be clearly identified as a measure of knowledge creation outcomes, defined appropriately.

One of the issues associated with knowledge creation research is the overlap with related constructs such as innovation, defined as the process by which knowledge is directed towards competitive ends (Dodgson & Hinze, 2000). Like knowledge creation, indicators that have been used to measure innovation include patent citations and new product development (Dodgson & Hinze, 2000; OECD, 1996; Tsai, 2001). Utilising the same measures for both constructs is conceptually messy. Whether knowledge creation is a component of the innovation process, separate to the process of commercialisation, or a broader construct that incorporates innovation, both the definition and measures need to be differentiated from this and other similar constructs such as creativity. By separating the outcome of knowledge creation from the immediate output, the taxonomy developed in this paper potentially provides a basis on which to differentiate concepts such as the generation of a new idea, from the notion of innovation as value-adding knowledge creation outcome. Future research should investigate the relationship between each component of knowledge creation and related constructs, including innovation and creativity.

There are some limitations to the findings reported in this paper. With content analysis, as with other methods, issues of bias, including sampling, coding, and reliability represent possible limitations to the research. For example, we must acknowledge that our review was not comprehensive and measures of knowledge creation may fall outside the taxonomy developed. In addition, some bias may have entered the coding, perhaps particularly with respect to placement of measures into process or output categories. Future research should attempt to reduce both biases by using diverse coders and additional techniques for identifying measures. Despite these limitations, this paper and the taxonomy developed within, provide an integrative and comprehensive tool for further testing and theory development. Such a taxonomy makes it easier to clarify similarities and differences among knowledge creation measures, develop new propositions for future investigation, and identify neglected areas of study. Without a valid taxonomy, scholars have learned a great deal about knowledge creation, however, most studies have focused on specified outputs or processes. What more can we learn by utilising different types and combinations of measures? For example, which knowledge creation processes most effectively contribute to progress toward achieving knowledge creation outcomes? Knowledge creation research can be revitalized by the more comprehensive study of the various measurement types and levels in the taxonomy and by the simultaneous utilisation of different measurement types.
Table 1: Taxonomy of Knowledge Creation Measures

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Data Type</th>
<th>Reference Frame</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Subjective</td>
<td>Measures based on participants’ subjective categorisation of the immediate output of knowledge creation processes.</td>
<td>Participant interviews assessing knowledge creating processes in joint ventures including technology transfer, joint venture parent interactions and personnel movements (Inkpen, 1996)</td>
</tr>
<tr>
<td>Output Measures</td>
<td>Perceptual Measures</td>
<td>Objective</td>
<td>Measures based on non-participant categorisation of the immediate output of knowledge creation processes.</td>
<td>Enriched ideas coded by experienced research- and hypothesis blind researchers (Parent &amp; Gallupe, 2000)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subjective</td>
<td>Measures based on participants’ subjective categorisation of the immediate output of knowledge creation processes.</td>
<td>Telemedicine consultations coded as knowledge creating (Paul, 2006)</td>
</tr>
<tr>
<td>Outcome Measures</td>
<td>Operational Measures</td>
<td>Internally-referenced Measures</td>
<td>Measures based on an internal organisational assessment of new operational resources including new product, service, routine or document.</td>
<td>New product prototype development (Schulze &amp; Hoegl, 2006)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Externally-referenced Measures</td>
<td>Measure based on external criteria argued to reflect knowledge creation – often argued to indicate value of knowledge created.</td>
<td>Journal impact data (McFadyen &amp; Cannella Jr., 2004)</td>
</tr>
</tbody>
</table>
Table 2: Categorization of a sample of knowledge creation measures.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Orientation</th>
<th>Data Type</th>
<th>Reference Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Process</td>
<td>Output</td>
<td>Outcome</td>
</tr>
<tr>
<td>Case study analysis of knowledge creation processes (Inkpen, 1996)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Non-participant observation of knowledge creation processes (Nonaka &amp; Takeuchi, 1995)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Participant rating of perceived enriched unique ideas (Bryant, 2005; Fong et al., 2007)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Enriched ideas coded by experienced, research- and hypothesis-blind researchers (Parent &amp; Gallupe, 2000).</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Development of product prototype (Malhotra &amp; Majchrzak, 2004)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Legal reports in professional service firms (Robertson et al., 2003)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Successful patent application (Nerkar, 2003; Sigurdson, 2000)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Reference List


