RESEARCH IN LOGISTICS & PRODUCTION

ON NONAKA'S DYNAMICS OF KNOWLEDGE MANAGEMENT

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Abstract Purpose: The purpose of this paper is a study of factors that influence effectiveness of creation of knowledge in organization. Design/methodology/approach: analysis of knowledge system presented in the text, refers to the concept of Nonaka dynamics of knowledge creation. Findings: An extension of Nonaka's spiral of knowledge management is proposed, called in the text the "Nonaka's screw". Originality/value: The model of Nonaka's screw highlights energetic aspect of dynamics of knowledge creation, which can be formulated as important prerequisites of the knowledge management. - some extra energy must be used in order to make the knowledge move and to overcome barriers of knowledge creation; - without managerial support, creation of knowledge may be ineffective.

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1. INTRODUCTION

Knowledge is necessary to act effectively - in small scale of individual performance as well as in a scale of groups of people.

Considerations regarding knowledge management are dominated by the perspective of organizations that are consuming big amounts of knowledge. Expected high return on investment associated with relatively high cost of acquiring knowledge make the issue challenging. A focus is on technical aspect creativity, analysis of data and its logistics, which support creation of new knowledge, its retention, transfer and utilization.

In the text systemic analysis of knowledge management system is conducted. A focus is on knowledge management in organizations which are not consuming new knowledge extensively: their R&D function consists mostly in adaptation of existing solutions to needs of their product and processes. We study Nonaka's model of dynamics of knowledge creation, which consists of internalization, socialization, externalization and combination of knowledge. Alternative metaphor (Nonaka's screw) to knowledge spiral is proposed, which provides convenient framework for discussion of factors that influence knowledge change.

1.1. Human knowledge

Generally speaking, effect of applying knowledge should be increased ability to act. There are two tendencies in understanding knowledge:

- state that results after having absorbed certain amount of information
- factor that facilitates understanding and interpreting information

First approach reflects understanding of the knowledge as an asset of organization that can be purchased, distributed and sold. The second one directs more focus on organizational/systemic aspect of knowledge and is represented by the following definition: "knowledge is a structured set of information and rules of its interpretation" (Kozminski, 2004). Its idea can be illustrated by the phrase: "Even though Chinese characters can be beautifully written in pen and ink, the knowledge structure necessary to read the characters has to have been built up by years of skill training" (Langlois. 2001).

1.2. Vertical structure of knowledge

A system of knowledge is a structured set of data, information, standards and strategies. Hierarchic structure of knowledge (Kozminski & Jemielniak, 2008, p. 256) can be represented by the figure below.

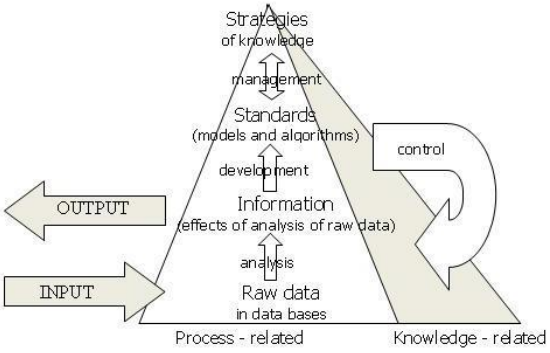

Fig. 1 Knowledge structure (Myszewski, 2011)

Data = sequence of characters (symbols, numbers etc.) that may have some meaning for the recipient, when combined with other data. Data refer to, or represent, conditions, ideas, or objects.

Information = meaningful data (EN ISO 9000, 2005)

The value of information lies solely in its ability to affect a behavior, decision, or outcome. A piece of information is considered valueless if, after receiving it, things remain unchanged (Business Dictionary).

Standard = pattern of a system or a process.

A standard is a structured set of information that instructs what and how to act (how to interpret incoming information) to achieve definite effect. Data (information) is a code that can be interpreted by using the standards. Standards used in organization operationalize information concerning its functions. These functions encompass both basic performance as well as knowledge management.

Strategic level of system of knowledge consists of instruments that enable introducing order and planning future resources of knowledge on all structure levels, in particular: mission, vision, values and objectives concerning knowledge.

Strategic elements provide coordination with other areas of organization, by synchronizing strategies. Its deployment in standards, information and data institutes a system of knowledge management.

1.3. Functional structure of knowledge

Value of information depends on context in which it is assessed. Information and more generally, the knowledge is local. Content of information, form of representation may be very specific. Given any process there can be distinguished knowledge on this specific process, which consists of data, information, standards concerning the process. This knowledge is called process-related. There are also data, information and standards that concern the way in which process-related knowledge is managed. Examples are elements of strategy level such as: objectives, mission and

vision. This, what we call management-related knowledge describes operations on data, information and standards from process- and management-related knowledge.

System of knowledge is a mental construction, combining objects of various kinds. Word "system" accentuates role of relations that represent functions essential for knowledge. Some relations are depicted on the above diagram by arrows:

- communication with other external structures, for example: (measurement) system that provides data and (controller) system that makes use of information (executes commands)
- analyzing incoming data, which enables understanding an information and its effective use: some information is directed to the output, and some used in development of standards
- developing standards , which enables operationalization and improvement of knowledge
- control of flow of data and information, which enables realization of basic functions of knowledge system
- managing the system of knowledge, which includes defining strategic elements and executing surveillance over standards

Standards of knowledge determine way in which inputted data are converted in information. Some of these transformations concerns processes, which are realizing functions of organization, and some of them is associated with functions of knowledge system. They assure control/management of the knowledge system.

1.4. Horizontal structure of knowledge

Human behavior, attitudes and interpersonal relations are programmed by various schemes.

Table 1 Focused and tacit components of individual knowledge structure

Element of knowledge	Focused knowledge	Tacit knowledge
Raw data	purposeful observations associated with performing operation and effectiveness of learning	occasional loose observations
Information	generalizations of focused observations associated with performing operation and effectiveness of learning	intuition based on occasional loose observations
Standards	general and personal standards associated with performing operation and effectiveness of learning	non-algorithmisable schemes of action based on personal experience and skills
Strategy	individual intentions concerning competence regarding performing tasks and the effectiveness of learning	individual intentions concerning competence regarding performing tasks and the effectiveness of learning

They originate from education and upbringing, they reflect influence of various cultures, and some have deep biological roots. All these factors are contributing to the individual knowledge, which in part can be precisely articulated and in part can not be explicitly described and refers to some personal experience and intuition. It is idea of Polanyi (Polanyi, 1962) to distinguish both components of the individual human knowledge and to call them focused and tacit knowledge respectively.

2. ORGANIZATION KNOWLEDGE

The knowledge of organization may be considered the sum of what is known in the organization: either documented or resides in the intelligence and the competence of people.

2.1. Organization's explicit and implicit knowledge

The generalizations of concepts of human focused and tacit knowledge on collectives of people is a classification into component that is formally controlled by organization (explicit knowledge) and component formed of knowledge of its members (implicit knowledge) (Nonaka, 1994).

Table 2 Explicit and implicit components of organization's knowledge structure

Element of knowledge	Explicit knowledge	Implicit knowledge
Raw data	content of data bases formally used in organization	informal records and loose observations of people
Information	results of analyses of explicit data bases content that are used to perform organization's functions and support organization's learning	personal opinions of people that were not formulated in formal reports
Standards	obligatory standards associated with performing organization's functions and in particular with effectiveness of learning	general and personal standards and experience-based schemes used by people
Strategy	general organization's intentions regarding competence, associated with performing organization's functions and in particular with effectiveness of learning	informal policies and practices determining people's involvement in improvement of organization

Organization's explicit knowledge is a knowledge that has been or can be articulated, codified, and stored in certain media. It can be readily transmitted to others.

It is a collective knowledge on what to do and how to act in order to perform functions of organization. The organization's knowledge that is not explicit is called implicit. The implicit knowledge has not been articulated or codified or stored and therefore can not be transmitted to other people in organization.

2.2. Data and information

Data entering the system of knowledge is transformed into information in several parallel processes that are realizing basic functions of the knowledge system:

- archiving history of processes
- supporting monitoring processes
- developing standards

(including those of knowledge management)

Records (documents stating results achieved or providing evidence of activities performed (EN ISO 9000, 2005) contain information about past events that took place in the process. Among them are results of observation of the process' or product's characteristics. Combined with other data, they provide information about performance of organization.

Traceable records (that provide ability to trace the history or location), may be used to analyze processes off-line.

However, sometimes once records are done, they are archived and are not used any more. "Forgotten knowledge" is a better name for that kind of the organization's knowledge.

There is a group of loose data collected by individuals at work. Elements remain unrecorded and after certain time are replaced by new observations. Their value consists in complementing data about the system state from very local point of view. They may be useful when diagnosing failures of the system because they show the state from the bottom.

2.3. Standards

The core of the explicit knowledge is represented by documented standards and data bases. Examples of standards are algorithms and models of various kinds: general procedures and local instructions as well as various schemes, specifications and other documents and directives that are programming operation of people in organization.

By establishing obligatory standards, organization ensures that key operations are performed in unique way, which can be validated in advance. In this way the explicit knowledge is deployed among people. Some of organization's standards that belong to explicit knowledge are to enable and control a use of people's tacit knowledge.

General standards are expressing the content of the individual focused knowledge that people acquire in formal process of education or exchange of experience. They are not obligatory and the only purpose, why they are used, is their useful-

ness. This part of organization's implicit knowledge can be readily made the explicit knowledge of organization.

Personal standards are the content of the individual tacit knowledge. They are used to ease operation. Personal standards are extending specification of general standards and are expected not to be contradictory to obligatory standards.

Example: Procedure of problem solving is an example of general standard. It provides guidance on how to use records and people's tacit knowledge to have problem solved.

Some specific scheme of identifying causes of problem may belong to personal standards of the team leader.

2.4. Strategy of knowledge system

Knowledge management is a discipline that seeks to improve the performance of individuals and organizations by maintaining and leveraging the present and future value of knowledge assets (Newman & Conrad, 1999).

Main external functions of knowledge management:

- creation: comprises activities associated with the entry of new knowledge into the system, and includes knowledge development, discovery and capture.
- retention: includes all activities that preserve knowledge and allow it to remain in the system once introduced. It also includes those activities that maintain the viability of knowledge within the system.
- transfer: refers to activities associated with the flow of knowledge from one party to another. This includes communication, translation, conversion, filtering and rendering.
- utilization: includes the activities and events connected with the application of knowledge to business processes

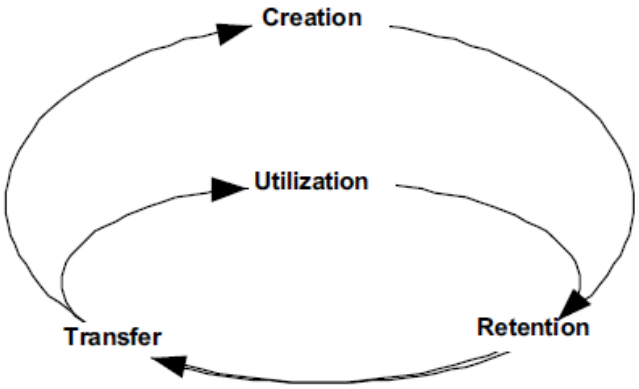

Fig. 2 Model of Knowledge flow. Source: (Newman & Conrad, 1999)

Standards of management-related subsystem define:

- what data and in which way are inputted to the organization,
- how they are stored, processed and distributed
- when and in what way standards are created and modified.

Strategy level of knowledge system provides direction to functions of knowledge system that is harmonized with other functions of the organization. By deploying strategy into details (objectives) prerequisites for establishing system of knowledge management are obtained.

It provides also reference signals for monitoring functions of knowledge management system. Acceptance criteria for assessing performance of knowledge management system are set there.

Standards of knowledge system are expected to be consistent with strategy of knowledge management (they should meet strategic objectives). The consistency can be verified by analysis of data that represent performance characteristics of both: the process- and management-related functions; possible inconsistency, once noticed, may initiate actions to eliminate it.

The possible action may be the following:

- to improve respective standards. This is an idea of corrective action. It is also an idea of the single-loop learning (Argyris & Schön, 1978)
- to modify respective element of strategy (in particular – that of the knowledge development). A reason to consider such action may be its evident error or inadequacy to current conditions. This is an idea of the double-loop learning (ibidem)

This scheme of knowledge management ensures that knowledge management system and the organization knowledge will be adjusted to changing conditions of functioning.

If the acceptance criteria are set incorrectly, problems will occur. Too weak, may cause that improvement actions may be launched too late. Too rigorous may paralyze regular functioning of organization by too frequent, improvement impulses. Monitoring of effect of knowledge management allows adjustment criteria upon experience.

By establishing scheme of monitoring processes an important source of data is instituted. Observation of result of controlled process and of parameters of state and environment are inputted as process- and management-related data. Their primary purpose is to be used in single- and double-loop learning scheme, by establishing appropriate feedback-loops. On the other hand, they form valuable data which can be used for development and improvement of knowledge management system.

3. NONAKA'S DYNAMICS OF KNOWLEDGE CREATION

3.1. Dynamics of knowledge transfer

A general process of knowledge creation consists in knowledge transitions. Formally, there are four possible combinations representing such transitions. They are shown in the Figure 3.

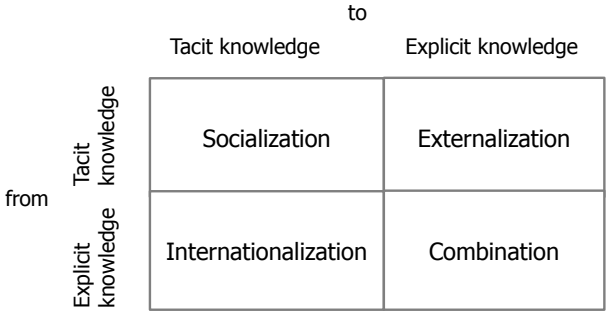

Fig. 3 Modes of knowledge creation. Source: (Nonaka, 1994)

Each particular process has specific interpretation. See the table 4.
Internalization – conversion of explicit knowledge into a tact one
Externalization – conversion of tact knowledge into an explicit one
Socialization – of portions of tacit knowledge
Combination – of portions of explicit knowledge

Table 4 Inputs and outputs of the Nonaka's transformation of organization's knowledge. Source: Author

Process	Input factor	Output impact
Internalization	Publishing of strategy, Training on operation standards Training on systemic standards	Motivation to being involved Improvement of personal skills
Exter-nalization	Personal observations and reflec-tions concerning basic processes and their control	Extension of explicit information pool Contribution to improvement of stand-ards Contribution to improvement of strategy
Socialization	Exchange of observations and reflections on process and control Exchange of experience and personal standards of operation and control	
Combination	Improvement of standards of operation and control on a base of existent explicit knowledge Improvement of strategy on a base of existent explicit knowledge In particular, analysis of data, establishing new standards	

By Nonaka, a general knowledge creation process is a combination of the four above named sub-processes.

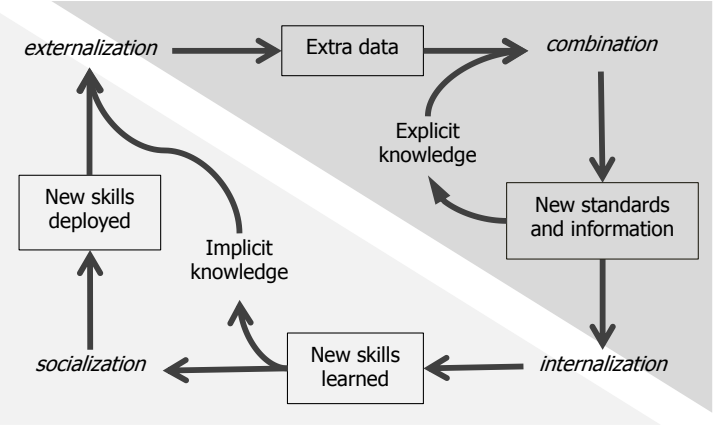

Fig. 4 Nonaka's dynamics of knowledge creation. Source: Author

Idea of knowledge creation shown at the Fig. 4 may resemble the "rule of screw", used in physics: rotating clock-wise causes the move in the direction perpendicular to the plane in which the diagram is located. Nonaka (Nonaka, 1994) refers to the "spiral of learning" which represents trajectory of points on the moving screw. This simple physical model evokes simple question: what makes the screw rotating? Continuing the metaphor, there are severe obstacles on the trajectory of the screw, which can block the movement of screw.

They are:

- externalization – how to make people ready to share their personal knowledge with the system?
- internalization - how to teach people effectively, how to teach values?
- socializing - how to make that right attitudes and appropriate personal standards will be deployed among people?
- combination - how to find time to improve standards?

Any of them can disable development and improvement of knowledge system. Some issues are:

- In the process of externalization an involvement of people is key issue and its effectiveness depends on involvement of managers. The possible positive outcome may be suggestions done by people that may give additional momentum to screw twisting;
- In the process of combination the effectiveness depends on quality of explicit standards of knowledge management and priorities given to improvement;

- In the process of internalization a care should be taken to assure that transfer of knowledge in trainings is effective. This includes not only process-related information and standards but also standards of attitudes, values which are crucial in the process of socialization;
- Process of socialization represents informal learning that takes place beyond the control of organization. Its effectiveness depends on results of the internalization.

The above may be generalized by the following conclusion. Basic source of movement of knowledge screw is given from the involved people or from the properly working knowledge system. In both cases it means that there is appropriate improvement culture and involved managers.

4. CONCLUSION

Enhancing explicit knowledge depends on effectiveness of externalization and combination. However effectiveness of involvement of people in the phase of externalization depends on effectiveness of formal and informal learning in phases of internalization and socialization. This in turn depends on quality of management-related explicit standards and involvement of managers. Leadership on all levels of management system enables effective socialization and internalization of explicit standards and practical skills that belong to implicit standards.

The impulse to improve knowledge system follows from strategic level.

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