Identifying and Capturing Knowledge from Networked Knowledge Spaces: Theoretical Insights and Applications

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Abstract: Knowledge Management (KM) has emerged as a new research discipline within organizational management. Encouraging and controlling the flow of knowledge is the central notion. This paper aims to conceptualize the significance of three broad factors that lead to knowledge transfer: Nature and form of knowledge, knowledge spaces, ICT supported networking. The emphasis will be on the influence of network structure and models of knowledge transformation during the transfer of knowledge. Knowledge is said to be dynamically transforming between tacit and explicit forms. Transformation of knowledge at various stages of the organization is highly dependent upon its transmission network as well as interaction between the concerned members. The nature of transmission is directly dependent upon the nature and flow capacity of direct and indirect communication paths of the network through which interactive knowledge transmission takes place. Interaction among the members or knowledge nodes can be viewed in two basic forms: 'receptive participation' and 'contributive participation'. There may be several instances where the combination of both at different levels can be observed and forms an environment of organizational learning. We attempt to develop a theoretical background for looking at KM from a network based perspective and identify the potential knowledge spaces. While networking these knowledge spaces, the structural features of the communication can play a vital role in creating an open access platform and promoting innovation. Technology and culture are the backbones of formal and informal communication where appropriate trade-off is required during designing the knowledge network and a fine synergetic balance between these two is necessary at the operational front. Networking knowledge gives a new dimension to organizational design and promotes a new research paradigm for the development of Digital Knowledge Ecosystems (DKEs). We apply learning from our study to develop a DKE in the Indian agriculture domain.

Keywords: Knowledge Management, Knowledge Transfer, Knowledge Network, Networked Knowledge Spaces

1 Introduction

Knowledge Management (KM) has emerged as a new discipline of organizational management in recent few years. Knowledge itself has different forms and nature which are either existing around or created through innovation and transformation for the purpose of application. Sustainability and growth are among the critical issues in business as well as social organizations where KM can play a pivotal role (Clark, 1999). KM refers to a systematic and organizationally specified process for acquiring, organizing and sharing both tacit and explicit forms of knowledge within and across the organizations (Scarbrough & Hislop, 1999). More specifically KM is defined as achieving organizational goals through the strategy-driven motivation and facilitation of knowledge workers[1] to develop, enhance and use their capability to interpret data and information (by using available sources of information, experience, skills, culture, character, personality, feelings, etc.) through a process of giving meaning to these data and information (Beijerse, 1999). The multiple perspectives covered by KM are evident from multiple combinations of two specific terms: knowledge and management as shown below:

a. Management of Knowledge, which implies an idea of a process through which knowledge is managed as a product.

b. Knowledge of Management, which suggests an idea of static state of intellect of an individual or an organization where skill of management is potentially stored.

c. Practicing Management with the help of Knowledge, which sees knowledge as the key input element for management practices.

[1] Knowledge workers are employees of a knowledge society, who are the owners of tools of production (Drucker)

d. Acquiring Knowledge by the practice of Management; which means knowledge gradually evolves with time and experience within the organization.

e. Accomplishing some task with the help of Knowledge and Management; here both are used as tools to achieve a given set of objectives.

Here, in all the perspectives, knowledge is perceived as a fundamental object to which the subject of management is applied to obtain some specific set of goals. Management itself requires some level of knowledge and hence KM can be viewed as a recursive process having interactive communication between the two distinctive elements 'Knowledge' and 'Management'. Knowledge is the key object and is an input resource for both KM as well as Organizational Management. Before going deeper into the different paradigms of KM, the basic building blocks of conceptual model of KM: 'Knowledge' and 'Management', have to be understood explicitly with respect to various conceptualizations.

The literal meaning of 'knowledge' as defined in the Oxford dictionary (2000) as 'the state of possession of information, understanding and skills that one acquires through education and experience: practical, medical or scientific'. Knowledge taxonomies are described in more detail in the next section. The term 'management' basically means 'business management', because large scale business was the first of new organizations to become visible (Drucker, 1994). In literature, 'Management' is synthesized as the strategy-driven motivation and facilitation of people, aimed at reaching organizational goals (Beijerse, 1999). Management is now seen as distinctive as well as an essential organ of all kinds of organizations irrespective of their nature, size and operations. The recent literature about KM relates it with information management systems which use a robust ICT infrastructure. Just like information is generally manifested in the knowledge when it moves up in the hierarchy, information management systems are transformed into knowledge management systems requiring more attention. KM requires four basic processes: creation, storing and retrieving, transfer, and application. The application of IT to KM initiatives reveals three common applications: coding and sharing of best practices, creation of corporate knowledge directories, and creation of knowledge network (Alavi & Leidner, 2001). Successful KM requires a skilful blend of people, processes and ICT, which can facilitate the evolution of a self sustainable digital knowledge ecosystem[2].

The level of intellectual capital[3] of any organization is primarily dependent upon the way knowledge flows inside and across the boundaries of the organization. Knowledge transfer depends basically upon four factors:

1. Nature and forms of knowledge,
2. The knowledge spaces,
3. The network of transmission, and an
4. ICT supported environment

Nature and forms of knowledge are not only important for the organizational outcomes they generate, but also important while developing a network based system for knowledge transfer. The nature of knowledge can be assessed by examining its evolutionary and applicability features. These include tacitness, explicitness and factors such as individual, social, declarative (know what), procedural (know how), causal (know why), conditional (know when), relational (know with) and pragmatic. Forms of knowledge describes state and structure in which knowledge exists, e.g. data and information, state of mind, object, process, conditions and capability (Alavi & Leidner, 1999; Alavi & Leidner, 2001; Wissens Management Forum, 2003; Beijerse, 1999; Kogut, 2000; Shariq, 1999; Shariq,1997).

The emergence of rapidly expanding technologies for distribution and dissemination of information and knowledge has brought to focus the opportunities for development of knowledge-based networks, knowledge dissemination, knowledge management technologies and their potential applications for enhancing productivity of knowledge work (Shariq, 1997). Network perspective of knowledge transfer provides two models of KM: the cognitive network model and the community network model (Scarbrough & Hislop, 1999). The cognitive model discusses the information processing view of the

[2]An organic system, which fosters ICT enabled knowledge exchange opportunities among individuals and communities, and allows dynamic knowledge exchange to evolve as environmental circumstances require.

[3] Intellectual Capital comprises two major elements: human capital (skilful people) and intellectual assets (codified knowledge) (Sullivan, 1999).

firm where valuable knowledge is located inside people's heads is identified, captured, stored and processed via the use of IT tools so that it can be applied in new contexts and the aim is to make knowledge inside people's heads widely available to reduce the threat of valuable knowledge assets literally "walking out of the door". In the community network model the approach is to share knowledge through active networking within and between occupational groups. The community network model emphasizes dialogue and sense making occurring through active networking (partly or fully enabled by IT), and the critical factor is trust, and collaboration. The cognitive model emphasizes linear information flows through static IT-based networks with the critical factor being technology. In both the cases, conceptual integration of network is the critical tool and application of information and communication technology (ICT) provides strength, stability and effectiveness to conceptually integrate the network. From the perspective of actor-network-theory (Tatnall & Gliding, 1999), a knowledge network can be viewed as connected composition of heterogeneous knowledge actors. Here knowledge actor may be considered static in the form of individuals or nodal institutions of a network, or dynamic and seen as carriers of knowledge e.g., humans and products[4]. In knowledge communities, Nodal Institutions are identified as observable unit of analysis in a knowledge network (Leydesdorff, 2003). The social process, its context and regulations are embedded within the knowledge space, ICT supported environment and networks. From the social perspective, these static nodes are viewed as members who develop relationships among themselves as a result of mutual interaction. These relationships can be mapped as direct and indirect links joining the member nodes through which they interact with each other. Physical and virtual form of transactions can easily be observed, measured and controlled by focusing attention upon theses links. Knowledge develops operationally at the level of such links in terms of reconstruction between the nodal institutions. Managing a knowledge network requires integration of managers in the system as one of the management nodes within the network from where these key nodes can facilitate efficient and smooth flow of knowledge objects.

Knowledge when separated from its originating space becomes a free and abstract object, and by the time it is captured by some other space, it does not remain in its original form. Some part of it is lost and some additional contents stick to it either as unintentional and undesired noise, or as intentional and desired 'quality' for the purpose of application. Transformation always happens when the knowledge is transferred between nodes (Shariq, 1999). Transformations can occur at either the sending or receiving nodes, or at the level of links connecting those nodes. Knowledge transfer is inherently interactive and dynamic and an adequate explanation of the basic building blocks requires the understanding of the cognitive processes happening at the nodes during knowledge transfer.

Social perspective on knowledge transformation focuses upon four basic and cyclic phases of knowledge transformation: socialization, externalization, combination and internalization; these are also known as knowledge spiral (Beijerse , 1999; Kazi, Wohlpart & Wolf, 2007; Nonaka & Konno, 1998). Internalization and externalization can be recognized as one the basic phases in the process of knowledge transformation specifically occurring at the nodal level. Member nodes and knowledge actors can be recognized as the drivers. 'Accessibility' and 'absorptive capacity' are two critically important characteristics of member nodes that play a crucial role in transfer of knowledge within the network (Scarbrough & Hislop, 1999). Besides these, 'emissive capacity' of the nodes can also play a vital role in knowledge sharing.

ICT can be view as a foundation platform as well as one of the possible vehicles for the Network based knowledge system. Technologies equip the network with the capacity of mitigating the negative outcomes as well as to capitalize on the positive opportunities. Use of ICT provides a strongly favourable environment and acts as a boost to the process of knowledge transfer. In fact most of the ICT enabled networks act primarily as a medium of transfer for the codified knowledge. Explicit or codified contents can be captured and communicated much easier through wired network. The resulting digital network can be further developed in the form of a digital ecosystem, which display associative and autopieotic properties (Sarkar & Rajgopalan, 2007). The integration of knowledge in this system generates the concept of a 'digital knowledge ecosystem'. Any ecosystem can be viewed as an organic system with changing environment where interactive communication takes place among heterogeneous organic members. Here knowledge is the fundamental element whose recognition and systematic channelization in the network is much emphasized for imparting usefulness to the knowledge.

This paper is organized into six sections. After this introduction to 'knowledge management', the second section is aimed at understanding the 'presence of knowledge' from various perspectives. Section three discusses the embodiment of knowledge under existing social spaces and its mapping

[4] Humans and products carries the knowledge in the form of mental constructs and physical constructs (embedded features) respectively.

with significant network spaces. Section four compares informal and formal networks with two opposite viewpoints: mechanistic and organic, and the role of ICT at various levels. In section five we study a illustrative case of a knowledge management project in the Indian rural domain with the help of synthesized theoretical framework of a networked digital knowledge ecosystem. The focus is on leveraging from knowledge resources by using a hybrid system design which involves adoption of ICT. The paper concludes by pinpointing the potential role of ICT and networking in capturing existing knowledge and creating new knowledge.

2 Identifying Knowledge

Identity requires Existence. Existentialist thinking represents protest against alienation of 'knowledge', its loss of identity and its transformation into an object. Knowledge is identified as a key resource outside the human and social system. Human awareness, observation and interpretation of its surrounding results into a certain set of mental constructs embodied into human mind (Beijerse, 1999). These mental constructs can be detached and codified and presented as social constructs (Donald, Mason, Robson, Lefrere & Collier, 2003), in the form of data and information. Information moves up in a hierarchy and is transformed into knowledge (Alavi & Leidner, 1999) when its utility is provided value and weight by users. While managing knowledge, it is important to discuss how the knowledge is identified, i.e. whether 'X' is stamped (recognized) as 'knowledge' or 'knowledge' is stamped into 'X'. Knowledge can be perceived as a virtual organizational object which can influence the internal and external environment of the system and dictates the subject of management. It has specific characteristics, which can be easily identified only if associated with some conscious or unconscious physical means. The physical manifestation of knowledge can be recognized either as an embodied state (Hovland, 2003) inside a manufactured product (Hedlund, 1994) which describes its external design, physical features and sense of utility, or as schedules and steps of operations happening within and across the organizations on which organizational performance depends.

Acting as a prerequisite of human action, Knowledge is intrinsically linked to people and created dynamically through changes to cognitive structure (Wissens Management Forum, 2003). Apart from this psychological categorization, knowledge can be categorized into 'tacit' and 'explicit' forms on the basis of articulability (Kazi, Wohlpart & Wolf, 2007; Nonaka & Konno, 1998; Novak & Wurst, 2005). Tacit knowledge is embedded in individual actions and derived from embodied experience, ideals, and values of the individual. It is highly personal, hard to formalize and difficult to communicate. Explicit knowledge is the codified form of data, information, scientific formulae, specifications, manuals etc., which can be easily captured and transmitted formally and systematically. Alternatively we can say that explicit knowledge is derived from the tacit knowledge process by categorized context and specifications (Figure 1). The 'Declarative' context describes the 'know about' phenomena, and answers the questions starting with what, which, who etc. 'Procedural' context describes the process, 'Causal' context describes the reasons and justification, 'Conditional' context describes the prerequisites for happening of any event and 'Relational' context defines social and professional the relationships between the participating entities (Alavi & Leidner, 2001). Thus explicit knowledge is implicit knowledge, better articulated through defining the context and setting. Explicit knowledge requires immediate capture and stored and eventually owned by some entity. The 'ownership' may be individual or collective, each having their respective features and identity of knowledge (Figure 2). The control of an 'object' appears to be the key characteristic of the phenomena of 'ownership' (Cummings, 2003). 'Knowledge' as a static object can be recognized as a 'state of mind' within the individuals. At a certain level, 'state of mind' turns out to be a 'capability' to perform some task. A set of capabilities are recognized as a 'condition' for accessing the resources and authoritative power. At certain instances, knowledge is owned 'collectively' by a social group or an 'organization' and recognized as a key 'asset' responsible for the organizational economic growth. Economic perspective identifies knowledge as a 'value' based technological or intellectual asset, which is either incorporated within any product or individual of the organization and constitutes a part of 'Intellectual Capital' (Kazi, Wohlpart & Wolf, 2007; Lai & T'sai-hsinChu, 2000; Shariq, 1997; Sullivan, 1999). The value of intellectual capital is often intangible.

Hence knowledge is evolved as a critical form of 'resource' which can either be protected by Intellectual Property Rights (Kazi, Wohlpart & Wolf, 2007; Randeree, 2006), or can be brought over to the open access platform (Suber, 2004) based on the respective business and social requirements. 'Resource' perspective of Knowledge requires short term and long term strategic planning as a part of management. The standardized process of management can be recognized as a 'systematically codified strategy' (Shin, 2004) of an organization, which can again be seen as high quality knowledge. Thus, knowledge can be the key economic variable of the firm and is expected to create two basic functions

for generating intellectual capital: value creation and value extraction (Wissens Management Forum, 2003; Cummings, 2003; Despres & Chauvel, 1999; Shin, 2004; Sullivan, 1999). Knowledge is said to be sticky in nature. The key properties of knowledge include: tacitness, dispersion, context, specificity, transferability, reception or absorption and complexity (Quintas & Jones, 1997).

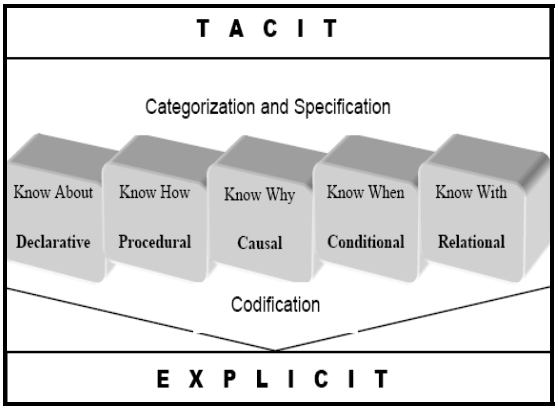

Figure 1.Transformation of knowledge from 'Tacit'to 'Explicit' form.

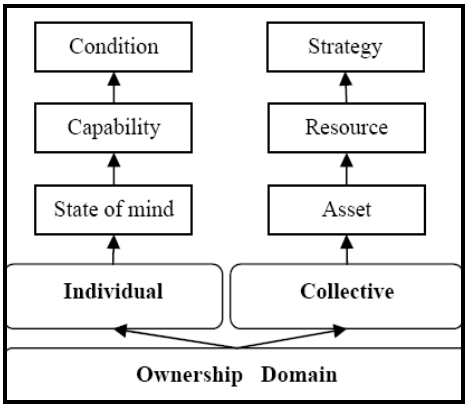

Figure 2. Defining knowledge based on ownership

After the discussion about the recognition of existing knowledge, it is important to look out for opportunities for sharing as well as creation of new knowledge. Studies reveal that the construction and sharing of knowledge is an inherently social process in which the learner actively constructs meaning, through a process of information exchange and social interaction with the people (Cummings, 2003; Donald, Mason, Robson, Lefrere & Collier, 2003; Kazi, Wohlpart & Wolf, 2007; Novak & Wurst, 2005; Tolsby & Kirkebak, 2007). As a part of knowledge management, creation and sharing of knowledge requires ideal and favourable knowledge spaces supported by integrated technology.

3 Identifying Existing and Potential Knowledge Spaces

These are the spaces or regions where knowledge remains intrinsically embedded as a virtual object. While navigating through the 'knowledgescapes'[5], we can find specific isolated or integrated spaces, which can be categorized according to the activities concerned with knowledge e.g., creation, storage, sharing, transfer and application. Knowledge spaces are closely associated with the nature and form of knowledge as discussed in the earlier section. Tacit knowledge is highly personal; it originates and exists within the minds of the individual and specific collective practices of the organization. While explicit knowledge can be found in codified documents, research literature, books, journals, blueprints, yellow pages, template, virtual memories of computers and databases, etc. These are unconscious static storage spaces where one can access and retrieve knowledge. Any naturally existing unconscious substance or manufactured product can also be perceived as an embodiment of information and acts as a repository of knowledge. From these static knowledge storage spaces knowledge can be accessed, retrieved and processed by users through the interaction of their internal and external cognition (Scarbrough & Hislop, 1999), resulting in the construction of new forms of knowledge. Knowledge Construction may happen either at an individual level or at the collective level. Collective participation always promotes innovation and sharing of knowledge across multiple members of the group. The group can be recognized as a set of individuals, or a group of organizations working together and exchanging knowledge across their formal boundaries via interactive communication. Such groups are often termed as 'Knowledge Communities' (Assimakopoulos & Yan, 2005; Prothmann, 2006) or Communities of Scholarship (Bendersky & McGinn, 2007). Knowledge Communities are groups of

[5]Knowledgescapes refers to the cognitive spaces, we humans navigate as we pursue and are pursued by knowledge (Shariq, 1999).

people with a common passion to create, share, and use new knowledge for tangible business purposes (Prothmann, 2006). Community of Scholarships can be understood as inter-disciplinary organizational bodies, where cross disciplinary understanding stems from the sharing based foundation of knowledge itself. In a much broader social perspective, such communities are identified as 'Community of Practice (CoP)'. CoP are commonly constituted through shared work practice over a period of time where soft knowledge is transferred through situated learning and all the participants have a common understanding of collective practices and goals (Prothmann, 2006). Such communities are supposed to create and share knowledge under certain systems for their mutual benefit. The physical locations accommodating the activities carried out by these communities can be named as 'intellectual geography' (Sawayer & Rosenbaum, 2000).

In the context of knowledge sharing, knowledge spaces can be related with the Japanese concept of 'Ba' (Nonaka & Konno, 1998), which is thought as a shared space for emerging relationships and promotes easy knowledge transfer. This space can be physical (e.g. office, dispersed business space), virtual (e.g., e-mail, teleconference), mental (e.g., shared experiences, ideas, ideals), or any combination of them. Such spaces are often seen as the repositories and carriers of intellectual assets and organizational culture. Within these social spaces, it is quite easy to find the knowledge transformations spaces where cyclic events of socialization, externalization, combination and internalization occur (Kazi, Wohlpart & Wolf , 2007; Nonaka & Konno, 1998) (Figure 3). Knowledge spaces, when viewed in the domain of a knowledge network, contain two basic elements of consideration: 'knowledge nodes' and 'transferral links', each having their specific characteristics (Figure 4).

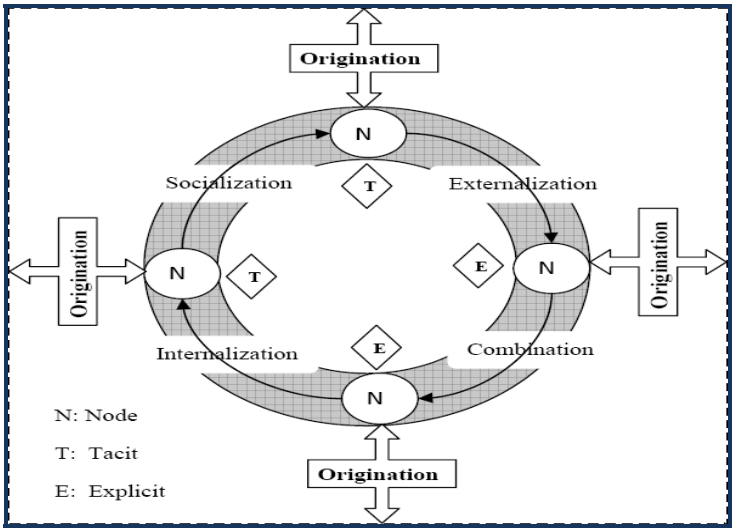

Figure 3. Social Spaces In A Network Perspective[6]

The 'knowledge nodes' can be seen in the form of a conscious element, like an individual, group, organization or a community of organizations. Nodes can be perceived as fundamental knowledge-actors who can actively control the knowledge creation and its flow across the network. The 'transferral link' is the basic travel path of information and knowledge in various forms. It can be either virtually embedded in the form of 'social relationships' or physically constructed as wired transmission lines. Such links can also be viewed as a collective platform or as a different kind of 'intermediate node' in the network where the rest of the knowledge nodes can interactively participate to perform activities like knowledge creation and sharing.

Knowledge spaces when viewed from the activity viewpoint can be categorized according to the importance of roles of either nodes or links (Table 1). Activities where characteristics of nodes play an important role are: origination, construction, absorption, adoption, adaptation and application of knowledge. Activities where links are considered important players are: accession, transmission, sharing, and transformation of knowledge. However some degree of overlap can also be observed in some activities where both nodes and links contribute. For example, absorption rate of knowledge by

[6] Developed from Nonaka's Knowledge Spiral (Nonaka & Konno, 1998).

the node is highly influenced the rate of knowledge flow across the links; Sharing and transmission through the link is highly dependent upon emissive and absorptive capacity of the participating node.

Table 1. Categorizing Activities at the Network Space

Activity-Space	
Nodes	**Links**
Origination Creation/ Construction Emission Absorption Adoption/ Adaptation Application	Accession Transmission Sharing Transformation (Socialization, Externalization, Combination & Internalization)

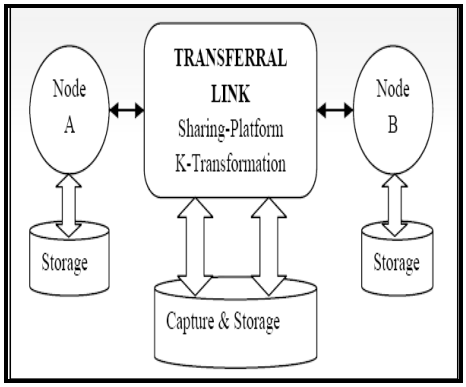

Figure 4. Network Spaces for Knowledge

4 Networking of Knowledge Spaces and Significance of ICT

Knowledge networks can promote innovation and construction of new knowledge from existing knowledge. It requires a suitable environment and proactive knowledge spaces, which can be framed again as future source of knowledge creation and also encourages knowledge sharing (Kazi, Wohlpart & Wolf , 2007; Novak & Wurst, 2005; Tolsby & Kirkebak, 2007) and organizational learning (Hovland, 2003). During the process of networking the knowledge spaces it is essential to see the expected nature of communication between the knowledge nodes. The consideration can be given on two basic methods of communication: 'Arrow approach' and 'Circuit approach' (Clampitt, 2001). The 'arrow approach' sees communication as a one way activity and focuses on the sender of the content, while the 'circuit approach' can be seen as a feedback based network loop and a dynamic interplay between sender and receiver nodes. These approaches can be compared with top down push and bottom up pull and contrasted with fundamentally distinguishing assumptions; "Effective expression is effective communication" and "Good Understanding is effective communication" in respective cases. Effective expression requires internal willingness and ICT supported emissivity of the knowledge nodes for knowledge sharing while understanding requires accessibility and absorptive capacity of the receiving knowledge node. Besides these nodal requirements, transferral links should possess adequate flow capacity and support the communication. Despite acting as a foundation and nodal interface, ICT can have enormous potential to widen the flow capacity and provide knowledge transfer opportunities to the participating knowledge nodes in the network; as a result the quantity of technologically pushed knowledge contents sometimes exceeds the requirements of a strategically pulled knowledge requirements (Katsoulakos & Zevgolis, 2004). Therefore, from an economic point of view, it is important to match the flow capacity of the links with the emissive capacity and the absorptive capacity of the knowledge nodes. Networks can be seen as a means of collaboration between organizations and groups in production, retention and dissemination of knowledge with a common vision. Dissemination of knowledge requires some 'time' from its inception to implementation. ICT is one of the effective foundation platforms which can facilitate e-collaboration and shorten this 'time' and economically justifies itself (Ortiz) ICT uses powerful networking and interactive tools like e-mailing, video-conferencing, instant computer to computer messaging systems, mobile telephony, voice chats, etc. Studies have already revealed that the use of internet not only supplements the mutual interaction among the people (Wellman, Haase, Witte & Hampton, 2001), but also results into the strengthening of weak ties and creates newer ones (Rajagopalan & Sarkar, 2008) as a positive externality (Clark, 1999; Clampitt, 2001) contributed by the concerned social network.

The nature of the network has a critical influence upon knowledge transfer and its transformation across the transfer channels. Communication, exchange and activities within the networks may be undertaken either through formalized channels and procedures, or in an informal and unstructured way, or a combination of both at certain levels. Locally based networks are likely to be informal in nature

where personal exchanges take place between the interdependent members predominantly based on trust and commitment. Within these networks, Knowledge exchange is supposed to be constructed by dynamic interplay between the members. Global networks are generally formally constructed (Ruskulis, 2002). Formally established networks are obliged to communicate in a formal way where nodes are contractually positioned under compliance in a vertical hierarchy with consistent conditions, pre-assigned tasks, pre-specified outcomes and static relationships (Table 2). Including alien nodes in the network from geographically distant and unseen regions is a critical factor for ensuring trust and commitment levels in an informal local network. In contrast, global networks with preconditioned contractual obligations from the respective nodes, alien or familiar, ensure its' own stability and sustenance.

Table 2. Mechanistic Vs Organic Network

	Mechanistic/Formal	**Organic/Informal**
Conditions	Stable, Consistent	Changing, Creative
Network Nodes	Highly Specialized, Independent	Interdependent
Links	Depending upon functional relationship, Static	Continuous adjustments through interaction, dynamic
Structure	Vertical Hierarchic,	Lateral Hierarchic,
Sharing	Contractual	Trust
Location of Knowledge	Reinforced at the hierarchic positions	Spread everywhere in the network
Knowledge representation	Static, Pre-specified	Dynamic, Constructed
Flow Control	Compliance	Commitment
Outcomes	Pre-specified	Innovative

5 Application Link: The NAIP-Knowledge Management System

In an effort to promote technology-led-pro-poor growth, and diffusion of new technologies for improving agriculture yield and rural livelihood in India, a multipronged effort has been initiated by Indian Council of Agriculture Research (ICAR), with the assistance of World Bank, called the NAIP[7]. One of the many objectives of this project is to create a knowledge management system with the agriculture domain experts and practitioners from the agriculture extension system[8] based in the villages throughout the country. The NAIP's approach is to create a knowledge organization and facilitate knowledge management that allows the development of highly integrated approaches between agriculture research and education sector with established extension processes such as Krishi Vigyan Kendra (KVK), emerging actors in private sector extension and with organizations promoting rural information access centers. Knowledge communities of practice from geographically and culturally disparate research and academic institutes having common interests in agriculture come together using a digital ecosystem-based IT infrastructure which has a hybrid network structure between mechanistic and organic. The network created by the knowledge nodes is supposed to develop new and revived linkages between research and education sectors with agriculture extension, through the use of ICT mediation and contemporary practices of knowledge management.

5.1 Network Segmentation: Content Community and Target Community

The adopted process under NAIP-Knowledge Management project is to blend the multidisciplinary technological and research oriented knowledge organizations in order to connect the users through a series of software interfaces to enable multi-mode delivery. This group of knowledge organizations can be termed as the 'content community' who are responsible for assimilation of static knowledge and certifying dynamic knowledge or practice based knowledge from 'target communities[9]' (discussed

[7] National Agriculture Innovation Project, http://www.naip.icar.org.in/

[8] For example, Kisan Vigyan Kendra (KVKs) for providing scientific knowledge to the agriculture community.

[9] The terminology 'target community' and 'content community' has been developed by the authors in an effort to characterize the different nodes in the network.

later). The member institutions of this community are functionally clustered into three main groups with different roles and responsibilities. The first group[10] consisting of IITK, IITB, IIITM-Kerala and NAARM-Hyderabad, is supposed to play the role of ICT resource institutions. Private sector partners including NGOs in applied IT development are expected to be brought on as consultants/contractual service providers for short term requirements of the partners. As digital knowledge ecosystem develops, it is expected that such partners would voluntarily participate based on mutual benefits. The second group of institutions consisting of G B Pant University of Agriculture and Technology and University of Agricultural Sciences-Dharwad, supposed to provide agriculture information and learning resources. The third group consisting of ICRISAT-Patancheru[11] and NAARM-Hyderabad would facilitate interaction among agriculture research scientists and educators as well as among the technology developers. So we can see there are many separate nodes and group of nodes of similar functional area working together as a community of practice and acts as a significant source of 'explicit knowledge'.

In addition, there is tacit content which is contributed by 'target communities' who are at the receiving end in the form of KVKs and other deployment partners, where farmers and agriculture workers can interactively communicate, access and exchange knowledge content. The 'target community' is responsible for dissemination of knowledge to the farming community who would apply the learning in their daily practices. Most of the tacit content is supposed to be provided by the rural local communities at the receiving end enabling dynamic information to be captured in the digital knowledge ecosystem (DKE). Thus, while this 'target community' is predominantly the 'user group', they are also the knowledge creators through their active participation and sharing experience in the DKE. 'Mutuality' in knowledge sharing is the motivation for participation of both the communities within and between themselves. This network is formed only on the grounds of 'common' interests. Content and target communities are identified, not selected and so because of the existing nature of the respective communities.

5.2 Power distribution and creation of hierarchy

One of the most critical issues in knowledge sharing in the network is distribution of power across the actor nodes to control knowledge flow. Power structure, which decides the nature of hierarchy and direction of flow across the network links, can be addressed by balancing the context of 'open access' (Suber, 2004) and content security implications (Randeree, 2006). Putting access pre-conditions upon knowledge content may pose barriers to the flow and restrict the undesired diffusion of knowledge, which is a critical aspect from 'security' vantage point, while open access strategy is critical from the 'sharing' vantage point within the network and can promote intentional 'effusion' of knowledge.

Considering the hierarchical dimension of the knowledge network, nodes can be clustered into two operative segments; a cluster of 'content community' which predominantly acts as constructor and controller of the knowledge flow; and a cluster of 'target community' who are predominantly users of the created content and are being controlled by the former cluster. Content sharing is supposed to be the obvious process within the 'community' as reflected from its concept of origination into its existing form, while security is critical to the content transfer across the boundaries of different communities. There may be certain nodes in both the segments, which have the role of both sender as well as receiver and communicate with each other in order to create knowledge content within the boundaries of their respective clusters. In an effort to create a functional e-community of practice among experts and practitioners in the agricultural domain to promote a process of autopoietic social learning, we propose a network structure which contains a combination of both lateral (within the community) as well as vertical (across the community) hierarchy in the knowledge network depending upon the nature of knowledge flow (Figure 5).

The interactive interface and medium of content transfer is provided by an ICT enabled foundational platform, which acts as a repository of knowledge content and also as a virtual administrative body. Knowledge nodes under the respective communities have to possess certain conditions to enter the network and to use the content stored in the integrated knowledge repository. Communication within the network has the potential to follow both arrow and circuit approaches according to the position and responsibility of the respective nodes. However, in order to proceed from

[10] IITK: Indian Institute of Technology, Kanpur; IITB: Indian Institute of Technology, Bombay; IIITM: Indian Institute of Information Technology and Management; NAARM: National Academy of Agricultural Research and Management.

[11] ICRISAT: International Crops Research Institute for the Semi-Arid Tropics

ICT enabled network spaces towards a digital knowledge ecosystem (Bray, 2006), there is a continuous requirement of exploration and exploitation of knowledge to develop a dynamic, organic, and demand led knowledge sharing system. Such a network transformation can minimize the strategic influence of arrow approach and maximize the influence of circuit approach of communication. Incorporating the existing and easily grasped depictions of cultural patterns within the communities into the network practices can essentially foster inclusive learning, and participative knowledge sharing. Communications of the informal networks can also be systematically embedded and formalized into a standard knowledge sharing platform integrated with the formal knowledge network using semantic tools.

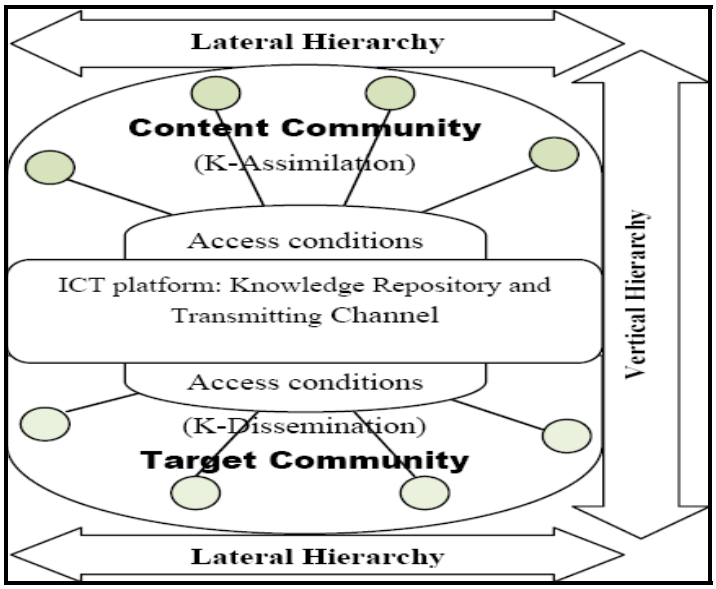

Figure 5. Proposed Knowledge Sharing Network.

The NAIP-KM knowledge sharing platform is now being formalized through extensive interactions with all its stakeholders, the content and target communities, as well as other potential nodes such as corporate bodies involved in rural business and rural development bodies including NGOs. Understanding the social value creation is critical at this stage of the NAIP-KM endeavour.

6 Conclusion

Knowledge, communication and social networks constitute the central dimensions of knowledge management. Knowledge management has been transforming from information management mechanics to a social sharing culture, enabling the organization to consistently create new knowledge, disseminate it through the organization and manifest it into technologies and products. Knowledge spaces are the nodal elements of the knowledge network and ICT is the key enabler to foster capacity generation at the links and facilitate flow across the knowledge nodes. Sharing of knowledge including existing and potentially identified knowledge spaces within network structures is the initial step to capture knowledge. Appropriate networking of knowledge spaces is essential to develop an organic knowledge architecture assuring the smooth flow of captured knowledge with secured and controlled diffusion. ICT plays a foundational, embedded as well as complementary role for transforming the knowledge from existing static form to the fluid state and enables it to flow to the unreached positions of the network. The structure of network embedded with socio-technical characters has many critical aspects of its sustainability. A network having organic structure and decentralised control has the presumption that all the members are actively and complementarily playing their roles and capable of dynamically changing their functions and responsibilities responding to the change in network environment. To qualify for entering into the organic network, actor nodes have to possess high level expertise and multifunctional flexibility to adapt to the dynamic conditions. Organic state is characterized by its fluidity and dynamism, and actor nodes having aforesaid features provide sustainability to the whole network. Thus the network within the ‘expert’ content community discussed in this paper appears comparatively more efficient and sustainable while the network formed within the

'naive' target communities seems to be unstable in nature. However, the network created between the two communities certainly diffuses the character of sustainability and stability through the sharing of knowledge and experience. The ultimate aim is to have a changed knowledge management scenario, where poorly informed spaces became knowledgeable proactive knowledge sharing nodes, demoralized knowledge actors transformed into motivated and absorptive ones, and dispirited mechanistic organizations reinvigorated into organic learning systems. The approach towards one such effort in the Indian agriculture domain has been briefly described in this paper, after synthesizing the pre-requisites of such a system from literature.

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References

Alavi, M. & Leidner, D. E. (1999). Knowledge Management Systems: Issues Challenges and Benefits. *Communications of Association for Information Systems*, 1 (7), 1-37.

Alavi, M. & Leidner, D. E. (2001). Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues. *MIS Quarterly*, 25 (1), 107-136.

Assimakopoulos, D & Yan J. (2005). Social Network Analysis and Communities of Practice. In: Coakes E. & Clarke S. (Eds.), *Encyclopedia of Communities of Practice in Information and Knowledge Management,* London (pp. 474-480): Idea Group Inc.

Beijerse Roelof P. uit. (1999). Questions in Knowledge Management: Defining and Conceptualizing a Phenomenon. *Journal of Knowledge Management,* 3 (2), 94-109.

Bendersky, C. & McGinn, K. L. (2007). Incompatible Assumptions: Barriers to Producing Multidisciplinary Knowledge. *Working Paper 08-044*.

Bray, D. A. (2006). Designing a Knowledge Ecosystem: A Solution for Organizations Confronting Hyperturbulent Environments. *Queen's University Annual International Knowledge Management Doctoral Consortium*, November 2008. Atlanta.
Clampitt, P. G. (2001). *Communicating for Managerial Effectiveness*. USA. Sage Publication

Clark, C. H. (1999). The Growth of Canadian Knowledge Networks. *Journal of Knowledge Management*, 3 (4), 304-307.

Cummings, J., (2003). *Knowledge Sharing: A Review of Literature*. OEDCM, The World Bank.

Despres, C. & Chauvel, D. (1999). Knowledge Management(s). *Journal of Knowledge Management*, 3 (2), 110-120.

Donald, M. N., Mason, J., Robson, R., Lefrere, P. & Collier, G. (2003). Revolution in Knowledge Sharing. *Educause Review*, *Sept/Oct 2003*.

Drucker, P. F. (1994). The Age of Social Transformation. *The Atlantic Monthly*, *Nov. 1994*.

Hedlund, G. (1994). A Model for Knowledge Management and N-form Corporation. *Strategic Management Journal*, 15, 73-90.

Hovland, I. (2003). Knowledge Management and Organizational Learning: An International Development Perspective; An Annotated Bibliography. *Working Paper 224*, *August 2003,* Overseas Development Institute, London.

Kazi, A. S., Wohlpart, L. & Wolf , P. (2007). *Hands on Knowledge Co-Creation and Sharing: Practical Methods and Techniques*. A book by the knowledge board community for the global knowledge community, Knowledge Board, Germany.

Katsoulakos, P. & Zevgolis, D. (2004). Knowledge Management Review 2004. *K-Net, version 3e.*

Kogut, B. (2000). The Network as Knowledge: Generative Rules and Emergence of Structure. *Strategic Management Journal*, 21, 405-425.

Lai, H. & T'sai-hsinChu. (2000). Knowledge: A Review of Theoretical Frameworks and Industrial Cases. *Proceedings of the 33rd Hawaii international Conference on System Sciences*.

Leydesdorff, L. (2003). Communication and Knowledge: How is the Knowledge Base of an Economy Constructed? *15th Annual Meeting of the Society for the Advancement of Socio-Economics (SASE)*, 27 June 2003. Aix-en-Provence.

Nonaka, I. & Konno, N. (1998). The Concept of 'Ba': Building a Foundation for Knowledge Creation. *California Knowledge Management Review*, 40 (3), 40-52.

Novak, J. & Wurst, M. (2005). Supporting Knowledge Creation and Sharing in Community Based on Mapping Implicit Knowledge. *Journal of Universal Computer Science*, 10 (3), 235-251.

Ortiz, J. (n.d.). Measuring the Economic Impact of E-Collaboration", Retrieved 13th June, 2008, from http://www.igi-global.com/files/prefaces/ijec%20preface%203(3).pdf.

Prothmann, T. M. (2006). Knowledge Communities, Communities of Practice, and Knowledge Networks. *Free University Berlin, Germany* (pp. 264-271). Idea Group Inc.

Quintas, P., Lefrere, P. & Jones, G. (1997). Knowledge Management: A Strategic Agenda", *Long Range Planning*, 30 (3), 385-391.

Rajagopalan, R. & Sarkar, R. (2008). Digital Networks and Sustainability: Do We Need Government. *IEEE,* 49-54.

Randeree, E. (2006). Knowledge Management: Securing the Future", *Journal of Knowledge Management*, 10 (4), 145-156.

Ruskulis, O. (2002). Facilitating information dissemination and exchange through formal and informal networking", in: Gandelsonas, C., (ed.), *Communicating for Development: Experience from the Urban Environment*. (pp. 64-77). ITDG Publishing, London.

Sarkar, R. & Rajgopalan, R. (2007). Digital Ecosystems: Community Networks or Networked Communities. *OPAALS Conference 2007*.

Sawayer, S. & Rosenbaum, H. (2000). Social Informatics in the Information Sciences: Current Activities and Emerging Directions. *Information Science Research*, 3 (2), 89-95.

Scarbrough, H. & Hislop, D. (1999). Knowledge Management and Innovation: Networks and Networking. *Journal of Knowledge Management*, 3 (4), 110-120.

Shariq, S. J. (1999). How does knowledge transform as it is transferred? Speculations on the possibility of a cognitive theory of knowledge-scapes. *Journal of Knowledge Management*, 3 (4), 243-251.

Shariq, S. J. (1997). Knowledge Management: An Emerging Discipline and a Professional Society for Facilitating Adaptive Change to Suitable World Order in 21st Century. *The first International Conference on Technology Policy and Innovation, July 2-4.*

Shin, M. (2004). A Framework for Evaluating Economics of Knowledge Management Systems. *Information and Management*, 42, 179-196.

Suber, P. (2004). Creating an Intellectual Commons through Open Access. Retrieved June 15th, 2008, from http://dlc.dlib.indiana.edu/archive/00001246/ 01/ suberrev052804.pdf.

Sullivan, P. H. (1999). Profiting from Intellectual Capital. *Journal of Knowledge Management*, 3 (2), 132-142.

Tatnall, A. & Gliding, A. (1999). Actor Network Theory and Information Systems Research, *Proceedings of 10th Australian Conference on Information Systems*.

Tolsby, J. & Kirkebak, P. (2007). Partaking as a Tool for Knowledge Creation and Sharing in Practice. *Electronic Journal of Knowledge Management*, 5 (1), 115-122.

Wellman, B., Haase, A. Q., Witte, J. & Hampton, K. (2001). Does the Internet Increase, or Supplement SOCIAL capital? Social Networks, Participation and Community Commitment", *American Behavioral Scientist*, 45 (3), 436-455, SAGE Publications.

Wissens Management Forum, Austria. (2003). An Illustrated Guide to Knowledge Management. Retrieved June 10, 2008, from www.wm-forum.org.