

A Study on Knowledge Sharing in Distributed Environment

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Abstract : This exploratory study aims to investigate issues that, according to the Nonaka's theoretical model, are believed to hold significant ramifications on the effectiveness of creating and sharing organizational knowledge among distributed workers. These include changes in accessibility of knowledge with different levels of implicitity, and the choice of communication media as a knowledge management channel. Related data were gathered from distributed-workers in Japan through interviews and a survey questionnaire. Data analysis revealed changes in the dynamics of internal and external interactivity, in the accessibility of necessary knowledge, and in the reliance on electronic media for knowledge exchange. The findings' implications are discussed from the perspective of knowledge creation and sharing, and further suggestions have been made for the direction of future research efforts.

Key words : Distributed environment, Knowledge Sharing and creation, Global company, Information and Communication Technology, Virtual organization

1. Introduction

Due to the globalization of market and rapid technological changes, organizations today face severe competition. Thus, to face this severe competition, organizations seek to build strategy that concentrate their core confidences, and at the same time, entrust other resources to outsourcing companies. Through this strategy, they seek to reduce costs, accumulate and develop core confidences such as organizational knowledges and core technologies. To occupy global market, global companies and virtual companies that perform job-related activities on virtual space have increasingly emerged. And, currently, e-business also that can do business without physical market boundary has been recognized as an critical strategy for successful business on global market(Bovet, 2000).

For these reasons, we are frequently witnessing the emergence of more distributed organizational structures on physical(or cyber) space. And, the concept of this distributed-work arrangement has received a great deal of attention in the business world(Higa, 2002; Shin, 2000). In fact, business such as logistics service have traditionally had distributed organizational structure. Because logistics service is to link production with consumption, they usually have a central office and several branch offices that are distributed over wide area. And currently, other organizations also have sought to downsize their body, and at the same time, spur to establish distributed business

environment in which people work away from central office in various set-ups. Especially, information and communication technologies(ICTs) have facilitated adoption of this arrangement. Advances in ICTs have made the Internet and email popular media in both the business world and daily life. They have enabled communication among distributed-workers, and to perform job-related activities on distributed environment. That is, today's ICTs are widely recognized as indispensable tools for successful implementation of distributed-work(Shin, 2000).

In the mean time, knowledge has become the driving force of the new society, in which effective use and management of organizational knowledge for formulating strategies and creating products and services is a key to business success (Gold, 2001). Production and service more and more depends on information and knowledge. To survive such environment, organizations should acquire/learn new knowledge. For these reasons, knowledge management(KM) has become an critical issue that has been studied in various disciplines.

However, although today's distributed environment is one of important strategies for successful implementation of business, KM in distributed environment have little been studied. In the KM research area, knowledge creation model by Nonaka and Konno(1998), has been widely recognized as the representative KM model(Cohen, 1998). These knowledge creation researchers have always argued that effective face-to-face communication among workers and

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apprenticeships in and out of an organization are critically needed for organizational knowledge sharing (Inkpen, 1996; Nonaka and Konno, 1998). However, since distributed-work distances workers from their main organizations and co-workers, these social interactions are severely limited. Especially, according to Jarvenpaa and Ives (1994), effective facilitation of knowledge creation and sharing among distributed entities is instrumental for the success of this organization and for improved worker productivity. Nevertheless, previous research have not presented any suggestions for effective knowledge sharing in this environment.

The objective of this research was to conduct an exploratory investigation of factors that are expected to significantly affect the dynamics of knowledge sharing and creation among workers who perform job-related activities in distributed environment through ICTs. Draw on the SECI model (Nonaka, 1994) that theoretically explains the reproductive process of organizational knowledge, three types of changes incurred by distributed-work—namely, social and task relationships, accessibility of organizational knowledge, and the usage of electronic media as a knowledge management channel—were expected to have significant ramifications on knowledge management. Therefore, in this exploratory study, we first analyzed how this arrangement caused changes in their dynamics, and corresponding implications of the findings were discussed from the perspective of distributed knowledge creation and sharing. Based on the analysis, we proposed future research directions that could expand our work.

2. Literature Review

According to Webster's Dictionary, knowledge is "the fact or condition of knowing something with familiarity gained through experience or association." However, the meaning of knowledge is polysemous, multi-dimensional and philosophical (Nonaka and Takeuchi, 1995). Although, it can be easy and quick to transfer information from one place to another, it is often very difficult and time-consuming to transfer knowledge from one person to another. That is, knowledge is different from information and is not capable of the sorts of friction-free movement usually attributed to information.

Drawing on Polanyi's work (1962), Nonaka (1994) suggested that knowledge could be divided into explicit and tacit. Explicit knowledge (i.e., research reports, specifications,

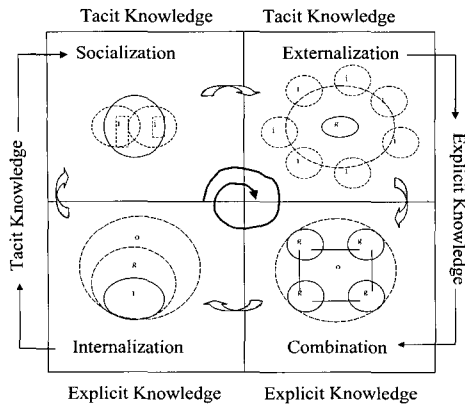
and simple software codes) needs little interpretation and can be communicated easily in words and numbers. In contrast, tacit knowledge (i.e., subjective insights, scientific expertise and intuitions, and operational know-how) is highly personal, and hard to formalize, and requires a high degree of interpretation. Explicit knowledge may be more related to declarative, content-oriented, or "know-what" type of knowledge; meanwhile, tacit knowledge may be more associated with procedural, process-oriented, or "know-how" type of knowledge (Becerra, 2001).

Much of the associated research on knowledge management focuses on knowledge creation and sharing (or re-use) (Cohen, 1998; Markus, 2001; Ruggles, 1998). Nonaka (1994) argued that, if knowledge management activities are simplified in terms of input-process-output, knowledge creation (input) and distribution and sharing (output) are more important than the process when it comes to building an active and dynamic understanding of an organization. Much of the knowledge creation research has investigated social conditions and dynamics of new knowledge. Nonaka (1994) explained it from the perspective of four knowledge conversion processes: socialization, externalization, internalization, and combination.

As for the related research of knowledge sharing and re-use, the importance of social interactions has been discussed by many studies (i.e., Alavi and Leidner, 2001; Nonaka, 1994). It was suggested that knowledge should be integrated into people's jobs and there must be organizational culture and incentives to encourage knowledge seeking and sharing (Gold, 2001; Markus, 2001). To effectively share un-codified knowledge, Ruggles (1998) stressed the importance of the resource that enables internal-expertise mapping and creating networks of knowledge workers. Kouwenhoven (1998) proposed employing knowledge stewards whose role is facilitating knowledge sharing among workers. Besides, Wijnhoven (1999) stressed the importance of using rich communication tools such as video-conferencing to share more complex and implicit knowledge.

3. Research Question & Theory

This exploratory study aims to investigate issues that, according to the Nonaka's theoretical model, are believed to hold significant ramifications on the effectiveness of creating and sharing organizational knowledge among distributed workers. The research questions addressed how



Source: Nonaka and Konno (1998)

Fig. 1 Spatial Evolution of Knowledge Conversion and Self-transcending Process

this environment changes worker perceptions in *social and work relationships*, *the accessibility of organizational knowledge*, and *the choice of communication media as a knowledge-sharing channel*. SECI model (see Fig. 1) offered a conceptual basis that related the studied dimensions to the knowledge creation and sharing process by distributed-workers. According to the model, the formation of knowledge involves spiraling interactions between explicit and tacit knowledge, through which four self-transcendence processes of *socialization*, *externalization*, *combination*, and *internalization* are implicated. In short, the underpinning of the SECI model is depicting the conversion between tacit knowledge and explicit knowledge through various social mechanism. It explains organizational knowledge creation and sharing through the management of knowledge transfer from an individual dimension to an organizational dimension.

In the mean time, this model's methodology basically builds *Ba* that prompt each of the above four self-transcendence processes. *Ba* is an abstract platform or shared space created to advance individual and/or collective knowledge. According to Nonaka and Konno (1998), information resides in media and networks, and it is tangible, but knowledge is embedded in *Ba*, where knowledge is acquired through individual experiences or reflections on the experience of others. As an abstract space for promoting organizational communication, four *Bas* were introduced, one *Ba* for each stage. Among them, *originating Ba* for *socialization*, *interacting Ba* for *externalization*, and *cyber Ba* for *combination* offer a theoretical relevance to the studied dimensions.

Originating Ba promotes socialization in a world where individuals share feeling, emotions, experiences, and mental

models and is the primary *Ba* from which the knowledge creation process arises. Tacit knowledge is deeply rooted in an individual's actions and experience, which are highly personal and hard to formalize (Nonaka, 1994). Thus, tacit knowledge sharing requires a great deal of personal engagement in the form of formal and informal meetings, training sessions, and apprenticeship in and out of an organization. According to Nonaka et al. (1998), tacit knowledge sharing with external entities (i.e., customers and business partners) is as important as intra-organizational knowledge sharing.

Interacting Ba is more consciously constructed than originating *Ba*. It is the place where tacit knowledge is made explicit and thus supports the externalization process. Dialogue in different modalities (i.e., personal contacts as well as electronic communication, formal as well as informal encountering and correspondence) would be critical to this conversion.

Distributed-organization overcomes temporal and spatial restrictions using ICTs. Because this organization demands that much work is done away from a head office, the change of social interactivity may affect the effectiveness of knowledge externalization through the *interacting Ba*.

Cyber Ba is a space that supports the combination phase of knowledge conversion. Here the combining of new explicit knowledge with existing information and knowledge generates and systematizes explicit knowledge throughout the organization. This is where explicit knowledge is further transformed into more complicated knowledge sets. Nonaka and Konno (1998) indicated that the key for success is communication and the systemization of knowledge such activities as capturing, integrating, dissemination, editing, and processing of explicit knowledge. In distributed environment, *cyber Ba* should promote the aggregation and systemization of explicit knowledge in virtual manners (i.e., spatially separated and temporally asynchronous). Distributed-workers, therefore, may have more difficulties than central workers in accessing necessary knowledge, placing the former in a disadvantaged situation in taking advantage of available resources for constructive knowledge re-production. Accordingly, the facilitation of accessibility to organizational knowledge resources may be critical to create an effective *cyber Ba* at this organization. The importance of system (i.e., organizational memory) and infrastructure design (Gupta et al., 1995 Wijnhoven, 1999) for supporting knowledge-workers' job-related work may be understood from this

perspective. In addition, *Exercising Ba* supports the internalization phase. This *Ba* facilitates the conversion of explicit knowledge to tacit knowledge.

4. Research Methodology

4.1 Survey Design

Brief description of the question items is made below.

- (1) Distributed-work impacts on Social and work relationships

This focus was placed on analyzing perceived changes in social interaction and work independence(or autonomy), and their effect on distributed-workers' knowledge creation and sharing. *Social interactions* are crucial to create tacit knowledge through shared experience and to combine and amplify different bodies of explicit knowledge held by individuals. And changes in social interactions resulting from distributed-work may affect the dynamics of knowledge creation and sharing process. *Work independence* is a main inducement for individual commitment to knowledge work, and its changes resulting from distributed-work could not only give people freedom to absorb knowledge but also motivate them to form new knowledge(Nonaka, 1994). And, for this, the survey should include question items regarding the role of *ICT support and productivity*.

- (2) Distributed-workers' view regarding the accessibility to knowledge

This dimension examines the perceived difference between distributed and non-distributed work arrangements in terms of acquiring knowledge with different levels of implicitity. Effective creation of knowledge demands quick processing of existing knowledge and information, and this necessitates easy access to necessary information (Nonaka, 1994). Distributed workers, however, may have limited accessibility to knowledge resources available at an organization and this may interfere with their knowledge creation process. Furthermore, the accessibility may be worsening as the knowledge types become more implicit and complicated.

- (3) Distributed-workers' perception regarding the usage of communication media

Distributed-workers' *media usage* may represent the social process to exchange mostly explicit forms of knowledge. But they may also use media to transform tacit

knowledge into more explicit forms. The patterns of media usage in distributed-work context for communicating knowledge at different levels of implicitity may be highly different from those in non-distributed environments. Such discrepancy may have significant implications on the effectiveness of knowledge creation and sharing among distributed-workers because exchanging implicit knowledge may demand information and functional richness of communication media (Wijnhoven, 2001).

The survey instrument adopted a seven-point Likert-scale response format as recommended by Hansen (1999). Survey items were developed after an extensive literature review and thorough scrutiny by co-authors. Pre-testing of survey items was conducted to identify any constructional defects. The instrument was then validated in accordance with the procedure recommended by Straub (1989). Lastly, it was presented to industry practitioners for review and their suggestions were incorporated into the final version.

4.2 Data Collection

Survey data were collected from distributed-workers of twelve companies in Japan with a sizable distributed-work arrangement in place of which the businesses include consulting, logistics service, telecommunication service, manufacture and so on. Copies of the questionnaire were mailed to coordinators for distributed-work program of those organizations and they distributed the questionnaire to distributed-workers. Participants could return the completed survey either to their coordinator or directly to us. In addition, the questionnaire was posted on the web and coordinators were asked to distribute the URL among distributed-workers who preferred to respond through the web. With the indirect distribution of survey questionnaires through distributed-work coordinators and additional usage of the web as a feedback channel, the response rate was not clearly measured.

A total of 58 distributed-workers returned the completed surveys. Most of the participants were male (84%) only 9 were female (16%). Among the respondents, the majority held an information-system related job (64%), followed by research and development (12.5%), finance and accounting (9%), and marketing/sales (5.5%).

5. Survey Data Analysis

The interpretation of average values based on a seven point Likert-scale is subjective in nature. Therefore, we

applied the following heuristics to maintain consistency in the interpretation and discussion of statistical results: strongly disagree (1), disagree (2), somewhat disagree (3), undecided (4), somewhat agree (5), agree (6), and strongly agree (7).

First, data analysis confirmed that ICT support had a significant role in increasing productivity and job performance (see Table 1). Workers weakly agreed that distributed-work increased opportunities for personal interactions with non-corporate people. The Pearson correlation coefficient, 0.571, showed a strong positive association between the number of distributed-work days called "telework days", and opportunities for external interaction. In the meantime, workers were neutral regarding the effect that work had on social interactions with co-workers.

Distributed-work tends to result in higher work independence than central work and this higher work independence may lead to the enhancement of domain knowledge and experience. In the meantime, it was also acknowledged that decreased social contacts with co-workers could somewhat negatively affect the opportunity for knowledge sharing. The increase in social interactions with outsiders, however, was not regarded as crucial in improving workers' domain knowledge.

Accessibility for knowledge: In this part of the survey, distributed-work and central work were compared in terms of perceived convenience in accessing knowledge of different levels of implicitness. To do so, we borrowed the taxonomy of organizational knowledge Wijayanayake (2000) introduced based on Wijnhoven's (1999) and Bohn's (1994) works. The scheme ranked organizational knowledge into eight levels from *simple data transfer* to *highly specialized*

Table 1 Summary of descriptive statistics

	Mean	SD
ICT support & Productivity increase	4.96	2.00
Social interaction with		
Outsiders increase	4.29	1.78
Co-workers decrease	4.02	1.70
Opportunity for knowledge & experience from Work independence	4.30	1.80
Social interaction with outsiders	3.79	2.37
Opportunity for knowledge & experience from Social interaction with co-workers	4.23	1.44
Opportunity for work independence:		
Distributed-work	4.32	1.94
Central Office	3.38	1.72

and tacit knowledge transfer depending on the difficulty of codification (Table 2).

In fact, there may be a controversy on whether data can be regarded as a type of knowledge when data, information, and knowledge are viewed as a conceptual hierarchy in their ascending (Alavia, 2001) or descending order (Tuomi, 1999). In this study, however, we regard data as potential knowledge (Wijnhoven, 1999) that can be transmuted into a more advanced form of knowledge.

In our study, rather than utilizing the Wijayanayake's (2000) scheme as it is, we validated its integrity by asking workers to rank the items in terms of their perceived knowledge complexity. That is, in order to test the validity of knowledge complexity task considered in the questionnaire, 58 distributed-workers of twelve companies in Japan with a sizable distributed-work arrangement were asked to write the order of complexity of knowledge. Here,

Table 2 Knowledge complexity level

1	Data required for work
2	Method of identifying simple problem encountered in a job
3	Method of evaluating key factors affecting a job
4	Method of controlling (managing) a job in a normal (typical) situation
5	Method of controlling (managing) a job in a problematic (unusual) situation
6	A knowledge (know-how) that explains how changes make to variable (business practice, job) affects the output (business results, job)
7	A knowledge(know-why) that enables prediction and simulation of a business/job process, which can be used to control the business/job process before it goes out of control
8	Non-theorized knowledge that required for highly specialized jobs

Source: Wijayanayake (2000)

Table 3 Wilcoxon rank tests for knowledge complexities

Complexity level	Mean(SD)	Min	Max	Z-scores	P values
1	2.29 (2.13)	1	7		
2	2.24 (0.90)	1	7	0.77	0.44
3	3.18 (1.30)	1	8	4.82	0.00**
4	4.00 (1.13)	2	7	3.14	0.00**
5	4.49 (1.62)	1	8	2.06	0.03**
6	5.62 (1.14)	3	8	3.81	0.00**
7	6.24 (1.23)	3	8	2.94	0.00**
8	6.89 (1.58)	3	8	3.74	0.00**

* Z-scores and P-values represent test statistics of neighboring levels

we used knowledge complexity interchangeably with its codification difficulty and therefore its implicitness (Wijayanayake, 2000). As the data took the form of ranking and the normality assumption would be almost certainly violated, non-parametric statistics were used to compare the mean values. Each pair of neighboring values was compared by the Wilcoxon Rank test. The results mostly confirmed Wijayanayake's (2000) taxonomy. Workers, however, did not differentiate between level 1 and level 2 ($Z=0.77$ and $P=0.44$) (Table 3). Thus, original values for level 1 and level 2 were collapsed in the new seven-layer scheme.

A comparison was made between distributed-work and central work in terms of knowledge accessibility at each level (Table 4). The statistics indicate that workers didn't recognize the difference between centralized and distributed work arrangements in accessing highly explicit forms of knowledge (level 1) such as "data required for work" and "the method of identifying simple problems encountered in a job." This may be rather natural in that explicit knowledge is easier to structure and codify with available technologies (i.e., database and rule base) and therefore geographical distribution does not become a limiting barrier to its accessibility given the ubiquity of networks.

However, when the knowledge implicitness falls between level 2 and level 6, they perceived better accessibility in the centralized work. In the meantime, there was no significant difference between two work modes when there is a need to acquire *non-theorized knowledge required for highly specialized jobs* (level 7).

This may be an indication that such an advanced and implicit form of knowledge may be hard to find and therefore geographical or spatial factors do not constitute a significant barrier anymore. Overall, the difficulty in obtaining tacit knowledge with distributed-work calls for

approaches different from those of centralized work for creating and sharing knowledge among distributed workers. *Communication media usage:* Table 5 summarizes three communication media chosen to acquire different types of knowledge. In interpreting the table, "email > DB&KB > Tel", as an example, indicates the order of preference being email statistically the highest in the mean value followed by DB&KB. As another example, "email > DB&KB = Tel" indicates the same preference sequence as the first case, but the mean values of DB&KB and Tel are not statistically different.

The summary reveals associative patterns between media use and the mode of work. In distributed environment, email was the premier medium for exchanging various types of knowledge, except the last category where telephone usage was slightly higher than email usage without a statistical significance. It is also recognized that telephone usage in distributed environment rose consistently as the difficulty of knowledge codification increased. The preference for telephone surpassed that of DB&KB from the third level. Besides, although gradually increased with the knowledge level, FTF usage was understandably never higher than that of telephone in distributed environment.

In the non-distributed environment, DB&KB and email were preferred when the exchanged knowledge stayed at the lower level (level 1 and 2). FTF, however, took over DB&KB and email as the medium of choice when the transferred knowledge reached the 3rd level and thereafter. Telephone usage expanded as well and, from the 5th level, replaced email as a preferred medium. Overall, heavy usage of email in distributed environment even for the exchange of highly implicit knowledge and much reliance on face-to-face interactions in central work even for the exchange of less implicit knowledge was prevalent.

Table 4 Information/Knowledge Accessibility: pair-wise t-test

New Knowledge Complexity level	Mean values		t-test	df.	Sig. (2-tailed)
	Distributed	Central			
1	5.74 (1.35)	5.84(1.29)	-.76	57	.44
2	4.79 (1.75)	5.51(1.37)	-4.67	56	.00*
3	5.10 (1.41)	5.55(1.07)	-2.71	57	.00*
4	4.34 (1.23)	5.09(1.27)	-5.20	57	.00*
5	4.07 (1.37)	4.88(1.15)	-4.78	56	.00*
6	3.68 (1.57)	4.74(1.26)	-6.02	57	.00*
7	3.88 (1.85)	3.86(1.82)	.04	57	.96

Table 5 Media usage in knowledge exchange

New Knowledge Complexity level	Distributed	Central
1	email>DB&KB>Tel	DB&KB=email>FTF
2	email>DB&KB=Tel	email=FTF=DB&KB
3	email=Tel>DB&KB	FTF=email>Tel
4	email=Tel>DB&KB	FTF=email=Tel
5	email=Tel>FTF	FTF>Tel>email
6	email=Tel>FTF	FTF>Tel=email
7	Tel=email>FTF	FTF>Tel=email

* Tel: telephone, DB&KB: database and Knowledge base
FTF: face-to-face communication

6. Discussions

Data analysis indicated that in general the degree of social interactions with co-workers due to distributed-work was not significantly affected, despite the expected decrease in face-to-face contacts with them. Nevertheless, it was also recognized that decreased personal contacts could negatively affect tacit knowledge sharing among distributed-workers.

It appears that distributed-workers were making up the lost personal contacts with peers and managers through effective use of ICTs. Exchanging tacit knowledge as it is through ICTs, however, would be difficult as no media can be as information rich as personal contacts (Daft, 1984 & 1986). We suspect, therefore, that distributed-workers were able to codify certain tacit knowledge during the use of electronic media. Despite the information leanness, electronic media carry rich functional features (i.e., archival, threading, and mass distribution). The functional richness might have facilitated the explication and tacit knowledge sharing through dialectic conversion of knowledge exchange. This conjecture is in line with the result of Wijayanayake (2000) whose statistical analysis indicated that the codification level of organizational knowledge was overall higher during distributed-work than before.

Distributed workers didn't see that the geographical distribution was a significant barrier in sharing either highly explicit or highly implicit knowledge. We reason that highly explicit knowledge can be relatively easily codified and therefore can be shared through ubiquitous networks. This reasoning was supported by the patterns of media usage for exchanging more explicit knowledge (Table 5), in which the use of lean media, including email, database, and knowledge base, was preferred in both distributed-work and central work. In the meantime, data analysis also indicates that the geographical distribution does not constitute a dividing factor anymore in acquiring highly implicit knowledge. This may become an indication that such an advanced form of tacit knowledge is hard to be conversed and may require repeated and prolonged social interactions and engagements. When the knowledge falls between level 2 and level 6, its accessibility was perceived better in centralized work, highlighting the importance of research to enable better knowledge creation and sharing in virtual space.

The summary of media choice (Table 5) reveals that there was a heavy usage of email in distributed-work even for the exchange of highly tacit knowledge and much

reliance on FTF in central work even for the exchange of relatively explicit knowledge. We may interpret this media usage from two completely different perspectives. On the one hand, this usage pattern may support the subjective notion of media richness contingent on social and situational contexts and the manner in which they are utilized (Fulk, 1987). According to the theory, the use of media in enhanced (or richer) mode may complement the lost personal contacts. On the other hand, increased usage of electronic media due to spatial separation may be the consequence of "forced" adoption despite the media's incapacity to effectively exchange tacit knowledge. The relative inconvenience of distributed-work in obtaining tacit knowledge shown in Table 4 may support this reasoning. Overall, the synthesis of data analysis appears to indicate that distributed-work has resulted in the upgrade of the effectiveness of knowledge codification via electronic media and also the loss of accessibility to advanced tacit knowledge.

Our work opens up two different research paths to improve understanding of knowledge creation and sharing in a distributed environment. First, if an organization can create a *Ba(s)* (not necessarily in the form of face-to-face gatherings and contacts) through which tacit knowledge is effectively shared, distributed-workers' need for personal engagements for acquiring complex knowledge may be curtailed, realizing a truly effective form of distributed-work. Simply maintaining information systems that refer to its locations such as skills databases (Wijnhoven, 1999) and knowledge networks (Ruggles, 1998) may not be an effective solution here because they still require electronic communication between distributed-workers and knowledge owners in virtual space. The challenge, therefore, would be structuring or organizing tacit knowledge so that distributed-workers can acquire it electronically.

The explication of tacit knowledge may be promoted via general media such as email, and this explication process may be supplemented by the use of personal contacts and increased accessibility to corporate knowledge resources. In other words, distributed-workers can explicate tacit knowledge into explicit knowledge through electronic media as in Wijayanayake (2000), and then share the embodied knowledge. Here, appropriate use of metaphor and analogy may further facilitate the transformation process between tacit and explicit knowledge during the electronic conversation (Nonaka, 1994).

In supporting the knowledge conversion and synthesis, electronic media might have advantages over more

traditional person-to-person engagements. First, its functional richness such as message archive and threading can become the basis of organizational memory and thus can promote repetitive and dialectic interactions that are important for the conversion process (Nonaka, 1994). Second, the electronic tools can support large-scale participation by people during the knowledge conversion process. As related, electronic media's role in increasing the number of weak ties in organizations was reported (Alavi, 2001). It may also be that the conversion process becomes faster and larger in scale when more people are involved (Nonaka, 1994).

In addition to the process of explicating tacit knowledge using electronic media, knowledge transfer could be further reinforced by furnishing face-to-face opportunities and improved infrastructure to facilitate the access for organizational knowledge sources. After all, our discussion comes down to the balanced use of information channels (electronic communication media, personal contacts, and intelligent ITs) to improve the effectiveness of tacit and explicit knowledge flow in the virtual setup.

7. Conclusions

Although Distributed-organization is increasingly becoming an important form of virtual process arrangement for the emerging knowledge society, knowledge management from such a distributed circumstance has been rarely examined. As one of the early investigations, we attempted to explore three research issues: changes in social and task relationships, accessibility of organizational knowledge, and the usage of electronic media in this environment. Our study indicates that these issues have important ramifications in knowledge management and therefore should be closely examined to design an effective strategy for knowledge creation and sharing applicable to a distributed-work program. We envision that, when truly intelligent ICTs become available and corporate processes for knowledge management activities are in place, centralized work may not necessarily be an ideal setup in creating knowledge and archiving it as organizational memory because excessive personal contacts may paradoxically limit opportunities for automated knowledge capturing, explication and organization via electronic media. Achieving this, however, demands two challenging but complementary lines of research be undertaken: the improvement of ICT intelligence and functionality; and the accumulation of soft know-how on organizational processes

for effective knowledge management.

There are limitations to our empirical work. Above all, the sample size might not be sufficient to claim the external validity of the analysis. And, in fact, the concept of distributed organization includes various types such as telecommuting that indicates working at home, and logistics companies that have a head office and several branch offices over the wide areas. Thus, although these types have the same attributes in basic aspects, there may be some differences among types of distributed-work in actual implementation of each business. In relation to this, organizations participated in this study mostly had well-designed distributed-work programs. And, workers who proficiently perform job-related activities on virtual work place, not physical work place, were participated in this study. For these reasons, our study is closer to knowledge sharing for telecommuting or virtual organizations. Thus, in order to present more detailed implications for knowledge sharing in certain distributed environment, empirical studies based on specific characteristics of that distributed environment are needed. However, despite the possible weaknesses in research methodology, we believe that the empirical results and following discussions of their implications can become a viable stepping stone for future research efforts. In extending this work, we suggest incorporation of such diverse research paradigms as case-based studies and the empirical generalization of case-based learning; a longitudinal investigation for knowledge creation and sharing patterns; and simulations or experiments based on communication tasks of differing complexities.

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