ESTABLISHING AN AD HOC INFRASTRUCTURE FOR INNOVATIVE TECHNOLOGIES DEPLOYMENT: THE CASE OF KNOWLEDGE-BASED SYSTEMS

MICHEL GRUNDSTEIN
MG Conseil, 4 rue Anquetil, Nogent sur Marne, 94130, France
Lamsade, Paris Dauphine University, Place du Maréchal De Lattre de Tassigny, 75775, Paris, France
E-mail: mgrundstein@mgconseil.fr

Abstract: In this paper, referring to the Model for General Knowledge Management within the Enterprise (MGKME), we emphasize two of the operating elements of this model, which are essential to insure the organizational learning process that leads people to appropriate and use concepts, methods and tools of KM considered as an innovative technology: the “Ad hoc Infrastructures” element, and the “Organizational Learning Processes” element. The Nonaka’s SECI models, and the Japanese concept of Ba, underlie these two elements. The case of the “Semi-opened Infrastructure Model” (SopIM) implemented to deploy Artificial Intelligence and Knowledge-based Systems within a large industrial company illustrates what could be the application of these concepts in the real field. Meanwhile, we partially validate MGKME. Furthermore, we consolidate the “Semi-opened Infrastructure” model, which becomes a pattern of reference allowing implementing an “Ad hoc Infrastructure” for innovative technologies deployment.

Keywords: Knowledge Management, Model for General Knowledge Management within the Enterprise (MGKME), Semi-opened Infrastructure Model (SopIM), Organizational Learning Processes, Innovative Technologies Deployment, SECI Model, Japanese concept of Ba.

1. Introduction

In the Knowledge Society (Lytras and Sicilia, 2005), Enterprises are more and more concerned with Knowledge Management (KM) as a key factor for improving their efficiency and competitiveness, notably their innovative capabilities. However, very often, KM is considered from a technological viewpoint that induces to consider knowledge as an object independent of individuals. Thus, as observed by Kjaergaard, Kautz and Nielsen (2008) “The practice of knowledge management is often reduced to the implementation of new IT-based systems, procedures for documenting and sharing information, and documents themselves though there are examples to the contrary. By focusing on externalization and documentation of knowledge, important organizational aspects, in particular human and social issues, can be over looked (p. 71).” Those practices disregard the innovative potentialities of KM. In our research group, supposing that Knowledge is not manageable as if it was a data or information, we postulate that KM must address activities that utilize and create knowledge more than knowledge by itself. With regard to this issue, we elaborated a sociotechnical approach of KM within the enterprise, and we synthesized it into an empirical model called Model for General Knowledge Management within the Enterprise (MGKME). Seven elements, classified into two categories, characterize this model. In particular, two of these elements, the “Ad-
Ad hoc Infrastructure”, and the “Organizational Learning Processes” are essential to insure the learning process that leads people to appropriate and use concepts, methods and tools of KM considered as an innovative technology.

In this paper, after having put down background theory and assumptions, we present MGKME, emphasizing on two of the operating elements suggested by this model: the “Ad hoc Infrastructures” element, and the “Organizational Learning Processes” element. That leads to introduce the Nonaka’s SECI model (Nonaka and Takeuchi, 1995), and the Japanese concept of Ba (Nonaka and Konno, 1998). Then, considering the case of innovative technologies deployment within a large industrial company, that are Intelligence Artificial and Knowledge-based Systems, we describe the “Semi-opened Infrastructure Model” (SopIM), which was implemented, highlighting the link with Nonaka’s SECI model, and the Japanese concept of Ba. In that way, we make a transposition that considers this model as an instance of the two MGKME’s element mentioned above. Consequently, we partially validate MGKME. Furthermore, we consolidate SopIM as a pattern of reference to deploy innovative technologies.

2. Background Theory and Assumptions

2.1. Research motivations, method, and objectives

Our research follows a constructivist paradigm (Perret and Séville, 2003) that is deeply rooted in our pragmatic experience in the real field.

As a practitioner having to manage deployment of innovative technologies (such as computer aided design, knowledge based systems, and others) in large companies just when these technologies were conceived into universities and laboratories, I observed that we always needed to elaborate a model with sociotechnical perspectives, which could be used as a pattern of reference for all stakeholders, in order to engender the essential learning process that leads people to appropriate and use these technologies. Notably, I elaborated, the “Semi-opened Infrastructure” model presented in this paper. This model is an empirical model that has been used in each case I handled.

Later on, when becoming Associate Researcher in the domain of KM, we perceived the lack of general model of KM that integrates sociotechnical perspectives. This point of view is often disregarded when considering the technical approach of KM, although hundred of frameworks can be found in the literature (CEN-CWA 14924-1, 2004). That leads us to elaborate MGKME that is briefly presented in section 3.

Meanwhile, our research on KM makes us discover the Nonaka’s SECI model, and the Japanese concept of Ba. That is the source of the idea to link these theoretical concepts to our pragmatic experience with the implementation of “Semi-opened Infrastructure Model” (SopIM), and to consolidate it. Thus we reached two objectives at the same time:

2. Consolidate SopIM as a pattern of reference to deploy innovative technologies.
2.2. **Three fundamental postulates**

Our observations and experiments within the industry, led us to set forth three postulates: (i) Knowledge is not an object; (ii) Knowledge is linked to the action; and (iii) Company’s knowledge includes two main categories of knowledge. We define these postulates below.

(i) **Knowledge is not an object**

Knowledge exists in the interaction between an interpretative Framework (incorporated within the head of an individual, or embedded into an artifact), and data. This postulate comes from the assumption emphasized by Tsuchiya (1993) concerning knowledge creation ability. He highlighted how organizational knowledge is created through dialogue, and pointed out how commensurability of the interpretative frameworks of the organization’s members is indispensable for an organization to create organizational knowledge for decision and action. Here, commensurability is the common space of the interpretative frameworks (e.g. cognitive models or mental models) of each member. Tsuchiya states, “It is important to clearly distinguish between sharing information and sharing knowledge. Information becomes knowledge only when it is sense-read through the interpretative framework of the receiver. Any information inconsistent with his interpretative framework is not perceived in most cases. Therefore, to share individual’s knowledge, members’ interpretative frameworks commensurability is indispensable.” (p. 89). In other words, knowledge that we use to understand a situation, solve a problem and act, results from the sense given, through our interpretative frameworks, to data that we perceive among the information transmitted to us. Consequently, explicit knowledge, codified, stored, and processed into digital information system, is not more than information. We call it “Information source of knowledge for someone”. We consider this information as knowledge when members having a large commensurability of their interpretative frameworks commonly understand it. For example, such is the case for members having the same technical or scientific education, or members having the same business culture. In these cases, codified knowledge makes the same sense for each member.

(ii) **Knowledge is linked to the action**

From a business perspective, knowledge is created through action. Knowledge is essential for the functioning of support, and value-adding processes (Porter, 1985). Activities contributing to these processes utilize and create knowledge. Thus, the actions finalize the company’s knowledge. This viewpoint takes into account the context and the situation, which allow utilizing and creating knowledge. In particular, we must analyze the role of the actors - decision-makers - involved with these activities in order to achieve the company’s missions. Therefore, knowledge is linked to their decisions, their actions, and their relations with the surrounding systems (people and artifacts).
(iii) Company’s knowledge includes two main categories of knowledge

Within a company, knowledge consists of two main categories (see Table 1): on the one hand, explicited knowledge includes all tangible elements (we call it “know-how”); and on the other hand, tacit knowledge (Polanyi, 1966), includes intangible elements (we call it “skills”).

The tangible elements are collective knowledge. They take the shape of formalized and codified knowledge in a physical format (databases, procedures, plans, models, algorithms, and analysis and synthesis documents), or are embedded in automated management systems, in conception and production systems, and in products. The intangible elements are inherent to the individuals who bear them, either as collective knowledge - the “routines” that are non-written individual or collective action procedures (Nelson and Winter, 1982) or personal knowledge (skills, crafts, “job secrets”, historical and contextual knowledge of environment, clients, competitors, technologies, and socio-economic factors).

Table 1: The Two Main Categories of Company’s knowledge

<table>
<thead>
<tr>
<th>KNOW-HOW (explicit knowledge)</th>
<th>SKILLS (tacit knowledge embodied by individuals)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Collective knowledge</strong></td>
<td><strong>Collective knowledge</strong></td>
</tr>
<tr>
<td>Knowledge that can be thought as objects</td>
<td>Routines</td>
</tr>
<tr>
<td>Knowledge that is formalized within documents and/or codified into knowledge-based systems, and databases</td>
<td>Knowledge that is incorporated within models and regular and predictable behaviors</td>
</tr>
<tr>
<td>Knowledge embedded in automated management systems, conception systems, production systems, and products.</td>
<td>People’s abilities, Professional Knack, Knowledge of company history and decisional contexts, Knowledge of the environment (customers, competitors, technologies) and socio-economic factors</td>
</tr>
<tr>
<td><strong>Information source of knowledge for someone</strong> (Digital Knowledge)</td>
<td><strong>Defensive Routines</strong></td>
</tr>
<tr>
<td>Knowledge that are obstacles to change</td>
<td>Knowledge that favors innovation and change</td>
</tr>
<tr>
<td><strong>Constructive Routines</strong></td>
<td>Specific knowledge belonging to each individual</td>
</tr>
<tr>
<td>Knowledge that is a volatile intangible resource, which depends on the continuity of the presence of employees in the company</td>
<td></td>
</tr>
</tbody>
</table>
2.3. Knowledge Management (KM) Perspectives

In 1990, the Initiative for Managing Knowledge Assets (IMKA, 1990) was initiated by a few companies (Carnegie Group, Inc., Digital Equipment Corporation, Ford Motor Company, Texas Instruments, Inc., and US WEST Advanced Technologies, Inc.). They defined for the first time the notion of knowledge assets: “Knowledge assets are those assets that are primary in the minds of company's employees. They include design experience, engineering skills, financial analysis skills, and competitive knowledge.” Gradually, numerous research works were carried out, enterprise’s KM initiatives were deployed, and an abundant literature enriched the domain of Knowledge Management. So that the concept of KM highlighted a broad range of topics and became a fuzzy concept taking as many senses as people speaking about it.

The introduction to KMIS conference (KMIS, 2009) shows the same understanding: “There are several perspectives on KM, but all share the same core components, namely: People, Processes and Technology. Some take a techno-centric focus, in order to enhance knowledge integration and creation; some take an organizational focus, in order to optimize organization design and workflows; some take an ecological focus, where the important aspects are related to people interaction, knowledge and environmental factors as a complex adaptive system similar to a natural ecosystem.”

Furthermore we distinguished two main approaches underlying KM: (i) a technological approach that answers a demand of solutions based on the technologies of information and communication (ICT); and (ii) a managerial and sociological approach that integrates knowledge as resources contributing to the implementation of the strategic vision of the company.

Most of time, KM is considered from a technological viewpoint. However, in our research group, relying on Tsuchiya’s works, we argue that knowledge is dependent of the individual’s interpretative framework, and the context of his action. Consequently, knowledge resides primarily in the heads of individuals, and in the social interactions of these individuals. It cannot be consider as an object such as data are in digital information systems. Thus, it appears that KM addresses activities, which utilize and create knowledge more than knowledge by itself. With regard to this question, since 2001, our group of research has adopted the following definition of KM (Grundstein and Rosenthal-Sabroux, 2003): “KM is the management of the activities and the processes that enhance the utilization and the creation of knowledge within an organization, according to two strongly interlinked goals, and their underlying economic and strategic dimensions, organizational dimensions, socio-cultural dimensions, and technological dimensions: (i) a patrimony goal, and (ii) a sustainable innovation goal” (p.980). The patrimony goal has to do with the preservation of knowledge, their reuse and their actualization; it is a static goal. The sustainable innovation goal is more dynamic. It is concerned with organizational learning that is creation and integration of knowledge at the organizational level.
To launch Knowledge Management initiatives Enterprises need referring to a pattern of reference, which integrates sociotechnical perspectives in their strategic vision of KM. In this article, we refer to MGKME, a Model for General Knowledge Management within the Enterprise developed by Grundstein (2005; 2007). This model supports the definition and the postulates described above. Moreover, it brings a general vision of KM, which is people-focused (Wiig, 2004).

3. MGKME, a Model for General Knowledge Management within the Enterprise

At first, the Model for General Knowledge Management within the Enterprise (MGKME) was aimed to constitute a pattern of reference for our research group. Today, it can be used to assess the Enterprise’s Knowledge Management Maturity Level (Grundstein, 2008). You will find a brief description of the MGKME hereafter.

The MGKME (see Figure 1), supports our full meaning of KM as defined in paragraph 2.3.

MGKME is an empirical model based both on our experience within the industry, and on our research works. The work of Morin and Le Moigne (1999) that focuses on Complexity and System thinking inspires it. MGKME suggests a sociotechnical approach defined by Coakes (2002) as “the study of the relationships and interrelationships between the social and technical parts of any system” (p. 5). It focuses on people and value adding processes. Moreover, the MGKME presents an attempt to articulate the

MGKME is composed of two main categories of elements. The underlying elements consist of (1) sociotechnical environment and (2) value adding processes. The operating elements focus on the underlying elements. They consist of (3) managerial guiding principles, (4) ad hoc infrastructures, (5) generic KM processes (Locating, Preserving, Enhancing, and Actualizing processes), (6) organizational learning processes, and (7) methods and supporting tools.

In this article we will focus on the “ad hoc infrastructures”, and the “organizational learning processes”, which are two elements of the model’s operating elements.

3.1. Ad-hoc Infrastructures

The ad hoc infrastructures are adapted sets of devices and means for action. Beyond a network that favors cooperative work, it is important to implement the conditions that will allow sharing and creating knowledge. Relevant infrastructures must be set up according to the specific situation of each company, and the context of the envisaged KM initiative. These infrastructures could be inspired by the SECI spiral of conversion Model proposed by Nonaka and Takeuchi (1995), and the Japanese concept of Ba that “can be thought as a shared space for emerging relationships (Nonaka and Konno, 1998, p. 40); Nonaka, Toyama, and Konno (2000, p. 16-17).

3.1.1. The SECI Model

The SECI (acronym for socialization, externalization, combination, and internalization) process of knowledge creation is introduced in the theory of organizational knowledge creation developed to describe how organizations create and utilize knowledge. This model was criticized by numerous authors as stated by Nonaka and Peltokorpi, (2007): “Instead of building on the theory or proposing viable alternative frameworks, scholars have criticized the nature and role of tacit knowledge and its conversion to explicit knowledge in this theory” (p. 68). However, according to our own experience within the industry, we found that SECI fitted very well with our own vision expressed before we heard of it (Grundstein, 1996, p.142). So, we agree with Nonaka and Peltokorpi when they state “The theory is holistic and should be understood as an interpretative frame to understand the process of knowledge creation and utilization in organizations” (p. 80). Furthermore it appeared to be a pragmatic tool well understood by practitioners.

The SECI Model includes the following elements (see Figure 2): (i) two forms of knowledge (tacit knowledge and explicit knowledge); (ii) a cycle in spiral of conversion
of knowledge (Socialization, Externalization, Combination, Internalization); (iii) three levels of social aggregation (individual, group, organization).

3.1.2. The Japanese Concept of Ba

To describe the concept of Ba, we will express our own understanding by paraphrasing Nonaka and Konno (p. 40): Ba is a shared space for emerging relationships and interactions between knowledge stakeholders. This space can be physical (e.g., office, dispersed business space), virtual (e.g., e-mail, teleconference), mental (e.g., shared experience and, ideas) or any combination of them. It can be a network of persons who share common objectives; a place would allow achieving the synthesis of the rationality and of the intuition as a wellspring of new knowledge; a place where would take place a shared knowledge creation; a platform that would allow individual and collective knowledge to progress. So, participate in a Ba stimulates the involvement of an individual, a group, an organization by giving them the possibility to transcend the borders and the limits of their own perspectives. In another article (Nonaka, Toyama, & Konno, 2000, p. 16-17) modified the name of Ba previously design in 1998. Hereafter, we briefly describe the four types of Ba (see Figure 2).

- The Originating Ba is a place where individuals share feelings, emotions, experiences, and mental models. It is the primary Ba from which the knowledge-creation begins and represents the socialization phase. Physical, face-to-face experiences are the key to

![Fig. 2. The SECI Model and the Japanese Concept of “Ba”](image-url)
conversion and transfer of tacit knowledge.

- The **Dialoguing Ba** (previously Interacting Ba) is a place where tacit knowledge is made explicit, thus it represents the externalization process. Through dialogue, individuals’ mental models and skills are converted into common terms and concepts. Two processes operate in concert: individuals share the mental model of others, but also reflect and analyze their own. Dialogue is key for such conversions; and the extensive use of metaphors is one of the conversion skills required.

- The **Systemizing Ba** (previously Cyber Ba) is a place of interaction in a virtual world instead of real space and time; and it represents the combination phase. The combination of explicit knowledge is most efficiently supported in collaborative environments utilizing information technology. The use of on-line networks, groupware, documentations, and database enhance this conversion process.

- The **Exercising Ba** is a space that facilitates the conversion of explicit knowledge to tacit knowledge. It supports the internalization phase. Thus, the internalization of knowledge is enhanced continuously by the use of formal knowledge (explicit) in real life or simulated applications.

3.2. **Organizational Learning Processes**

The Organizational learning processes underlay the whole Generic KM processes elements. The aim of the organizational learning process is to increase individual knowledge, to reinforce competencies, and to convert them into a collective knowledge through interactions, dialogue, discussions, exchange of experience, and observation. The main objective consists in fighting against the defensive routines that make barriers to training and change. So, it is a question of helping the members of the organization to change their way of thinking by facilitating an apprenticeship of a constructive way of reasoning instead of a defensive one. This is essential to make people use and appropriate new concepts and innovative technologies.

4. **Ad hoc Infrastructures for Innovative Technologies Deployment: the case of Knowledge-Based Systems (KBS) deployment.**

As an example of ad hoc infrastructure, we present the case of Knowledge-Based Systems (KBS) deployment within a large French Nuclear Power Plant Company. In that case, a **Semi-opened Infrastructure** was implemented. This typical infrastructure is described below as it may be thought as a concrete application of the concept of Ba.

4.1. **Overview**

The Semi-opened Infrastructure was launched to support deployment of new innovative technologies. At first, in 1978, it was dedicated to introduce Computer-Aided Design. Then, under another format, it became the organizational learning structure created and
led from 1983 to 1995 in order to introduce the concepts and technologies of Artificial Intelligence, and to develop and deploy Knowledge-Based Systems applications. It is this format that is described in this article. In that last case, the aim of the Semi-opened Infrastructure was to encourage the individual and collective apprenticeship, to favor knowledge acquisition, to leverage emergence of new products, and to implement computer applications using artificial intelligence technologies.

Nowadays the “Semi-opened Infrastructure Model”² (SopiM) answers the issues highlighted by the “ad hoc infrastructures” and “the “organizational learning processes” that constitutes two of the operating elements of the MGKME.

4.2. Semi-opened Principles

The semi-opened principles are presented figure 3.

Considering the field characterized by a specific context, where people are confronted with situations continually evolving, one can observe two reasoning loops: (1) The deductive reasoning loop that characterizes the analytic approach of operational and business units; and (2) the inductive reasoning loop that characterizes the systemic approach of an overall perception.

The Semi-opened Platform, which is a neutral space that favors the interactions, is an evolution and progress space where people interact following these two ways of reasoning. It is what, Edgar Morin (Morin and Le Moigne, 1999) call Dialogic Principle that “combines two principles or notions that must be mutually exclusive, but that are
integral parts of the same reality” (p. 264). In the Overall Perception Area, inductive reasoning is involved inducing partial models of action, processes, and techniques. In the Creative Relations Area, people interactions, in deep analysis, and knowledge sharing, engender symbiosis of ideas. The issue is to transcend the deductive rationality of operational units by sharing models of action, processes and techniques induced by the inductive rationality of a multidisciplinary group. That makes people transcending their own interpretative frameworks, and constructing collective representations.

4.3. Semi-opened Infrastructure Model (SopIM)’s Description

To expand, the “Semi-opened Infrastructure” requires a Multidisciplinary Group, and the existence of an Evolution and Progress Space. We describe below the infrastructure that was implanted in the case of KBS deployment (see Figure 4).

Fig. 4. “Semi-Opened Infrastructure Model” (SopIM) for Innovative Technologies Deployment

4.3.1. The Leadership Space

This space was constituted with engineers, organizers, and sociologists accustomed to doing inductive reasoning. This Multidisciplinary Group was in charge to deploy KBS over the whole company.

By comparison with SECI model and Ba (see figure 2), the Leadership space can be thought as an instance of the Originating Ba where physical face-to-face experiences are the key to conversion and transfer of tacit knowledge between people who complement each other.
4.3.2. The Evolution and Progress Space

This space represents a place, which was a physical room situated at Headquarters where P1 and P4 had to work and to learn in interaction with the Multidisciplinary Group. In the Evolution and Progress Space, P1 and P4 have had to practice their own deductive reasoning and to learn to work with the Multidisciplinary Group practicing an inductive reasoning. So people were interacting following dialogic principle. In the Evolution and Progress Space, learning was especially effective, and interpretative frameworks of P1 and P4 were evolving. Arrows show: (i) how P1 and P4 evolved in the Evolution and Progress Space; (ii) how P1 and P4 disseminated their new knowledge in their own unit, and how organizational learning was deployed. The Evolution and Progress Space has proved to be a place of contacts, a field of multiple cultures, where the potentialities of each knowledge owner have been capitalized.

The Evolution and Progress Space can be thought as both instances of the Dialoguing Ba and the Systemizing Ba because all phenomena described section 3.1.2 appeared in practical terms.

4.3.3. The Working Space

This space represents two operational units (Core Competence A and B), whatever is their geographical localization, where P1 and P4 are employees whose roles are to communicate on KBS, and to implement applications in their own unit. P1 and P4 are used to deductive reasoning.

The Working space can be thought as an instance of the Exercising Ba where people who have had the opportunity to work and to learn with the multidisciplinary group transmit their new knowledge (concepts, tools and methods of the innovative technologies) to the members of their own unit. There is a transfer of explicit knowledge and a continuous conversion of this knowledge to tacit knowledge by its use in the real life and implemented applications.

4.4. Outcomes

The status of knowledge-based systems (KBS) development, as of October, 1991, is presented on the basis of a simplified problem-solving process typology close to the company's preoccupations (see Table 2).

92 cases broken down as follows were handled: 27 studies, 31 mock-ups, 17 prototypes, 17 systems. 50 physical systems described in a catalogue in different domains: 38 in the interpretation and diagnosis domain, 10 in the conception and design domain, 2 in the monitoring and process control domain.
5. Conclusions

In this paper, referring to the Model for General Knowledge Management within the Enterprise (MGKME), we emphasized two of the operating elements suggested by this model: the “Ad hoc Infrastructures” element, and the “Organizational Learning Processes” element. From a KM viewpoint, these two elements are essential to insure the organizational learning process that leads people to appropriate and use concepts, methods and tools of KM considered as an innovative technology.

Then, considering the case of Artificial Intelligence and Knowledge-based Systems (KBS) deployment within a large industrial company, we made a link between the “Semi-opened Infrastructure” model implemented in that case, and the Nonaka’s SECI models, and the Japanese concept of Ba, which underlie the two MGKME’s elements mentioned above. In that way, we made a transposition considering this model as an instance of these two MGKME’s elements. Consequently, we partially validated MGKME.
Likewise, we pointed out that the “Semi-opened Infrastructure Model” (SopIM), although implemented more than a decade ago in different innovative technologies deployment circumstances, was consolidated by the theoretical Nonaka’s SECI models, and the Japanese concept of Ba. So, we recommend stakeholders, in charge to deploy innovative technologies within large enterprise, to use SopIM as a pattern of reference to implement an “Ad hoc infrastructure”, which insure them to practice a sociotechnical approach. That will engender the necessary organizational learning process that is essential to make people appropriate and use innovative technologies, allowing a successful deployment of these technologies.

References


