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A Framework for Assessing Inter-organisational Knowledge Management in New Product Development

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Abstract

This paper proposes a human-centred solution framework for KM in the extended enterprise. The framework allows for the identification of key prerequisites and enablers for inter-organisational knowledge management in the product development process. In the end the framework provides a check-list to assess inter-organisational co-operations towards their knowledge management preconditions. Looking at knowledge as being something bound to individuals, the authors are convinced that knowledge itself cannot be managed unless the individual and his communication behaviour is put at the heart of the observations. Building on the concept of von Rosenstiel [1] that describes the driving forces of human behaviour, examining the barriers related to knowledge management identified through interviews and questionnaires in engineering environments of a supply-chain in the telecommunication sector, and having made an extensive literature review, the authors present a valuable concept to close the gap of missing instruments for establishing lasting inter-organisational cooperations from a knowledge management perspective.

Keywords: knowledge management, integrated product development, extended enterprise, supply-chain management, human factors

1 Introduction

Traditionally, the original equipment manufacturer (OEM) was solely responsible for the development of new products and the suppliers' main duty was to deliver cost-effective and high quality parts, products and services as defined in the requirements specification by the OEM. Today, however, more and more businesses are moving towards a close collaboration with their costumers and suppliers already in the early phases of the product life cycle and in particular in the new product development phase. One of the reasons for engaging in cooperations is the need for specific know-how not available in the boundary of one's own organisation.

However, close cooperations also bear high risks for all partners, so that cooperations often fail (see Theis [2]). Depending on the performed study, the identified amount of failures vary between 30%-70%. One of the main causes mentioned in literature is the insufficient audit of the companies ability to co-operate. These facts and the high demand for supply-chain management projects indicate that there is still a need for instruments to optimise inter-organisational processes in vertical cooperations.

Should the access to external knowledge sources be the focus of a cooperation, it is necessary to look at the key drivers, influencing factors and prerequisites of inter-organisational knowledge management (KM). Although 10 years of research and industrial practice have brought forward a large body of knowledge and maturity in KM it is still difficult for companies to systematically integrate their day-to-day business with customers and suppliers through inter-organisational knowledge sharing activities. The majority of work concerning KM is restricted to

internal issues and companies do not use their mutual knowledge optimally due to their failure to identify and overcome cross boundary barriers to knowledge sharing.

The objective of the authors' research work is thus to identify the barriers for inter-organisational KM and to develop approaches for overcoming these barriers. It is the conviction of the authors that the principles of KM are basically the same across every level of collaboration. However, the importance of each principle for each level is different, thus resulting in the need for a gradual change of focus in activities, when addressing different levels. Based on this assumption, the authors propose a conceptual framework for KM which is related to different levels of collaboration (individual, team-oriented, organisational and inter-organisational) on the one hand, and focus of activities (training, motivating, organising, evangelising and contracting) on the other hand. The aim of the framework is to provide transparency about the prerequisites and enablers for inter-organisational KM, thus enabling organisations to get a deeper understanding of their as-is situation. It aims to support KM practitioners in assessing their KM practice with practical checklists and then to point to the right methods and tools for the right purposes.

2 Approach

The research work of the authors started with the identification of barriers to inter-organisational KM. We conducted semi-structured interviews and workshops with 30 design engineers in three companies in the telecommunications supply chain involved jointly in new product development. The interviews were analysed with the Theme Based Content Analysis (TCBA) of Neale and Nichols [3], and the barriers were classified using a classification technique proposed by Brandt and Hartmann [4], the TOP for socio-technical systems, according to which they can be categorised into technological, organisational, and people/human barriers.

In order to verify the collected data, a questionnaire was then sent to the design departments of 300 European companies and answered by about 50 companies. Issues addressed by the survey were, e.g. current strategies, incentives, measures to foster personnel's KM capabilities, barriers to and requirements for inter-organisational KM. Additionally, the data was compared in a literature review with other statements about KM barriers, though these are still mainly limited to intra-organisational barriers.

The authors then combined these findings with Rosenstiel's theory about human behaviour [1], mainstream KM concepts (such as e.g. Nonaka and Takeuchi [5] or Probst et al. [6]), and own work about pragmatic KM (see Thoben, Weber and Wunram [7]) for proposing a human-centred framework for inter-organisational KM. The framework was verified by discussing it intensively within the KM community and it was refined in several iterative steps. In order to transform the conceptual framework into a practical and operational tool, the authors elaborated for each element of the framework a set of prerequisites and enablers. This resulted in a final checklist with the enablers and prerequisites of inter-organisational KM.

3 Identifying the engineering knowledge to be managed

Beside other results, the interviews with design engineers and the surveys identified that most companies have not explicitly implemented an inter-organisational KM strategy up to now, despite the fact that KM has gained significant attention in recent years and that most companies consider the exchange of knowledge to be very beneficial and important. In their latest survey,

however, KPMG [8] have identified, that this will be on of the future tasks of companies active in KM along the next years.

The new product introduction process, as being knowledge intensive (confere Starbuck [9], Eppler [10]), is par se of special interest for knowledge management activities. Being aware of the fact that definitions of the term 'knowledge' are existent to a inflationary degree - thus being discussed differently depending on the perspective taken (see Schindler [11]) - the authors use the definition according to Probst et al. [6] as being the entirety of cognitions and abilities, used by individuals to solve problems. This comprises theoretical perceptions as well as practical day to day rules and guidelines. Further Probst et al. [6] state, that knowledge is based on data and information, however it is always bound to individuals. It is generated by individuals and represents their expectance about cause-effect relationships. This definition therefore implies, that knowledge cannot be managed without involving the individual design engineers. In addition, in order for the design engineers to be able to create knowledge the data and information environment must be regarded. In the following the term 'knowledge' will be used as super-term for all three elements in the above understanding.

In order consistently identify the knowledge, that design engineers in a supply-chain in the telecommunication sector intend to exchange, the authors developed a concept building on the works of Quinn et al. [12], Bach et al. [13], Wiig [14], Romhardt [15] and Metternich [16] (see figure 1).

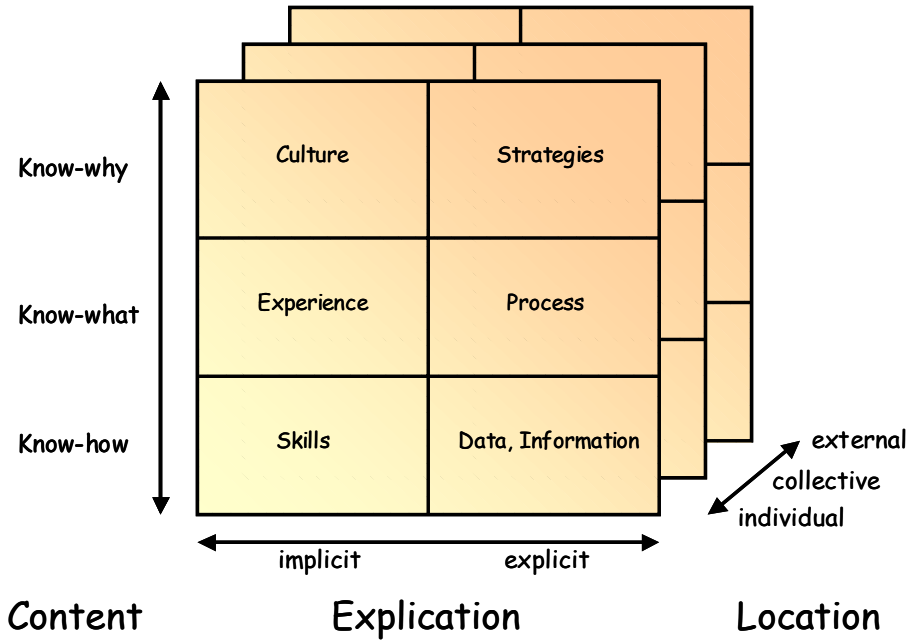

Figure 1. Knowledge classification framework.

The classifications of Quinn et al. [12] and Bach et al. [13] describe different types of knowledge according to their strategic usefulness. The basic difference between both approaches is the naming of the categories, while the content is very similar. Bach et al. [13] allocate the three identified categories to the operational level (know-how), to the middle management or tactical level (know-what) and to the strategic level (know-why). Wiig [14] gives a similar description of knowledge from a conceptual perspective. From a manifestation perspective, he proposes a structure in what form knowledge can appear to individuals. In a broad analysis of dichotomies for the description of knowledge Romhardt [15] concluded four dichotomies of knowledge to be most relevant for practical use (individual vs. collective, internal vs. external,

implicit vs. explicit, analogue vs. digital). His broad analysis of dichotomies for the description of knowledge and their practicability are of great use for CORMA. The model presented by Metternich [16] somehow seems to integrate all approaches presented above. However, the content perspective of his model does not reflect all issues as presented by Bach et al. [13]. Metternich [16] also does not distinguish between analogue and digital information and data like Romhardt [15]. The authors therefore felt the need to make a differentiation between the contents on all three strategic levels (strategic, operational and tactical) since it eases the process of granting access of individuals to specific information (e.g. if a manager wants to know about the general goals of a project and not about any technical details he will certainly not want to go through all files available. A corresponding structure facilitates the search). Following the argumentation of Romhardt [15] (knowledge is based on data and information) and therefore sees the necessity to consider the distinction analogue/digital in a model. This is necessary since the handling of digital data/information is obviously different from handling analogue data/information.

Though currently a close inter-organisational cooperation in product development seems to be usual, these primarily focus on the exchange of product data rather than real development know-how. In the analysis of the authors, design engineers expressed to better and more intensively share, amongst others, the following know-how topics across organisational boundaries:

- Product: e.g. manufacturability, testing results, best way to assemble etc.
- Technology: e.g. materials, patents, theories etc.
- Standards: e.g. in different countries, quality, proprietary etc.
- Trading: e.g. company strategy, intellectual property rights etc.
- Design: e.g. competitors design, principles, previous experience etc.
- Communication: e.g. language, jargon, interpretation etc.
- Process: e.g. design process, inter-company processes, communication processes etc.
- Information technology: e.g. data security, available tools, process mapping etc.
- Knowledge issues: e.g. assumptions, different contexts, experiences, “gut feelings” etc.

4 Barriers to managing knowledge across organisational boundaries

In their semi-structured interviews and their survey the authors identified a variety of barriers that obstruct the efficient sharing of knowledge across organisational boundaries (compare Barson et al. [17]), some of them are mentioned hereafter:

- *International differences*: The most obvious international difference is language. A British participant highlighted that, “We do not try to speak other languages which can be difficult. We take it for granted that others will and that it is easy. However, it must be very hard for them and they may not express themselves very well.”
- *Different working styles*: There are also differences in working methods and style. Another British contributor suggested that, “Germans are very thorough and will meet time schedules. We are not so methodical and thorough. Time schedules should be met, but are not set in stone.”

- *Organisational differences*: One contributor felt that organisational differences were greater than national differences. These differences include working methods, techniques, and reporting styles. Terminology and "corporate jargon" can also vary between organisations.
- *Departmental differences*: There are also differences in way different departments work and interact. For example friction between buyers and engineers was identified a number of times because of the different perspectives from which the two departments operate.
- *Scepticism towards technology*: The reaction of some was "oh no – not another system". There was a feeling that a knowledge management system would result in more work, more bureaucracy and "just another something to fill in." This links with the barrier concerning a need for reward in that the users of the technology should be able to see that it provides them with direct benefits.
- *Need for rewards*: The need for reward operates on both a company and an individual level. On a company level it was highlighted that, "The customer may take all our information, and not give us anything back. We do not get anything out of it." At an individual level, contributors wanted to see what they would get from sharing their knowledge. Perhaps surprisingly, contributors did not want explicit incentives for sharing knowledge, such as increased pay, but wanted to see the value to them of disseminating their knowledge and experience. "Knowledge is power, what is the personal advantage for the person who gives the 'know-how' into the system?"
- *Fear of penalty*: Contributors were also concerned that the knowledge they provided was interpreted correctly, and that they were not held responsible if this was not the case. "What happens to the person who gave the knowledge, when the interpretation form the user is in a wrong way?"
- *Fear of losing resources*: The loss of colleagues was seen as a threat. "If internal structures made are public – staff may be head hunted". The telecommunications sector, where the CORMA research is being carried out, is rapidly growing and recruiting; hence staff are jealously guarded.
- *Fear of losing company stability/market position*: "Our technical information is what makes us unique – to share the information with competitors could be suicide"; "As a customer we tend to tie up our suppliers down and bully people, we swallow up smaller companies, this could happen to us if we open up".
- *Protection of proprietary knowledge*: A common theme was the potential loss of proprietary knowledge, for example, "We feed all our information into customers and suppliers, who may then share it all with our competitors or other bodies". As identified earlier, there is a need for trust between the organisations, and a need for the partner companies to act responsibly with the proprietary information of another organisation.

5 The development of the CORMA KM framework

Building on the identified barriers, it could be concluded that inter-organisational KM barriers were predominantly due to human/people and organisational issues and that technological barriers were stated as not being very relevant. This further motivated the authors to focus on human-centred and organisational issues in their KM framework. Considering that knowledge is bound to individuals as stated earlier, and that knowledge is created solely by individuals through social processes (confere e.g. Nonaka and Takeuchi [5], Capurro [18]) the

authors have concluded that knowledge itself cannot be managed, but what has to be managed are humans and the conditions under which social processes take place.

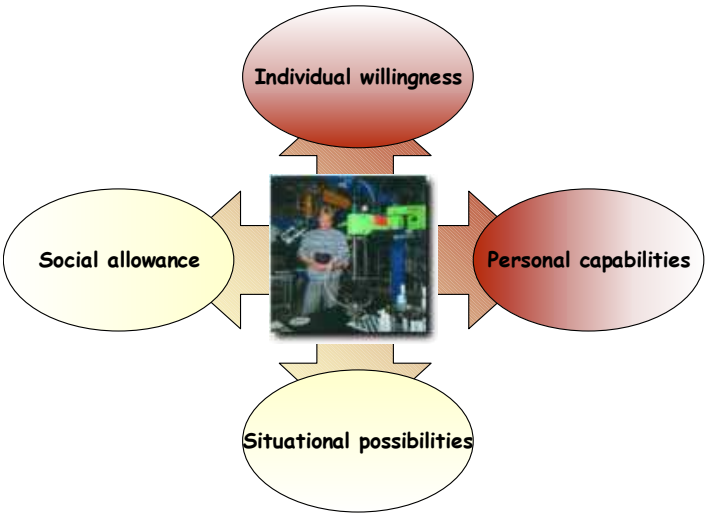

Figure 2. Drivers of human behaviour (adopted from [1]).

An important aspect of these social processes is the individual and his/her behaviour. According to [1] an individual's behaviour is basically driven by four forces (compare figure 2):

- Individual willingness (relates to motives and values)
- Personal capabilities (refer to skills and dexterities)
- Situational conditions (refer to impeding or favourable conditions)
- Social allowance (refers to group norms and regulations)

Starting from this concept it can be derived that there are internal preconditions (individual willingness, personal capabilities) and external preconditions (social allowance, situational conditions) that must be existent for a certain behaviour to take place in social processes.

The author's KM Framework (see figure 3 below) is conceived on the basis of this concept. Basically it consists of two dimensions of which one describes the level of cooperation (individual, team-oriented, organisational and inter-organisational) and the other describes the area of activity in which measures have to be taken (training, motivating, organising, relationship building, contracting, etc.). The first level of cooperation deals with the internal predispositions, whereas the other levels of cooperation deal with the external preconditions. When progressing from the individual level to the inter-organisational level, different preconditions related to different activity areas must be established at each level. It is important to point out that every higher level of cooperation must consider the aspects of all the lower levels.

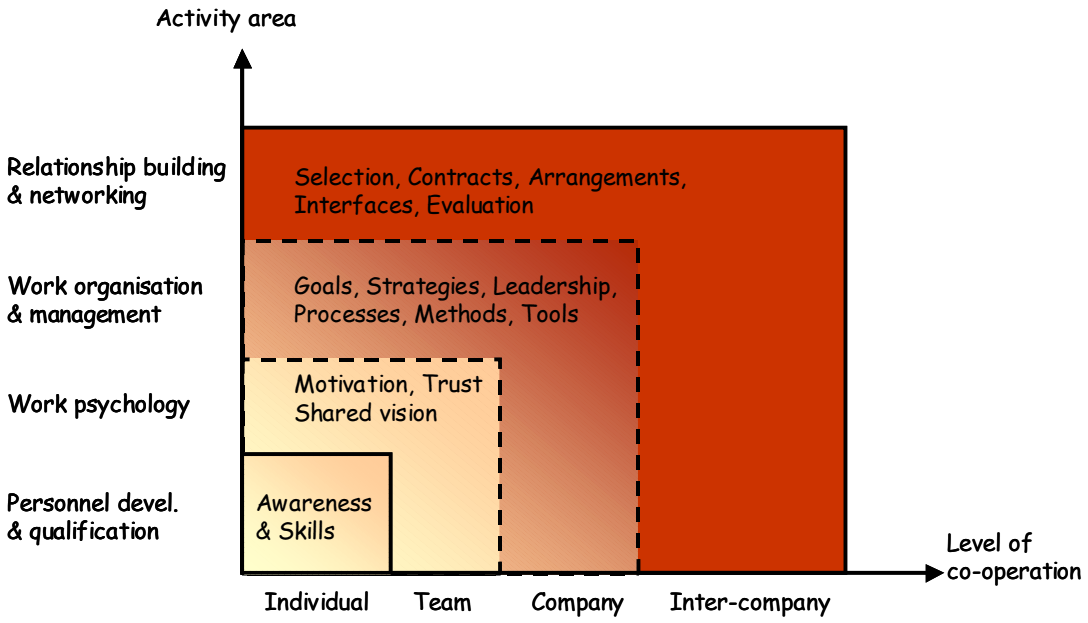

Figure 3. The CORMA KM Framework.

The framework is based on the assumption that inter-organisational KM begins at the smallest hierarchical level of cooperation, which is the individual employee. Thus, a condition precedent to practice KM is the availability of skills and abilities at an individual level. The main activity to be performed on this individual level is to train each individual, enabling him to practice KM (the related activity area is personnel development & qualification).

When entering the highest level of cooperation, which is the inter-organisational cooperation, the responsibility of the company level automatically increases, since it must address the issues of goals, strategies, processes and tools together with and in accordance to the cooperating company. Therefore, the main activities on this level will be the set-up of relationships, the establishment of contracts and arrangements, the definition of interfaces, as well as securing each company's intellectual property rights (IPRs) and interests.

Building on this framework 240 prerequisites for inter-organisational KM could be identified. These have been transferred into a web-based questionnaire that also provides real-time feedback of the assessment

6 Conclusions

Knowledge Management starts with the individual employee and moves across the boundaries of teams and organisations. The proposed KM framework serves well for explaining both intra- and inter-organisational KM and provides conceptual and practical guidance for assessing the prerequisites and enablers of KM in the product development process, or any other process. Future steps in the development of the framework will revolve around the identification of corresponding methods and tools that support each of these preconditions, and thus to provide even more assistance for implementing inter-organisational KM initiatives in product development processes. The difficulty in applying the framework lies in the acceptance of the fact, that there is no "one size fits all" solution for KM. The implementation of inter-organisational KM is very much dependent on the general strategy followed within the cooperation (e.g. codification vs. personification), thus the methods & tools applied could vary considerably. The CORMA KM Framework offers guidance to design engineers and other

people involved in the product development process. In addition a interdisciplinary participation in the implementation of KM is vital, specially for the new product development process in which by nature many different departments related to individual stages of the product-lifecycle are involved.

Though the proposed KM framework offers a concept to fill the gap of missing instruments to audit a companies ability to cooperate, its validity still have to be verified. For this purpose the IST project CORMA (www.corma.net) will start three distinct pilot projects in the telecommunication sector. Special attention will have to be paid to the sample of persons who are going to answer the online questionnaire, since questions might be answered differently depending on the hierarchical position and company.

7 References

[1] von Rosenstiel L., „Grundlagen der Organisationspsychologie“ Schaffer-Pöschel Verlag, Bd. 95, 2000.

[2] Theis C., “Qualitätsmanagement zwischenbetrieblicher Kooperation”, Dissertation at the Technische Hochschule Aachen, Berichte aus der Produktionstechnik, Vol. 97, Shaker, 1997.

[3] Neale H., Nichols S., “Theme-Based Content Analysis: A Method for User Centred Design and Implementation of Virtual Environments”, User Centred Design and Implementation of Virtual Environments, Special Issue of the International Journal of Human-Computer Studies, 2000.

[4] Brandt D., Hartmann E., “Research Topics and Strategies in Sociotechnical Systems”, Human Factors and Ergonomics in Manufacturing 9, 1999, 3, pp. 241-243.

[5] Nonaka I., Takeuchi H., “Die Organisation des Wissens – Wie japanische Unternehmen eine brachliegende Ressource nutzbar machen”, Campus, Frankfurt, New York, 1997, pp. 68-87.

[6] Probst G., Raub, S., Romhardt K., “Wissen managen – Wie Unternehmen ihre wertvollste Ressource optimal nutzen”, 3rd Edition, Gabler, Frankfurt am Main, Wiesbaden, 1997, p.46.

[7] Thoben K.-D., Weber F., Wunram M, “Towards Pragmatic Approaches for Knowledge Management in Engineering – Theory and Industrial Applications”, Proceedings of 13th International Conference on Engineering Design, ICED 01, Glasgow, 2001, pp. 91-97.

[8] KPMG Knowledge Advisory Services, “Insights from KPMG’s European Knowledge Management Survey” 2002/2003, p. 6.

[9] Starbuck W.H., “Learning by Knowledge-Intensive Firms”, Journal of Management Studies, Volume 29, Nr. 6, Blackwell Publishers, Oxford, 1992, pp. 713-740.

[10] Eppler M., Röpnack A., Seifried P., “Improving Knowledge Intensive Processes through an Enterprise Knowledge Medium”, Proceedings of THE 1999 ACM SIGPCR Conference, Managing Organizational Knowledge for Strategic Advantage. The Key Role of Information Technology and Personnel, 1999.

[11] Schindler M., “Wissensmanagement in der Projektabwicklung: Grundlagen, Determinanten und Gestaltungskonzepte eines ganzheitlichen Projektwissensmanagements”, Josef Eul, Lohmar, Köln, 2000.

[12] Quinn J.B., Anderson P., Finkelstein S., “Das Potential in den Köpfen gewinnbringend nutzen”, Harvard Business Manager, III/3, 1996.

[13] Bach N., Homp C., "Wissensmanagement als Querschnittsaufgabe des Kernkompetenz-Managements" Krüger, W. (Ed.): Arbeitspapiere Univ. Gießen, 1997.

[14] Wiig K. M., "Knowledge Management Methods – Practical Approaches to Managing Knowledge", Schema Press. Arlington, Texas, 1995.

[15] Romhardt K., "Die Organisation aus der Wissensperspektive – Möglichkeiten und Grenzen der Intervention", Gabler, nbf 245, Wiesbaden, 1998.

[16] Metternich J., "Wissen als Grundlage von Wettbewerbsstrategien – Ein Modell zur Analyse und Planung von Wissensstrategien". Shaker, Aachen, 2001.

[17] Barson R.J., Foster G., Struck T., Ratchev S., Pawar K.S., Weber F. and Wunram M., "Inter- and Intra-Organisational Barriers to Sharing Knowledge in the Extended Supply-Chain", e-2000 - Proceedings of the International Conference on e-Business and e-Work, Madrid, Spain, 2000, pp. 367 –373.

[18] Capurro R., "Grundfragen des Wissensmanagements", 1999. (WWW-site in german accessed 30.11.2000) http://v.hbi-stuttgart.de/WM/bausteine.htm#Grundfragen

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