Adapting Organizational Knowledge Management Cultures to the Knowledge Life Cycle in Innovation Processes

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Abstract

Innovation is a knowledge-intensive process with a specific knowledge culture and respective requirements towards knowledge management support. Although a common underlying core innovation process can be identified, process variants are influenced by factors like the organisational culture, type of innovation, and the application domain also have implications for the knowledge management culture within the innovation process. This paper discusses such factors influencing the innovation and knowledge culture as well as consequences for the systematic support of innovation by information and knowledge technology.

1. Introduction

The success of industrial and scientific research has always been dependent on new discoveries and innovations. Global competition and tighter budgets increase the pace with which innovation must happen nowadays and therefore managing innovation activities successfully becomes more and more challenging. Innovation comprises product and process development and occurs in industry as well as in academia. It starts with an adequate identification of goals including an appropriate problem description and ends with the successful exploitation of the solution to the problem. Therefore, innovation activities are understood as dealing with complex problem-solving processes in which different types of knowledge are required to solve the problems at hand. This means, innovation activities are knowledge-intensive processes in which knowledge of different types is applied and created in various activities [Pérez-Bustamente, 1999; Ruggles & Little, 1997].

Thus, systematic support of innovation processes with the final goal of accelerating innovation requires effective and efficient management of knowledge related to innovation with regards to activities like acquisition, creation, enrichment, retrieval, reuse, and combination of such knowledge. When taking a closer look on innovation activities in different areas a common core innovation process can be identified. Within the European project INNOVANET (see www.innovanet.eu.com) we developed and validated a high-level model of this process that consists of six process phases: Problem Identification, Ideation, Approach Development, Operationalisation, and Exploitation. The specific characteristics of the innovation process imply an innovation-specific knowledge life-cycle and knowledge management support that reflects innovation-specific knowledge (management) culture.

Innovation processes occur in organisations which differ in e.g. products, organisational structures, history of development, native country and language and therefore, culture. This respective context of each individual innovation process within an organization is dependent on the cultural factors which influence the characteristics of the process and forms a unique innovation culture as well as innovation process variants and can be described in terms of artefacts, values and basic assumptions. Some of these context factors also influence the innovation-specific knowledge (management) culture. After

presenting the aforementioned innovation process model and the associated knowledge life cycle (section 2) this chapter focuses on innovation culture factors that influence the knowledge culture and knowledge management practices in the individual innovation process (section 3).

The information and knowledge management tools employed in support of the innovation process reflect and influence the knowledge management practices (and culture). As a practical application of the identified context factors, section 4 of this chapter also discusses a blueprint for an innovation engineering environment (IEE) that was also specified and validated during INNOVANET. It systematically and effectively supports the innovation process by adequate information and knowledge technology. This IEE reflects the knowledge management characteristics of the innovation process as well as the process variants. The chapter closes with some conclusions for effective and systematic knowledge management in the innovation process.

2. Innovation Process and Knowledge Lifecycle

Innovation comprises product and process development, the production itself as well as the successful exploitation of new ideas (compare e.g. (Specht et al., 2002; Rogers, 1998; OECD, 1997)). Innovation occurs in the development of new scientific approaches and theories (scientific domain), developing new products and in enhancing the business processes (new production models, new marketing campaigns). In spite of this broad understanding of innovation a common core innovation process and an associated knowledge lifecycle can be identified.

2.1 Innovation Process

Innovation is embedded into a problem cycle (see figure 1). Innovations are triggered by selecting a problem out of a pool of known problems aiming to solve this. These problems may be imposed by market needs, triggered new requirements towards a product, or by changes in the environment. More systematically, we can distinguish

- *proactive* forms of problem identification, including trend setting, recognition of market opportunity, need creation, identification of research opportunity and
- *reactive* forms of problem identification, like open problem in production or processes, changed requirements, reaction to changed environments due to other innovations.

A successful development of a solution and the successful exploitation of the innovation result solve the problem which triggered the innovation. At the same time the innovation also changes the environment, i.e., it becomes part of the environment and thus creates new challenges and possibly new problems that can be solved by new innovations after awareness has been created for the new problem.

As already mentioned above, the high-level Innovation Process Model was developed and validated in an EU-funded project. This process model is a domain-independent meta-model which describes innovation as a number of activities distributed over time (Paukert et al., 2003). The process is divided into six distinguishable but overlapping phases called Problem Identification, Ideation, Approach Development, Operationalisation, Evaluation and Exploitation. The activities in Problem Identification include identification and description of the identified problem in the problem cycle. In Ideation, a solution for the identified problem is searched and characterized before an approach describing for solving the problem is developed. During Operationalisation a prototype of the solution is produced which is tested in an evaluation phase. Exploitation may consist of commercialisation of the developed product or process in a business context or distributing new scientific insights via publication.

The basically sequential order between these phases is in no ways strict. Overlaps may exist between and iterations within the phases as well as within the sequence of phases, especially in situations where, due to (intermediate) results or external events, revisiting earlier phases becomes necessary. Pérez-Bustamente also stresses this need for feedback (Pérez-Bustamente, 1999). Furthermore, well-defined points for deciding about the further processing are crucial within the innovation process.

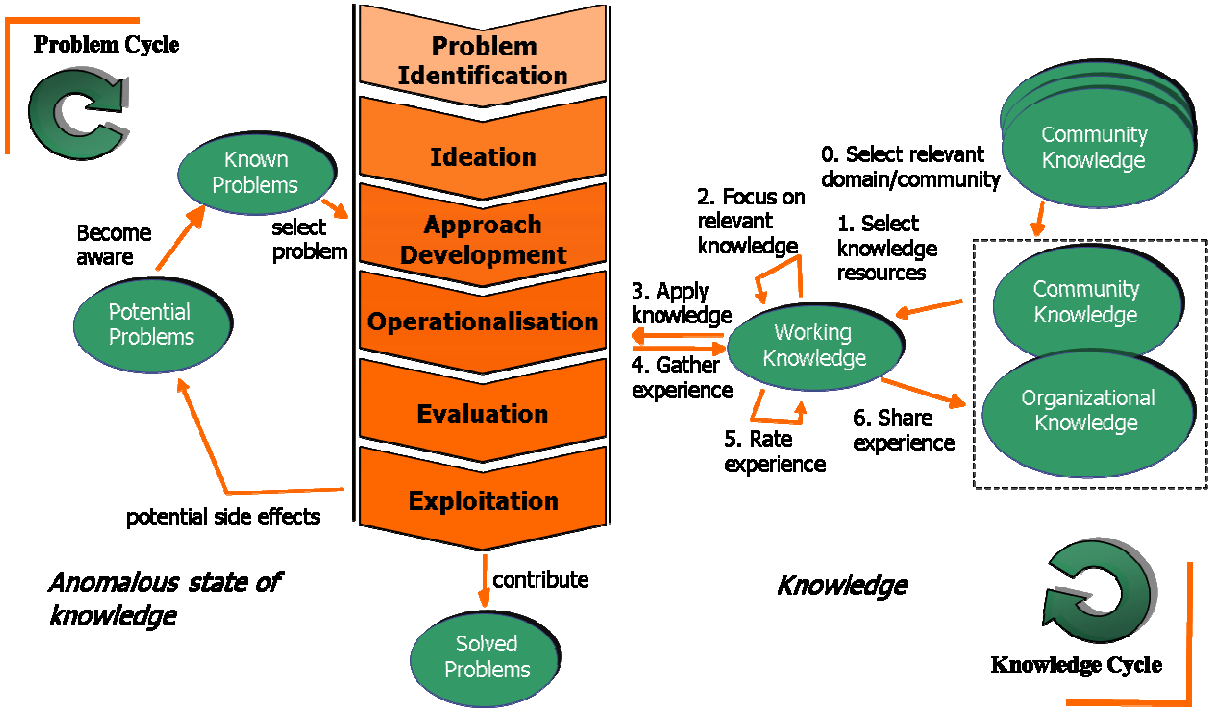

Figure 1: Innovation Knowledge Lifecycle (ILKC)

2.2 Knowledge Lifecycle within the Innovation Process

The overall innovation knowledge cycle is based on lower level knowledge life cycles (Pérez-Bustamente, 1999; Ruggles & Little, 1997) and covers the flow of knowledge in the innovation process with a special focus on knowledge application to support innovation. Especially, it follows the argument of Fischer and Ostwald (2001) that knowledge creation is integrated into the work process and is not a separate activity.

In each phase of the innovation process, relevant knowledge domains or communities need to be selected in order to find appropriate knowledge resources. Focusing on relevant knowledge objects, the knowledge objects are applied to solve the problem. By applying the knowledge, experience is gathered and rated in order to share this new experience with others. So, new knowledge is created in each phase of the innovation process.

3. Innovation Knowledge Culture Dimensions

Cultural as well as other factors lead to instantiations of innovation process variants and therefore influence the knowledge culture within innovation processes.

3.1 Understanding of culture

Kroeber and Kluckhohn (1952) define culture as behavioural patterns which are transmitted by symbols, including their embodiment in artefacts. The essential core of culture consists of values shared by the associated community. This broad definition of culture is suitable for different types of culture including nations, organizations and smaller groups of people like teams.

More specifically for our innovation context Sourrisseaux, defines organisational culture as "consisting of values, norms and behavioural patterns of all members of the organisation as well as their manifestations (artefacts) which were developed within a certain organisation and which are influencing the actions of the members in some way" (Sourrisseaux, 1994). This definition is almost congruent with other definitions of organisational culture (cf. Staehle, 1999, Isaac & Pitt, 2001).

Schein (1985) describes three levels of culture on which culture appears in different flavours.

Level 1 – *Artefacts* – is the most visible level of culture. It contains visible and audible behaviour patterns, art, architecture, and output of the cultural group, overt behaviour and technology.

Level 2 – *Values* – reflects a group's or person's vision of what "ought" to be. Such values are typically consciously perceived and can be articulated because they are part of the rule system of the group. Values, thus, form a general behaviour standard which gives security to people within the group (Ahlheim, 1990).

Level 3 – *Basic Assumptions* – contain invisible and unconscious assumptions which steer behavioural patterns. They are non-confrontable and non-debatable. The content of these assumptions can be the beliefs about the nature of reality, time and space, of human nature or of human relationships and so on.

In general, not only one organisational culture, but also several subcultures may exist within an organisation. These subcultures can develop when member groups of the organisations face similar problems, situations or experiences. This might develop within departments or at different locations of the same company (Robbins 2001), within a group of members of the same socio-demographic attributes or within a group of workers with the same activities (Staehle, 1999). Subcultures do not have to conflict with the overall organisational culture; they differ in their values but a corporate structure of values is identifiable (Merkens, 1988). According to Bleicher the relationship between corporate culture and subculture can be either complementary, indifferent or substitutive (Bleicher, 1991).

3.2 Innovation and Knowledge Cultures

Important factors that determine variants of the innovation process within an industrial or scientific innovation, i.e., research and development (R&D) context can be described along several dimensions of which some are listed below. The list is not intended to be exhaustive, but it provides an overview over relevant dimensions which have an impact on the culture of an innovation team.

- *Organisational context:* Organisations have their own culture which also influences cultural characteristics in an R&D context (see above). Moreover, organisational factors as the organisation structure impacts for example communication and control mechanisms in an organisation (Specht et al., 2002). Also, the organisation's reward structures (money, incentives, other benefits, recognition, reputation etc.) (Katz, 1997) and the definition of the leadership styles, for example problem-mindedness vs. solution-mindedness play an important role in the development of cultures. A high degree of bureaucracy within an organisation can even inhibit innovative behaviour (Agrell & Gustafson, 1996).
- *Type of innovation*: Innovations lead to problem solutions which can differ in the degree of novelty of the solution and the amount of change implied. The TRIZ terminology suggests 5 levels of innovation. This ranges from small incremental changes implementing improvements of existing systems or products on level 1 to revolutionary changes on level 5 that offer solutions outside the confines of contemporary scientific knowledge (Shulyak, 1977).
- *Application domain*: Each application domain requires different methods, conceptualisations, and knowledge objects for the development of new products, processes, or services and the development is constraint by other side conditions. Obviously, the evolving artefacts depend on the domain as well. Automobile industry, for example, needs preformed metal pieces, different patents, evaluation methods like measuring air flows for producing new vehicles. In the pharmaceutical industry, in contrast, drug development requires medical evaluations and is based on chemical and medical knowledge.
- *Methods and technology*: The innovation culture is also influenced by systematic (application-) independent methods and tools that are applied to support the process. This includes methods for project management, creativity techniques, risk analysis or IT support like communication tools, specific innovation support software, knowledge sharing software, etc.

- *Use of knowledge*: Knowledge is a key factor within innovation. The importance and appreciation which is attached to knowledge within an organization is reflected by its knowledge management culture, which influences the innovation process. Formalising and converting knowledge from its tacit to explicit state (Nonaka & Takeuchi, 1995) makes it independent from the individual and therefore shareable and exchangeable. Sharing knowledge is important since more people have access to it and thus a wider knowledge base for new thoughts and ideas. It increases the value of this knowledge and is an important goal of knowledge management. The readiness of persons to share their knowledge, on the other hand, is besides other factors influenced by the organizational culture.
- *Culture of the innovation team:* Cultures develop within groups whose members face similar experiences; thus, it can be expected that a specific innovation culture develops within an innovation team which comprises similar values, norms and behaviour. Similar to the innovation process, there is a common core of the culture based on similarities in all R&D contexts, because similar situations and problems are faced, e.g., unclear work results or changing work routines. Though, there are variants in the R&D cultures due to the fact that innovation teams develop their own group structure, group climate, and group beliefs (Agrell & Gustafson, 1996) which has an impact on the R&D department itself;
- *Individual mindsets and traits*: Mindsets and traits influence the innovative behaviour of an individual. For example, concern for quality and the degree of involvement in the innovation project are positively related to the performance (Tamhain & Wilemon, 1997). Creativity (Agrell & Gustafson, 1996) - the ability to produce new and original ideas - is a crucial ingredient in innovative environments to generate unidentified solutions to know problems. Although creativity can be increased by good collaboration, individual creativity is a central precondition for innovation.

A systematic analysis of innovation cultures along these innovation dimensions are an important prerequisite for improved innovation and innovation support:

- In spite of necessary variants in innovation cultures, some innovation cultures are more successful or allow faster innovation. An awareness for the own innovation culture and for the strength and weaknesses of other innovation cultures is the basis systematically improving the innovation culture within an organization.
- Each innovation culture demands its specific support by knowledge management techniques and tools which are adapted to the specific requirements stemming from the innovation culture. Awareness for the characteristics of the respective innovation culture is a prerequisite for adequately adapting technology to the innovation culture.

However, the systematic description and evaluation of innovation cultures is still in its infancy. An important step in this direction is the description of innovation culture within an organisation along the aforementioned dimensions in terms of artefacts, values of the group members, or basic assumptions. The organisational structure, the type of innovation, group structure, rewards, bureaucracy, the kind of technology and the use of technology can be identified by exploring respective artefacts by document analysis since these culture characteristics will be documented in one or the other way. The concern for quality, high involvement, creativity, group climate, leadership, the use of knowledge and transparency fall into the values category and can be identified with interviews or questionnaires. Beliefs of a group can only be found out with depth psychological interviews since the basic assumptions are mainly unconscious (Schein, 1985). In addition to enabling technology adaptation, awareness for the own innovation culture and other innovation culture is also a central precondition for improving the innovation culture within an organization.

4. Systematic Support of Innovation

For optimal support of the innovation process knowledge management techniques and technologies have to be adapted to innovation culture specific requirements. This section discusses the influence of selected innovation culture dimensions on knowledge management culture and technologies as well as

an adequate approach to systematic innovation support that can cope with the innovation culture and process variants.

4.1 Knowledge Management Culture Impact

Focusing on the Knowledge Management of a R&D department or a work group which conducts innovation, not all of the dimensions identified in section 3.2 are relevant for describing the Knowledge Management culture and not all of them influence knowledge management culture and practices within this group in the same way. Important examples of dimensions that strongly influence the knowledge management culture are the innovation type and organizational context.

The type of innovation according to the TRIZ systematic (Shulyak, 1977) causes differences in the behaviour of people searching for knowledge. For an innovation which consists of minor extensions or improvements the first three steps of the knowledge cycle (select domain, select resource, and focus on relevant knowledge) does not represent a challenge and might be even neglected if the improvement consists in changing the colour of plastic cups from green to red in a company which uses both kinds of colours. Larger innovations require new types of knowledge possibly not used before, which makes selection as well as adaptation of knowledge much more difficult. The challenge becomes even larger when knowledge from another domain or community is needed to solve an innovation problem. In this case the innovator is confronted with a different conceptualisation of knowledge. A level five innovation requires even more new knowledge and a new way of thinking. Due to its revolutionary character such large innovations invalidate part of the best-practice knowledge used so far in the domain. In addition, the level of uncertainty is much higher since innovators are lacking the possibility to judge the knowledge objects they retrieve in their searches adequately. It is obvious that these different characteristics of the innovation types result in different knowledge management cultures.

A further important innovation culture dimension that also influences the knowledge management culture is the organizational context. The organizational context impacts, for example, the readiness of persons to externalise their knowledge and make it available for other persons in the organization. The degree with which knowledge is considered as a personal or an organisational asset by individuals depends on how knowledge sharing is honoured in an organisation; transparency and availability of knowledge are ensured. Honouring knowledge sharing may be informal recognition by colleagues or supervisors or a mutual exchange of knowledge and support. Or it may happen explicitly with rewards, like a bonus or a promotion, by the management. Negative influences of the dimension organisational context become obvious when employees keep their knowledge to themselves and only reveal it when it is beneficial for them irregardless of the harm to the organisation. This may happen when employees see the only way for recognition and rewards by keeping knowledge as a secret as long as possible. An organisation with many regulations and formalised administrative procedures can inhibit knowledge sharing if this is connected to filling out many forms, asking permissions and requiring official approval also for minor decision.

4.2 Innovation Engineering Environment

Systematic support of the innovation process may contribute to accelerating innovation. Such innovation support and the knowledge management tools applied in innovation have to be flexible and adaptable in order to take into account that

- that the different phases of the innovation process have specific requirements,
- that innovation cultures differ from one R&D context to another, and
- that cultural characteristics can change over time (e.g. the type of innovation, team composition)

For an Innovation Engineering Environment (IEE) for systematically supporting innovation processes by knowledge technology the following four types of core components have been identified in the INNOVANET project:

- *Innovation Process Management:* This component is necessary to support the general management of innovation processes. Indeed, even though innovation processes present peculiar aspects, an innovation process is first of all a process, and as such it must be managed. Therefore,

the first component of the IEE contains tools that allow innovation managers to plan, log, and monitor the innovation process phases as well as the related activities and resources.

- *Generic Innovation Support Components*: This is the core component of an IEE. Its sub-components provide classes of functionalities which are intrinsic to knowledge management functionality of any innovation process, independently from the domain in which the innovation process occurs, and from the application. Four main classes of functionalities have been identified: adequate representation, intelligent matchmaking, discovery, and interaction support. An adequate and compatible modelling and representation of a wide variety of innovation resources like communities, processes, content, problems, persons and methods provides the basis for an intelligent support for matchmaking between such innovation resources like the matchmaking between humans and tasks, problems and solutions, tasks and methods as well as between concepts and perspectives of different communities. Such matchmaking facilitates decisions during the innovation process and provides inputs for the monitoring, steering, and optimizing innovation processes. Furthermore, the discovery of new knowledge, new (and typically unexpected) relations between entities, and regularities in large collections of data gives new impulses to an innovation process. Typical results of discovery are new knowledge, communities, pattern of behaviour, problems and analogies. Finally, the targeted support of interaction between the entities involved in an innovation process is another important functionality for successful innovation support. This includes support for the communication and collaboration between humans but also support for the targeted interaction between humans and other innovation resources.
- *Application-Specific Support Components*: Besides the discussed generic support tools that are applicable in all application domain, effective innovation support also requires tools that are domain-specific. This holds especially true for the approach development and operationalisation. Examples of such tools are design and simulation tools. In the design of the IEE it is important to enable the flexible integration of existing and newly developing application-specific tools supporting
- *Innovation Environment Configuration Support*: The systematic innovation support tool and its components are only the common starting point for the final IEE. This functionality has to be specialized for the different phases of the innovation process. Specialization may include method and tool selection, tool configuration, and user interface design. IEE specialization results in a system architecture that provides specific support for the different phases of the innovation process based on the generic tools and functionalities suggested by the Innovation Knowledge Lifecycle. However, we are well aware that, although generic innovation support components can be identified for every process phase, specific domains, organization, and even innovation teams may require a fine tuning of the environment according to their specific innovation culture. The specialized system is thus an IEE framework rather than a tool. Employing the tools contained in the Innovation Environment Configuration support component the framework can be customized into the IEE Tool determined by the requirements of the innovation culture context it is used in.

Following a metadesign approach (Fisher 2000) tools for the customization step can be part of the framework itself increasing the flexibility of the approach and enabling to involve the innovators themselves into the customization process. This also allows the evolution of the system, when the innovation culture within an organization changes along one or more of the aforementioned dimensions.

5. Conclusions

The influence of technology on organisational cultures must not be underestimated. Schein (1985) defines technology as separate cultural factor – new technology brings its own occupational culture. Changes in technology affect the requirements on employees and leaders, organisational and communicational patterns are subject to change as well as social relationships (Neuberger & Kompa, 1987). This also means that the introduction of an IEE as it is sketched above will not only support innovation but also will effect the way innovation is done within an organization, i.e. the innovation

culture. A systematic study of innovation culture is thus a prerequisite for building an adequate IEE, in order to assure that the IEE will influence and foster the innovation process in the right way, i.e. accelerating innovation, supporting the selection of successful innovation ideas, fostering an open and creative knowledge management culture within an organization.

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