Firms' Knowledge Creation, Protection, and Institutions

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Abstract

Knowledge is the most important source of sustainable competitive advantage. Firms need to continuously create new knowledge efficiently to maintain their competitive advantages. Firms' knowledge creation involves the conversion of employees' tacit knowledge to explicit knowledge. The two factors that define knowledge creation are the size and intensity of useful knowledge and the institutions that a nation is molding to create knowledge. The ideation technique has emerged as a knowledge creation technique. This paper evaluates the ideation technique and found that it solicits employees' tacit knowledge and improves creativity. Therefore, the ideation technique is a candidate to be considered for further development.

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Introduction

The global economy has been changing rapidly in recent years and knowledge has naturally become the most important input in economic change. Scholars of the knowledge-based theory of the firm have maintained that knowledge is a key determining factor of competitive advantage in today's economy. According to Liebeskind (1996)," there is a widespread consensus that we are moving towards an economy where competitive advantage will be determined by knowledge rather than by access to raw materials and cheap labor (Liebeskind, 1996, p. 105)." Drucker (1993) considers knowledge as the only meaningful resource and Nonaka et al. (2000a) argue that knowledge and skills give a firm a competitive advantage, because it is through this set of knowledge and skills that a firm is able to innovate new products/processes/services or improve the existing ones more efficiently and/or effectively. Scholars in the knowledge-based theory of the firm view the firm as a knowledge creating entity and argue that knowledge and the ability to create and utilize such knowledge are the most important source of a firm's sustainable competitive advantage (Cyert et al., 1993; Henderson and Cockburn, 1994; Kogut and Zander, 1996; Leonard-Burton, 1995; Nahapiet and Ghoshal, 1998; Nonaka, 1994; Nonaka and Takeuchi, 1995; Spender, 1996; Teece et al., 1990).

Knowledge is the most important source of a firm's sustainable advantage because a firm's knowledge is likely to help create and maintain both Ricardian and Schumpeterian (monopoly) rents (Liebeskind, 1996). Liebeskind (1996) argues that firms need to create, exploit and defend knowledge to protect sources of rent. Firm knowledge is composed of knowledge sets controlled by individual agents (Foss and Manke, 2005). Thus, efficient knowledge creation needs to direct attention to the possible incentive conflicts and intertemporal allocation of an individual agent's knowledge sets. Knowledge creation also involves the conversion of tacit knowledge to explicit knowledge (Kogut and Zander, 1992; Nonaka and Takeuchi, 1995).

Because Ricardian and Schumpeterian rents tend to be dissipated by competition, knowledge protection is needed to prevent expropriation and imitation of knowledge by rival firms. Liebeskind (1996) argues that firms, as institutions, play a critical role in creating and protecting valuable knowledge. Liebeskind (1996) also points out that unlike tangible assets, protecting knowledge assets by social institutions (property rights) is problematic because property rights in knowledge, such as patents, copyrights and trade secrets, are very narrowly defined under the law, and are costly to write and enforce. She then argues that incentive alignment, employment contracts, and the ability to reorder rewards over time can serve as the protective institutional capabilities of the firm. Liebeskind extends the scope of knowledge protection by replacing the limited and costly property rights in knowledge with far more extensive possession rights. She argues that not all firms may be equally competent at deploying institutional capabilities to protect their knowledge, and differences in firms' protective capabilities can lead to differences in profits among firms.

The institutional framework that defines the deliberate incentive structure of a firm plays a critical role in creation and protection of knowledge. North (2005) argues that economic change is a result of changes in "(1) the quantity and quality of human beings; (2) the stock of

human knowledge particularly applied to the human command over nature; and (3) the institutional framework that defines the deliberate incentive structure of society" (p. 1). He gives priority to institutional change in accounting for economic change. This paper, therefore, investigates how firms as institutions create and protect knowledge to improve their profits and to maintain sustainable competitive advantage.

The paper is organized as follows: Section two reviews the nature of knowledge; sections three and four discuss issues in knowledge creation and protection; section five examines the effectiveness of the ideation technique adopted by firms for knowledge creation and protection; finally, section six concludes the paper.

The Nature of Knowledge

According to Winter (1991), firms are repositories of knowledge. Knowledge is considered as the only meaningful resource (Drucker, 1993) and the most important source of a firm's sustainable competitive advantage (Kogut and Zander, 1992; Nonaka, 1994; Teece et al., 1990). As knowledge gains its prominence in firm innovation and competitive advantage, lively discussions on the nature of knowledge have emerged among knowledge scholars. However, knowledge is a multifaceted concept with multilayered meanings (Nonaka, 1994). Nonaka adopts a definition of knowledge as "justified true belief" in his organizational knowledge creation (Nonaka, 1994, p. 15). His distinction between knowledge and information is as follows:

> In short, information is a flow of messages, while knowledge is created and organized by the very flow of information, anchored on the commitment and beliefs of its holder. This understanding emphasizes an essential aspect of knowledge that relates to human action (Nonaka, 1994, p. 15).

His recognition of the importance of knowledge related to action shows the connection of knowledge creation to continuous innovation and competitive advantage (Nonaka and Tateuchi, 1995, p. 6).

Kogut and Zander (1992) add to this by categorizing organizational knowledge into information and know-how: "Knowledge as information implies knowing what something means. Know-how is as the compound words state, a description of knowing how to do something (p. 386)." Information as knowledge includes facts, axiomatic propositions, and symbols. But know-how, as Kogut and Zander (1992) point out, is a frequently used, but rarely defined term. They cite von Hippel's definition:

> Know-how is the accumulated practical skill or expertise that allows one to do something smoothly and efficiently (von Hippel, 1988, p. 6).

Kogut and Zander argue that the pivotal word in von Hippel's definition is "accumulated," which implies that know-how must be learned and acquired. Therefore, learning and acquiring (creating) knowledge has significant implications in organizational knowledge and change.

Cook and Brown (1999) draw a distinction between knowledge and knowing. They regard knowledge as something people possess and knowing as action calls for an "epistemology of practice (p. 381)." They state that the epistemology of possession tends to privilege explicit over tacit knowledge and knowledge possessed by individuals over that possessed by groups. They argue that "current work on organizations is limited by this privileging and by the scant attention given to knowing in its own right (p. 381)." They maintain that knowledge as something possessed is abstract and static, but necessary to action. Knowing is, however, a part of action or practice; therefore, knowing is dynamic, concrete and relational.

> We held that knowledge is a tool of knowing, that knowing is an aspect of our interaction with social and physical worlds, and that the interplay of knowledge and knowing can generate new knowledge and knowing is a powerful source of organizational innovation. Harnessing this innovation calls for organizational and technological infrastructures that support the interplay of knowledge and knowing (Cook and Brown, 1999, p. 381).

The interplay of knowledge and knowing has emerged as very important factor in knowledge creation. Knowing was initiated by Ryle (1949) and to him knowing how is a

disposition, a skill, and is a matter of competence.

The most frequently talked about category in knowledge is a distinction between tacit and explicit knowledge. Polanyi's (1966) well-known idea of tacit knowledge states the fact that we can know more than we can tell (p. 4). According to Schön (1983), tacit knowledge is rooted in action, procedures, routines, commitment, ideas, value and emotion. Grant (1996) identifies tacit knowledge with know-how and explicit knowledge with knowing about facts and theories. Nonaka, et al. (2000b), state that "explicit knowledge can be expressed in formal and systematic language and shared in the form of data, specific formulae, specifications, manuals and such like (p. 7)".

Another well-known concept in knowledge is Hayek's dispersed knowledge (Hayek, 1945). Hayek raises a question on the use of knowledge in society: What is the problem we wish to solve when we try to construct a rational economic order? He argues that knowledge is dispersed and is not given in its totality to individuals.

> The peculiar characteristic of the problem of a rational economic order is determined precisely by the fact that knowledge of the circumstances of which we must make use never exists in concentrated or integrated form, but solely as the dispersed bits of incomplete and frequently contradicted knowledge which all the separate individuals possess. The problem of society is thus not merely a problem of how to allocate "given" resources – if "given" is taken to mean given to a single mind which deliberately solves the problem set by these "data." It is rather a problem of how to secure the best use of resources known to any member of society, for ends whose relative importance only these individuals know. Or, to put it briefly, it is a problem of the utilization of knowledge not given to anyone in its totality (Hayek. 1945, pp.519-520).

Therefore, characteristics of knowledge are tacit and dispersed.

Discovery of knowledge, invention and innovation contribute to improvements in processes, products, services and management systems which lead to competitive advantage. Machlup (1962) argues that inventions are sometimes made by accident, not as a result of special purposeful efforts. However, he further points out that "we may regard invention as a special effort of labor, capital, and enterprise, and inquire into the motivations behind the

expenditures of this effort (p. 144)." Schön (1967) defines technology, invention and innovation in his book, *Technology and Change*:

> I would like to use "invention" to mean the process of bringing new technology into being, or again, the new technology created in the process. "Technology" will mean any tool or technique, any product or process, and physical equipment or method of doing or making, by which human capability is extended. "Innovation" will mean the process of bringing invention into use, and "diffusion," the spread of its use beyond its first instance (Schön, 1967, p. 1).

We can now clearly see the connection between technology and innovation.

Nelson (2005) points out that "the growth of the late 1990s in the U.S. was marked by both high investment and rapid technological advance (p. 28)." Changes in information technology (IT), bio-technology (BT) and management are known as major sources of the growth boom in the 1990s. Nelson (2005) pays attention to technology and asks "What is technology?" He describes technology as follows:

> There are a few simple metaphors about technology. One is that prevailing technology is like "a set of blueprints," suggesting the conception of a "technology library," albeit one in which some of the "books" are proprietary. The notion that technology is "knowledge" has also been around for some time, suggesting something more embodied in human minds (Nelson, 2005, p. 29).

Nelson further adds the concept of social technology to physical technology. Nelson and Sampat (2001) distinguish physical technology and social technology. In the conventional sense, when we think of technology it is the physical technology. They developed the notion of institutions as standard social technology involving the coordination of human action. Nelson and Sampat (2001) argue that it probably is useful to think of physical and social technologies as co-evolving. They express their view on major changes in institutions for significant economic progress.

> Our view involves a strong belief in the importance of shared culture in molding what people think is appropriate to do, but at the same time a belief that in many cases at least individual and group learning processes winnow our grossly inferior or self destructive practices, and when new challenges or opportunities arise, there can be major changes in institutions which allow significant economic progress (Nelson and Sampat, 2001, p. 52).

We, therefore, discuss knowledge creation and protection based on the notion that technology is knowledge, and institutions play a significant role in knowledge creation and protection.

Knowledge Creation

The main characteristic of today's economy is dynamic innovation. The dynamic capabilities approach to the firm captures well the main characteristic of knowledge, which is knowledge creation. Firms become innovative and competitive through efficient knowledge creation. Several scholars developed the knowledge creation model (Kogut and Zander, 1992; Machlup, 1962; Nelson and Winter, 1982; Nonaka and Takeuchi, 1995). Nonaka and Takeuchi (1995) anchor their knowledge creation to the concept of knowledge conversion:

> Our dynamic model of knowledge creation is anchored to a critical assumption that human knowledge is created and expanded through social interaction between tacit knowledge and explicit knowledge. We call this interaction "knowledge conversion" (Nonaka and Takeuchi, 1995, p. 61).

They postulate four different modes of knowledge conversion: (1) from tacit knowledge to tacit knowledge, which we call socialization; (2) from tacit knowledge to explicit knowledge, or externalization; (3) from explicit knowledge to explicit knowledge, or combination; and (4) from explicit knowledge to tacit knowledge, or internalization (Nonaka and Takeuchi, 1995, p. 62). They define combination as a process of systematizing concepts into a knowledge system. They argue that "reconfiguration of existing information through sorting, adding, combining, and categorizing of explicit knowledge can lead to new knowledge (p. 67)."

Combination as knowledge creation draws attention from several scholars. It originates from Schumpeter (1934), and Kogut and Zander (1992) advance the notion of a firm's combinative capabilities. Schumpeter's new combinations of productive means are: (1) the introduction of a new good or of a new quality of a good; (2) the introduction of new methods of production; (3) the opening of a new market; (4) the conquest of a new source of supply for raw materials or half-manufactured goods; and (5) the carrying out of the new organization of any

industry, like the creation of a monopoly position or breaking up of a monopoly position (Schumpeter, 1934, p. 66). Kogut and Zander (1992), then, point out that creating new knowledge does not occur in abstraction, but occurs from current abilities:

> Rather, new learning such as innovations is products of a firm's combinative capabilities to generate new applications from existing knowledge. By combinative capabilities, we mean the intersection of the capability of the firm to exploit its knowledge and the unexploited potential of the technology . . . (Kogut and Zander, 1992, p. 391).

These authors illustrate the importance of combinative capabilities of a firm's knowledge creation and knowledge scholars, therefore, direct their attention to what firms do rather than what firms are (Kogut and Zander, 1996).

Firms need to carefully consider the characteristics of tacit and dispersed knowledge in knowledge creation. A firm is seen as a knowledge system as noted by Grant (1996), whereas Tsoukas (1996) sees the firm as a distributed knowledge system. Tsoukas argues that the organizational problem firms face is the utilization of knowledge which is not, and cannot be, known by a single agent. A firm's knowledge is distributed not only in a computational sense (Kiountouzis and Papatheodou, 1990; Hutchins, 1993), or Hayek's (1945, p. 521) sense that the factual knowledge of the particular circumstances of time and place cannot be surveyed as a whole, but more radically in the sense that it is inherently indeterminate: nobody knows in advance what knowledge is or need be. Furthermore, a firm's knowledge is distributed in an additional sense that it is partly derived from broader industrial and societal contexts (p. 22). Hayek (1945) points out that knowledge is dispersed and each individual has only partial knowledge.

Thus far, we have discussed a firm's knowledge creation as if firms learn and create knowledge. However, firms themselves do not possess knowledge as Foss and Mahnke (2005) rightfully reminded us. They point out that so called "firm knowledge" is composed of

knowledge sets controlled by individual agents (p. 86). Therefore, knowledge creation needs to direct attention to the organizational economics perspective: the benefits as well as the costs of alternative contractual, organizational, and institutional structure. Organizational economics perspectives deal with issues in principal-agent, transaction cost, property rights, team production and complementarities between organizational elements. Foss and Mahnke (2005) raise the following issues:

> How can employees be induced to making their human capital firm specific when this puts them at a risk? What are the complications of knowledge creation in teams? Do individual incentives enable or impede knowledge creation in teams? (Foss and Mahnke, 2005, p. 86)

We may add additional issues on organizational elements: What is the optimal supply of an agent's knowledge when he or she is demanded to supply knowledge each year? What is the effect of the agent's knowledge supply on knowledge creation if the knowledge supplied by him or her threatens his or her job security?

These issues need to be explored in research. Foss and Mahnke (2005) suggest ten refutable propositions from organizational economics perspectives, but we will introduce five propositions deemed to be relevant in knowledge creation:

Proposition 1: Firms sponsoring certified acquisition of general skills as a form of merit pay will induce higher employee investments in firm-specific capital.

Proposition 2: Knowledge creation in teams will be less effective as team sizes grow because shirking and free-riding will increase.

Proposition 3: Knowledge creation in teams will be more effective in firms that use combinations of team-based and individual incentives.

Proposition 4: Knowledge creation in teams will be more effective if the team members are entitled to exclude non-exploring team members by self-selection.

Proposition 5: Teams employing combinations of individual incentives, team incentives, and exclusion rules will be more effective at knowledge creation than teams relying on clan control (Foss and Mahnke, 2005, pp. 91-95).

The above five propositions are organizational perspectives that may affect knowledge creation. Effects of these propositions on knowledge creation can provide a good framework to connect organizational perspectives and competency creation.

We need to further refine the notion that technology is knowledge (Mokyr, 2000; Nelson, 2005) for our discussions in knowledge creation. According to Nelson (2005) technologies are "know-how," which is in fingers as well as head (Pavitt, 1987; Dosi, 1988). Nelson (2005) states that "modern technologies are described in blueprints, texts, pictures and equations (p. 29)." Therefore, people need to learn and master them to be useful in the production of goods and services:

> A great deal of learning by doing and using is often necessary to gain real mastery of a technology (Nelson, 2005, p. 29).

Mokyr (2000) refers to learning as access cost and further illustrates the nature of access cost.

> Although knowledge is a public good in the sense that the consumption of one does not reduce that of others, the private costs of acquiring it are not negligible in terms of time and often real resources as well. … Access costs depend on the technology of access, the trustworthiness of the source, as well as the total size of knowledge (Mokyr, 2000, p. 257, p.258).

Information technology can store explicit knowledge and it makes information flow in and out of agents' minds more rapidly. However, as the total size of knowledge gets larger, more specialization and division of knowledge are required and more specialization and division of labor increase access costs because it would take more time to learn specialized knowledge.

Another type of knowledge to be considered in knowledge creation is "useful knowledge." Mokyr (2000) defines "useful knowledge" as knowledge about natural phenomena. Mokyr elaborates further on his definition of useful knowledge set:

> Knowledge resides either in people's minds or in storage devices from which it can be retrieved. From the point of view of a single agent, another's mind is a storage device as well. The total useful knowledge in a society can then be defined simply as the union of all pieces of useful knowledge contained in living persons' minds or storage devices. I will call this set Σ. A discovery then is simply

> the addition of a piece of knowledge hitherto not in that set (Mokyr, 2000, p. 256).

Mokyr (2000) also defines a second form of knowledge – techniques. Techniques are sets of instructions or recipes on how to manipulate nature. He argues that techniques are the end product of some knowledge in Σ so they have an epistemic base in Σ. Mokyr refers to this set as $\aleph$. A how-to manual, for example, is a codified set of techniques. Mokyr points out that the distinction between Σ and $\aleph$ parallels the distinction between knowledge "what" and knowledge "how." He argues that "the relationship between Σ and $\aleph$ is in some ways akin to the relationship between genotype and phenotype in biology in that not every gene ends up coding for a protein, but for any phenotype to emerge, some basis for it has to exist in the genome (p. 261)." He mentions three elements of Σ to be determinants of $\aleph$: the size of Σ (what is known), the degree of diffusion (who and how many know what is known), and the marginal access costs (how much does it cost me to find out what I do not know).

Techniques ($\aleph$) are private goods and useful knowledge (Σ) can be a public good. Discoveries add to Σ and inventions increase $\aleph$. Agents and firms have to decide which knowledge they choose to acquire and which technologies they choose to develop. Mokyr (2000) argues that "changes in techniques also open up new scientific questions and technical developments in instruments and laboratory methods make new research possible. Positive feedback from Σ and $\aleph$ and back can lead to virtuous cycles much more powerful than can be explained by technological progress or scientific progress separately (p. 263)." Positive feedback between useful knowledge and techniques is a powerful source of scientific and technological progress.

Knowledge creation needs to verify truthfulness of knowledge and valuate the possibility of market success on new technology. According to Polanyi (1962), the difference between Σ

and 8 boils down to the observation that Σ can be "right or wrong" whereas 8 can be "successful or unsuccessful." The central test for scientific knowledge is, "Is it valid?" Popper (1959) argues that there can be no positive answer to this question and the ability to stand up under attempts at refutation may be the best humans can hope for. On the other hand, Vincenti (1990) argues the central test for technological knowledge is, "Is it useful?" Technological knowledge is part of a cultural system that is basically concerned with accomplishing practical ends, rather than with knowledge for its own sake (Nelson, 2005). Successful techniques should have significant positive impact on firm performance. On the other hand, unsuccessful techniques may cause an adverse effect on firm performance. Although creativity is a powerful resource for competitive advantage, only a fraction of innovative ideas are eventually successful. According to Bader (2007) only 0.6 percent of innovative ideas are eventually successful. The success rate in the pharmaceutical industry is even lower at .01 percent, while research and development costs have escalated rapidly.

Therefore, enabling knowledge creation (von Krogh et al., 2000) involves issues associated with tacit knowledge, explicit knowledge, interaction between tacit and explicit knowledge, distributed(dispersed) knowledge, organization perspectives, Σ and 8, and positive feedback (Kaufman, 1993, Camazine et al., 2003) between Σ and 8. Positive feedback between useful knowledge and techniques reinforces an initial change in the same direction and amplify their growth.

Knowledge Protection

Knowledge protection has become a key factor in maintaining a monopoly position for an extended period of time. Therefore, knowledge protection is as important as innovation. Liebeskind (1996) points out that knowledge protection can be made by social institutions and

institutional capabilities. She argues that "property rights—patents, copyrights, and trade secrets—are very narrowly defined under the law and are costly to write and enforce (p. 95)." However, there are concerns on overprotection of knowledge by patents as noted by Nelson (2005). Nelson argues that the failure of protecting scientific commons can be harmful in discovery of new knowledge. The narrow definition of intellectual property rights may be a reflection of broader concerns for long-run growth and technological progress. Ordover (1991) frames the issue as a tradeoff between static and dynamic efficiency.

> Static efficiency considerations mandate that the knowledge-asset, resulting from research and development investments undertaken by firms and individuals, be made widely available to all those who are willing to pay the low marginal cost of dissemination. This perspective implies that public policy should encourage the widespread use of knowledge-assets, and hence suggest property rights in such assets should be minimal. But if the owners of knowledge-assets have only minimal property rights, their returns may not be high enough to recoup their initial investment, much less attain a sufficient return to compensate them for undertaking a risky project. As a result, the initial investment may not be undertaken, thereby harming dynamic efficiency. This perspective argues for public policies that provide strong and exclusive property rights for knowledge-assets, even if this is to the detriment diffusion (Ordover, 1991, p. 43).

Regardless of public policy debates, firms have strong incentives to protect their knowledge-assets because knowledge protection helps them to maintain sustained competitive advantage obtained from knowledge creation.

Liebeskind (1996) suggests that firms can design institutional capabilities which integrate governance and capability perspectives of the theories of the firm. The governance perspective of the firm deals with issues associated with the agency theory, the property rights theory, the transaction cost theory, and the team theory in knowledge protection. Liebeskind (1996) argues that through institutional capabilities firms can protect knowledge from expropriation or imitation more effectively than market contracts by aligning incentives, writing employment contracts, and re-ordering rewards. In knowledge creation, agents or a team of

agents are involved in knowledge production. When interests of agents are not aligned with the principal, agents may pursue their own interests and behave opportunistically. Employment contracts can be designed to protect knowledge by stipulating employee conduct rules and job designs. Reordering rewards include deferred stock options, pension plans with delayed vesting and promotions over time. Liebeskind (1996) points out that deferred rewards will reduce employee mobility.

Institution

Institutionalists deal with the origin and historic development of institutions and, therefore, there is an affinity between institutionalisms and biology (Hodgson, 1993, 1998). According to Hodgson (1998), "the core ideas of institutionalism concern institutions, habits, rules and their evolution (p. 168)." North (1991) defines institutions as "the humanly devised constraints that structure political, economic and social interaction. They consist of informal constraints, (sanctions, taboos, customs, traditions, codes of conduct), and formal rules (constitutions, laws, property rights). Throughout history, institutions have been devised by human beings to create order and reduce uncertainty in change (North, 1991, p. 97)." Since firm's knowledge creation intimately involves changes and innovation of the firm, we need to study it from an institutional context.

Knowledge creating firms as institutions may be required to devise new institutions such as incentives, organizational hierarchies, and interactions among team members as well as society at large (universities). Firms that devise institutions which are successful at dealing with problems in knowledge creation will gain competitive advantage. However, North (2005) points out the problems that humans confront—the endless novelty and the non-ergodic nature of our world. These problems bear little resemblance to those facing a hunter/gatherer individual. He places emphasis on social change and human adaptability:

> The degree of novelty obviously is a crucial determinant of our potential success in dealing with the problems. We tend to talk glibly about technological change, the internet, and genetic alteration as solutions to our problems without recognizing the new and novel problems that will result from the consequent alterations in the human environment. The interdependent world we are creating requires immense societal change and raises genuine problems about human adaptability (North, 2005, p. 168).

Similarly, knowledge creating firms require changes not only in the firms, but in society as a whole. Therefore, we need to pay attention to eventual consequences of physical and social technologies. The current financial crisis which originated from the securitization of mortgages (social technology) offers good evidence for the point (Park, 2009).

Nelson and Sampat (2001) define social technology as "patterned human interaction (p. 40)" in coordination with production activities and suggest that the term "institution" is to be associated with social technology. They use the concept of institutions corresponding to Veblen's "widespread habits of action," (Veblen, 1958) and to Schotter's "the way the game is played" (Schotter, 1981). They also define the concept of institutions as "the rules of the game", and not all institutions are social technologies, but rather only those that have become a standard and expected thing to do, given the objectives and the setting. Nelson and Sampat assert that different physical technologies have different physical (as well as institutional) requirements for their implementation.

> Some require specialized machinery, some specialized materials. Similarly, different social technologies are institutionalized in different ways (Nelson and Sampat, 2001, p. 41).

Social technologies are embodied and molded by organizational and governance structure. Then "standardized social technologies are formed, and held in place, in the context of the broad system of norms, beliefs, and rules of the game that prevail in a society (Nelson and Sampat, 2001)." They point out that Chandler's M-form and quality circle are examples of social technologies. They argue that the language of routines, as developed in Nelson and Winter

(1982), is a useful vehicle for characterizing social technologies. We believe that the concept of social technology provides an analogy of "engineering design to social technology" (Park, Wafa and Shin, 2008). Engineering design is the process of devising a system, component, or process to meet desired needs (ABET, p. 5). The M-form is designed to solve coordination problems and the quality circle is to address quality problems in Japanese firms. Economic growth results from the co-evolution of physical and social technologies as Nelson and Sampat indicated.

Scholars in institutionalism (Mokyr, 2000; Nelson, 2005; North 2005) agree that the institutional framework that defines the deliberate incentive structure of a society is an important factor in firm performance and a nation's economic growth.

Knowledge Creation Practices

We have surveyed the nature of knowledge, knowledge creation, and institutions. Since knowledge creation means conversion of tacit and dispersed knowledge into explicit knowledge in firms (Kogut and Zander, 1992; Nonaka, 1994, Nonaka and Takeuchi, 1995), knowledge creation is to increase 8. Figure 1 is a graphical presentation of knowledge creation and its impact on firm performance and national competitiveness.

Firms convert tacit and dispersed knowledge into explicit knowledge and combine knowledge. Knowledge creation can mean that firms increase useful knowledge and techniques (Σ and 8). However, the conversion of techniques into innovation creates uncertainty because innovation is not always successful. Firms, then, need to mediate uncertainty in their innovation. But how do firms solve these problems or issues in their practice of innovation (knowledge creation)? Knowledge creation practices – ideation, brainstorming, mindmapping, billboarding - involve solving these problems and aid knowledge conversion. The global economic environment is continuously changing and firms are facing different problems all the time. Business firms are required to change and to create knowledge. Business innovation system is a

process of gaining knowledge in solving problems caused by the changing economic environment.

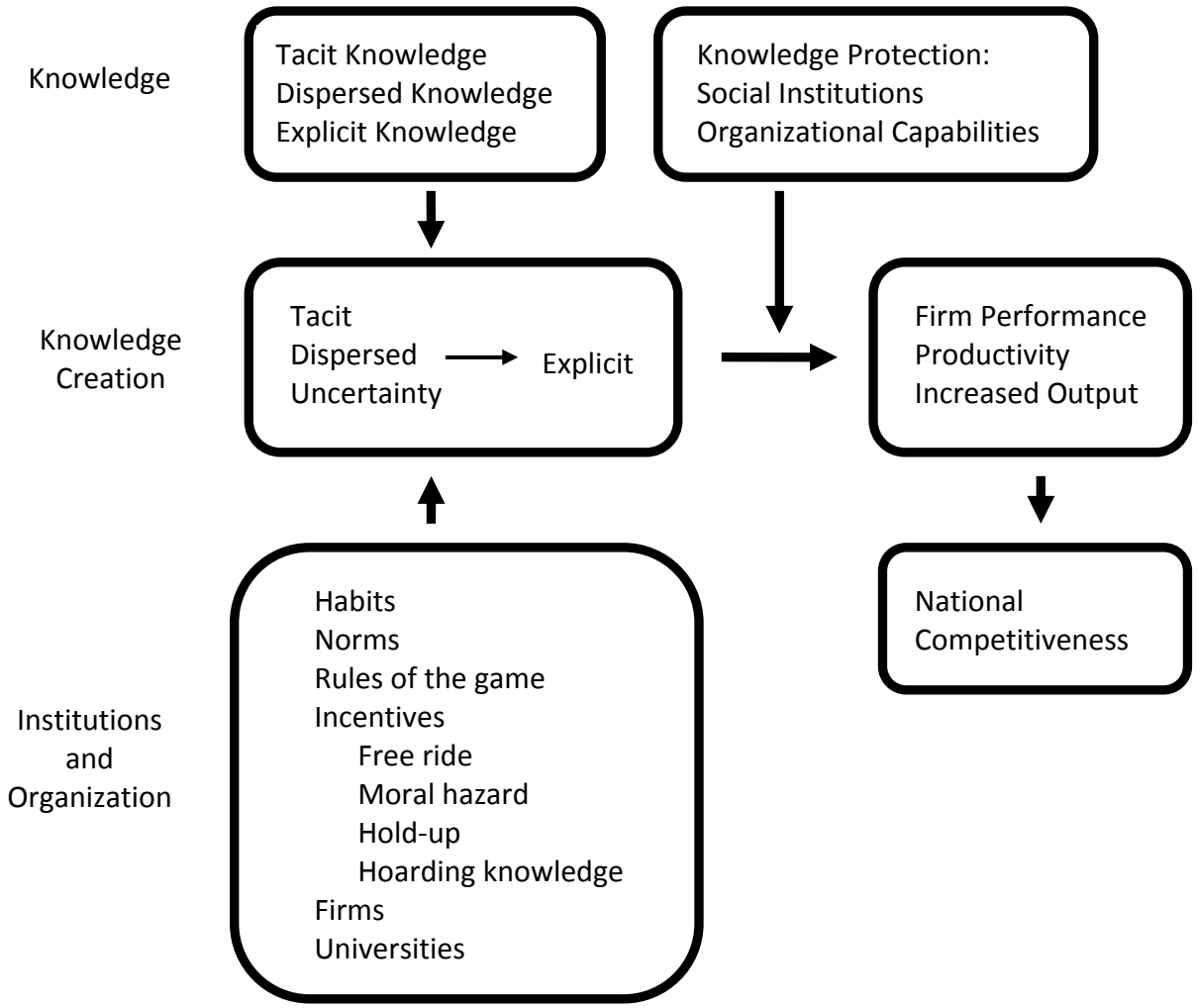


Figure 1: Factors effecting knowledge creation and impact of knowledge creation.

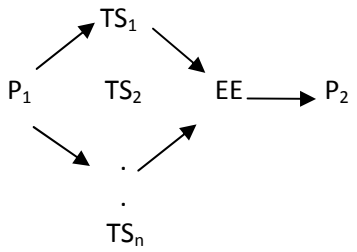
Popper (1982) offers a good framework for evolutionary epistemology. He argues that "all organisms are constantly, day and night, engaged in problem-solving (p. 110)." and problem-

solving always proceeds by the methods of trial and error. Popper describes the fundamental evolutionary sequence of events as follows:

$$[P \rightarrow TS \rightarrow EE \rightarrow P]$$

Where P = problems, TS = tentative solutions, EE = error elimination.

There can be the multiplicity of the tentative solutions (TS_1, TS_2…); the initial problem is P_1 and the new problem is P_2. The new schema accommodating the multiplicity of the trials can become like the following:



We can apply the same framework for solving knowledge creation problems. There have emerged many practices in knowledge creation: ideation, brainstorming, mindmapping, billboarding, etc as stated above.

Nonaka and Takeuchi's (1995) knowledge spiral posits that there are four modes of knowledge conversion: socialization, externalization, combination and internalization. They argue that "organizational knowledge creation is a continuous and dynamic interaction between tacit and explicit knowledge. This interaction is shaped by shifts between different modes of knowledge conversion, which are in turn induced by several triggers (p. 70)". Their explanations on different modes of knowledge conversion are as follows:

> First, the socialization mode usually starts with building a "field" of interaction. This field facilitates the sharing of members' experiences and mental models. Second, the externalization mode is triggered by meaningful "dialogue or collective reflection," in which using an appropriate metaphor or analogy helps team members to articulate hidden tacit knowledge that is otherwise hard to communicate. Third, the combination mode is triggered by "networking" newly created knowledge from other sections of the organization, thereby crystallizing

> them into a new product, service, or managerial system. Finally, "learning by doing" triggers internalization (Nonaka and Takeuchi, 1995, pp. 70-71).

Nonaka and Takeuchi (1995) point out that socialization, externalization, combination and internalization yield sympathized knowledge, conceptual knowledge, systemic knowledge and operational knowledge, respectively.

As mentioned before, an organization cannot create knowledge by itself. Nonaka and Takeuchi's well-known spiral of organizational knowledge creation involves "a spiral process, starting at the individual level and moving up through expanding communities of interaction, that crosses sectional, departmental, divisional, and organizational boundaries" (Nonaka and Takeuchi, 1995, p. 72). Therefore, tacit knowledge of individuals is an important basis for knowledge creation. Individuals increase tacit knowledge by learning—by doing their jobs, by their experiences and by investing in learning.

There are numerous techniques and tools to generate new ideas, but we examine the ideation technique from a knowledge creation perspective. Ideation is defined as "the process of generating or conceiving of ideas and concepts that may be useful for attaining some desired state or outcome (Briggs and Reinig, 2007, p. 1)". Simpson (2008) defines it more simply and concretely: "Ideation is the systematic search for targeted opportunities, and new markets, and new services (p. 1)." We can study the techniques of many successful knowledge creating firms, such as Dow Chemical, Johnson and Johnson, Toyota and Samsung. Typical processes they follow in new product development are: (1) trend analysis; (2) customer interaction; and (3) creative thinking (Simpson, 2008, p. 2-3).

First, a firm needs to understand industry trends to identify high potential opportunities. A mega trend analysis offers a future direction of the market and the firm can build a vision for the future from an analysis of the mega trend. However, we have to caution that the future technological development is not easy to predict.

Second, firms can find an addressable market and its size from customer interaction. Firms explore market needs based on voices of customers (VOC). Information from voices of customers provides market needs because customers' complaints and dissatisfaction with a product can be addressed by a new product or service. Firms are required to evaluate whether people must have the product (a necessity) or it is nice to have (a luxury good). The initiator or initiating team also examines market penetrability. Some markets are so difficult to penetrate because of their supply chain and network systems that new comers have insurmountable barriers to overcome. However, after evaluation of market needs and market penetrability, the firm embarks on a new project.

Third, the firm's initial step for the new project is assessment of its technology and skill set. The project initiator gathers experts on the project and holds a brainstorming session. He or she posts the project on an ideation website to solicit new ideas on the project. This process creates interaction among experts and socialization crystallizes the idea. All knowledgeable employees respond to the posted project on the company's ideation website, which helps convert tacit knowledge to explicit knowledge. Then the initiator of the project forms a project team to proceed with bringing the project to fruition. Ideation encourages creative thinking by interaction among experts and posing ideas on the ideation website. Interaction can generate positive feedbacks (Kaufman, 1993) and helps create new opportunities on which firms can build new competencies. Positive feedbacks generated by interaction between consumers and knowledge workers as well as an entire supply chain can become very powerful sources of knowledge creation. As firms build new successful competencies they achieve their competitive advantages.

Ideation is a technique which is originated for the systematic search for targeted opportunities, new products, new processes, new markets and new services. If this technique is

effective and selected by markets, it will become a routine. Ideation emerges as patterned human interaction in knowledge creation which is referred to as social technology (Nelson and Sampat, 2001). This social technology turns to an institution and institutions are important scaffolding on which any human society or nation can build its economic growth and prosperity(North, 2005). Employees who have participate in brainstorming and ideation own the process of knowledge creation. They may develop a sense of ownership and protect the knowledge that they help create.

An important implication drawn from knowledge creation is that knowledge creation practices need to solve problems stemming from knowledge creation in a dynamic evolutionary way. Boland (1979) made a similar point regarding the dynamic nature of institutions. Boland (1979) proposes that all social institutions exist to solve social problems. He argues that "dynamic theories must recognize false knowledge and a theory of dynamic behavior must specify the systematic way each individual responds to the discovery that his knowledge is false (p. 968)." We can make a similar point that knowledge creating firms need to become dynamic and respond to the new discovery and invention in a systematic way. Ideation is a tentative solution(Popper, 1982) to knowledge creation problems and knowledge workers engage in problem-solving through the ideation process. They eliminate errors by their methods of trial and error and experiences, but they face new problems as they solve the initial problem. Therefore, ideation becomes a dynamic evolutionary process of knowledge creation and problem-solving.

Current ideation in firms address problems in tacit and dispersed knowledge in knowledge creation. However, it does not fully address the governance Issues which are critical in knowledge creation(Foss and Mahnke, 2005). Ideation elicits tacit and dispersed knowledge from employees. Ideation provides a sense of process ownership to employees who initiate a

new project and participate in the process of knowledge creation by offering their tacit knowledge. Firms obtain dispersed knowledge from many individuals making knowledge hoilstic in ideation. However, it does not fully address governance issues which are critical in knowledge creation(Foss and Mahnke, 2005). Ideation needs to integrate governance and knowledge creation of the firm to elicit more productive efforts from knowledge workers in firms' knowledge creation. Well-designed ideation can become an institution of knowledge creation which contributes to better firm performance and national competitiveness.

Conclusion

This paper examined firms' knowledge creation and protection, and emergence of knowledge creating institutions. Discovery of knowledge adds to Σ and new invention increases δ. Firms are required to increase δ to create competitive advantages and profits. Techniques (δ) may be invented serendipitously. However, in today's economy they are more likely to be invented by useful knowledge (Σ), intensity of useful knowledge, access costs of knowledge and institutions. Universities, information technology and the knowledge sharing rule can reduce marginal access costs of knowledge. Scholars point out that organizational factors such as property rights assignment, incentive alignment and an individual's knowledge hoarding are important determinants of knowledge creation and protection. Patents, intellectual property rights and trade secrets are social institutions which protect knowledge for business firms. Therefore, a society or a nation needs to consider these factors carefully in molding its knowledge creating institutions. We conclude that ideation is a candidate for knowledge creating institutions.

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