



**FOM Hochschule für Oekonomie & Management
Essen**

Master Thesis

submitted in partial fulfillment of the requirements for the degree of
Master of Business Administration (MBA) on the subject

**Process-oriented Knowledge Management Concept:
An application for small and medium-sized enterprises within the
structural and mechanical engineering business**

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Essen, 25th July 2012

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Abstract

In current times the economical situation of enterprises is characterized by financial and economic crises which require consideration of tangible and intangible corporate values to be competitive. Knowledge - one aspect of immaterial asset - offers an opportunity to create benefit in case of its adequate management. The focus of research is set on identification of a knowledge management concept being suitable for practical application.

Within this work “ease of use” and “high degree of process-orientation” are identified as characteristics being indispensable for a successive applicability of a knowledge management approach within small and medium-sized enterprises. Based on the business process-oriented knowledge management of Fraunhofer IPK a modified approach is proposed. These modifications lead to an enhanced theoretical framework that is implemented to business daily work in a further step.

The theoretical concept consists of three layers being necessary to consider and if needed to improve for successive knowledge management. The choice of an adequate business process to be analyzed represents the central part of this method. The second layer describes the cycle of core activities being generation, storage, distribution and application of knowledge. The surrounding corporate environment is evaluated within the third layer by using the three aspects technology, human resources and organization.

According to the developed knowledge management strategy, the analysis of the three layers - describing the current corporate situation - enables the choice of adequate knowledge management instruments which have to be implemented within the corporate structure to improve the overall corporate knowledge management situation.

The modified business process-oriented knowledge management approach is applied within NEM Power-Systems being a small and medium-sized enterprise out of structural and mechanical engineering business. Out of the application findings, explicit recommendations towards the management team for further knowledge treatment are given.

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List of Abbreviations

BPOKM	business process-oriented knowledge management
e.g.	for example
ICT	information and communications technology
IPK	Institute for Production System and Design Technology
KM	knowledge management
KMC	knowledge management concept
LE	large enterprise
NPS	NEM Power-Systems
p.	page
pp.	pages
R&D	research and development
SME	small and medium-sized enterprise
SMEB	structural and mechanical engineering business

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“An investment in knowledge
always pays the best interest.”
- Benjamin Franklin (1706-1790) -

1. Introduction

1.1. Motivation

Nowadays the business environment is affected by driving forces like structural change, globalization as well as information and communications technology (ICT). These factors cause an increasing relevance of the resource of knowledge.¹ This is certainly not a new discovery since nearly two decades ago Drucker already stated,

“The basic economic resource is no longer capital,
nor natural resources, nor labour. It is and will be knowledge“.²

But nevertheless in recent years - characterized by financial and economic crisis - the treatment of corporate intellectual assets gains growing interest since it has an impact on cost reduction, competitive advantage and business outcome.³ Although the development of ICT enables a better availability of information and knowledge - leading to an improvement of economic productivity - the permanent increase of information is not an overall solution.⁴ A further problem arises because an uncontrolled accumulation of data does not - due to possible information overload - necessarily lead to an improved knowledge supply.⁵ Thus, it is essential to manage the resource of knowledge by an individual approach, knowledge management (KM).⁶

¹ See North (2011), p. 14

² Drucker (1993), p. 7

³ See Bach, Vogler & Österle (1999), p. 23

⁴ See Bryson (2006), p. 61

⁵ See Lehner (2009), p. 8

⁶ See Zaunmüller (2005), p. 1; Mertins & Seidel (2009), p. 1

1.2. Description of Problem

In recent times, a variety of concepts has been developed and suggested for KM in enterprises.⁷ None of these approaches is suitable for a general use since application of knowledge management concepts (KMC) strongly depends on individual business environment like e.g. corporate culture, motivation and skills or support by management.⁸ Implementation of an approach for KM is usually confronted with challenges like⁹

- limited time of the employees,
- lack of acceptance by the employees for KM,
- organizational process structure not designed for KM,
- no encouragement by current corporate culture for knowledge sharing,
- difficulties in case of preparing and structuring knowledge,
- lack of understanding of KM and benefits or
- lack of measurement, motivation, rewards to share knowledge.

Beside these general aspects - being important to consider for KMC integration - one has to distinguish between the different sizes of organizations. For large enterprises (LEs) successive implementations as well as benefit resulting out of applications of KM have been reported in literature.¹⁰ Nevertheless within the year 2009, 99.7% of all companies in Germany are small and medium-sized enterprises (SMEs) generating 39.1% of the total turnover and employing 60.8% of the total employees.¹¹ The overall conditions in SMEs differ from the ones in LEs due to¹²

- limited human and financial resources,
- perception barriers and
- concentration on operational and financial performance.

⁷ See Deking (2003), p. 188; Klosa (2001), p. 63

⁸ See Mertins, Heising & Vorbeck (2003), pp. 8-9

⁹ See Deng & Yu (2006), p. 65

¹⁰ See Reineke (2004), p. 3; Mertins & Seidel (2009), p. 1

¹¹ See Institut für Mittelstandsforschung Bonn (2009)

¹² See Garengo, Biazzo & Bititci (2005), pp. 28-30

To provide the potential of KM also for SMEs the Bundesministerium für Wirtschaft und Technologie initiated the campaign “Fit für den Wissenswettbewerb” in 2002.¹³ One of the supported projects of this initiative is the project “ProWis” of the Fraunhofer Institute for Production System and Design Technology (IPK). Aim of this project is not the development of new KMCs but rather the practical support of 15 SMEs by the implementation of KM. Thereby existing concepts and methods are modified onto individual SME needs.¹⁴ Awareness for the relevance of KM in SMEs is existent as a survey being conducted within the before mentioned project states. Within this research knowledge has been identified (beside cost reduction and competition) to be one of the three most relevant challenges of SMEs.¹⁵

To sum up, although one is aware of the significance of KM an adequate realization and implementation of KMCs within SMEs is challenging and case sensitive according to the special requirements of the individual enterprise.¹⁶

1.3. Objectives of Research

Aim of this work is to develop a KMC suitable for the practical use within small and medium-sized enterprises as part of a solution to reduce the before mentioned challenges. The proposed approach is applied within a certain SME out of structural and mechanical engineering business (SMEB).

The engineering process is selected as practical case study due to characteristics of knowledge intensity and core competence within the organization. A key component within the engineering process is the design department. Typical examples from daily business are novice designers needing KM to get all information required to improve their knowledge about products, processes, tools and to become experienced and skilled. But also experienced designers need KM to have quick access to information from other experts or projects. Another critical point is the interaction between different departments since interface deficiencies are often generated in case of knowledge transfer.

¹³ See Bundesministerium für Wirtschaft und Technologie (2007)

¹⁴ See Mertins & Seidel (2009), p. 2; Heck (2002), pp. 42-43

¹⁵ See ProWis (2006)

¹⁶ See Gust von Loh (2008), p. 48

The further research questions rise out of the before mentioned aspects:

- Which relevant criteria have to be considered in effective KM for SMEs within the structural and mechanical engineering business?
- Is there any existing concept suitable for these SMEs?
If not: Which are the improvements necessary for an application of the existing ones?

The goal of this work is to answer these questions.

Since implementation of KMC is complex and time consuming the procedure is not completely finished within a few weeks of this study work. A realistic period for KM implementation ranges from several months for department-wide projects to more than a year for corporate-wide systems.¹⁷ Within this work an approach is proposed and partly applied. Challenges and problems occurring within this phase of implementation procedure are identified and recommendations for further action are developed. This work shall be a first step towards a knowledge-oriented business culture within the treated SME out of SMEB.

1.4. Methodology of Research

The current work consists of a theoretical as well as a practical part wherein both deductive and inductive modes of knowledge generation are employed.¹⁸ A literature review helps highlighting the actual state of the art for the topic of KM. The examination includes the total bandwidth of KM literature from the basis of the standard books to other references including journal papers, conference proceedings as well as resources available on the internet.¹⁹ The focus is set on the different types of KMCs and their application with respect to SMEs. Although LEs shall not be included within this research the limited availability of literature of KMCs applicable for SMEs leads to the necessity to review approaches generally. The most popular concepts are critically analyzed and evaluated by considering the special needs for SMEs. In this deductive phase current theories from literature are

¹⁷ See Bergeron (2003), p. 176

¹⁸ See Blaikie (2009), pp. 154-155; Lancaster (2005), pp. 22-27

¹⁹ See Bryman & Bell (2007), pp. 95-106

used to formulate hypotheses, which are validated through observation taken from literature.

In addition, a case study strategy is applied to understand the SME requirements in a real life context.²⁰ NEM Power-Systems (NPS) is one of the global leaders in the design and supply of exhaust gas systems for the power industry having 55 employees and an annual revenue of 30 million euro. The method of individual observation helps to gather information that is related to the choice of adequate KM concept.²¹ After the development of a KM approach a mail survey is conducted within NPS to determine the status quo of the use of knowledge. To minimize the processing time for the participants the questionnaire only consists of questions of closed-end and rating-scale type.²² Numerical data gained out of the survey is evaluated by application of qualitative and quantitative analyzing methods.²³ In this inductive phase the observations from the case study are analyzed and used for the generation of new knowledge based on lessons learned.

Beside the before mentioned methods of qualitative research (critical review of literature) and quantitative research (primary data collection using self-administered questionnaires) the author uses a focus group interview to get an deeper insight into the current state of knowledge sharing capabilities in the treated organization.²⁴ To gather the input for further analyses selected employees are interviewed in a group of 9 persons to collect information about the actual corporate situation of KM within the different components of the engineering process. To find out what existing KM tools are suitable solutions leading to an enhancement for a certain scenario feedback of involved employees helps to realize possible solutions which gain acceptance. The research results of both before mentioned phases serve to define the NPS requirements for a KMC and to give recommendations for further actions. An overview of the methodology conducted within this work is given in Figure 1.

²⁰ See Jackson (2012), p. 87; Zikmund, Babin, Carr & Griffin (2012), pp. 139-140

²¹ See Arthur, Waring, Coe & Hedges (2012), pp. 165-167

²² See Jackson (2012), pp. 92-94

²³ See Bernard (2000), pp. 501-545

²⁴ See Lindlof & Taylor (2011), pp. 182-183

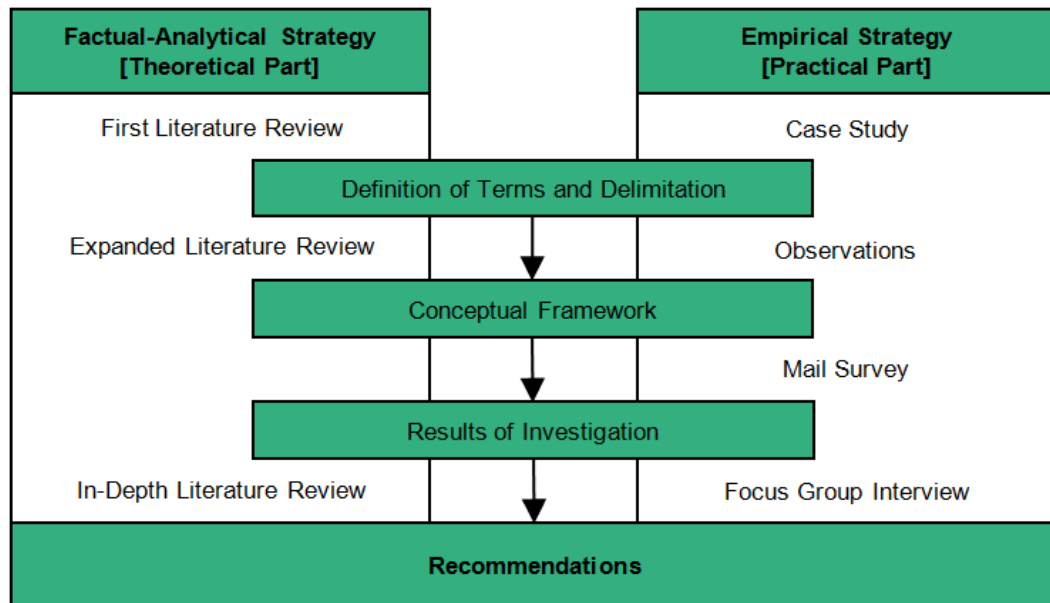


Figure 1: Methodology of Research²⁵

1.5. Structure of Work

Chapter 1 introduces the subject of knowledge management by presenting general arguments for the relevance of this topic. The analysis of the actual situation within the practical use of KMCs highlights certain deficiencies which will be addressed by the objects of this work. Special research methodologies are chosen to realize the development of a KMC suitable for SMEs.

In Chapter 2 the basic terms in the context of the current research are defined. The requirement is to focus on the relevant aspects to fulfill the objectives of this work and not to give an overall overview of KM in general.

A summary of the existing concepts applicable for KM is given in Chapter 3. The relevant literature is reviewed on the one hand side to establish an understanding of the state of the art and on the other hand side to describe the most promising approaches in detail. A critical analysis evaluates the suitability for the practical application of these models within SMEs. Since the realization of the described concepts requires the use of KM methods and tools, the most relevant of these are presented at the end of this section.

²⁵ Source: created by the author

The results of assessment of the theoretical part are used in Chapter 4 to define an individual approach. Under consideration of the requirements defined in Chapter 2 for KMCs suitable in SMEs, a mixture of modification and combination of existing models leads to a proposed process-oriented KM approach.

The practical use of the developed KMC is demonstrated by a certain example. Thus, the engineering company NEM Power-Systems is thoroughly described in Chapter 5.

For this enterprise the developed KMC is applied in Chapter 6. The focus is set onto analyses of the actual corporate situation concerning business processes and knowledge management landscape, choice of adequate KM tools for the individual situation as well as proposal of an enhanced corporate situation by applying the KM methods within the existing business processes structure.

Chapter 7 concludes on how the research objectives of this work are achieved and takes a look on further tasks to be fulfilled in future times. The structure of the present work is illustrated in Figure 2, whereby the main section of this work consists of a theoretical part, a part of concept development and a practical part.

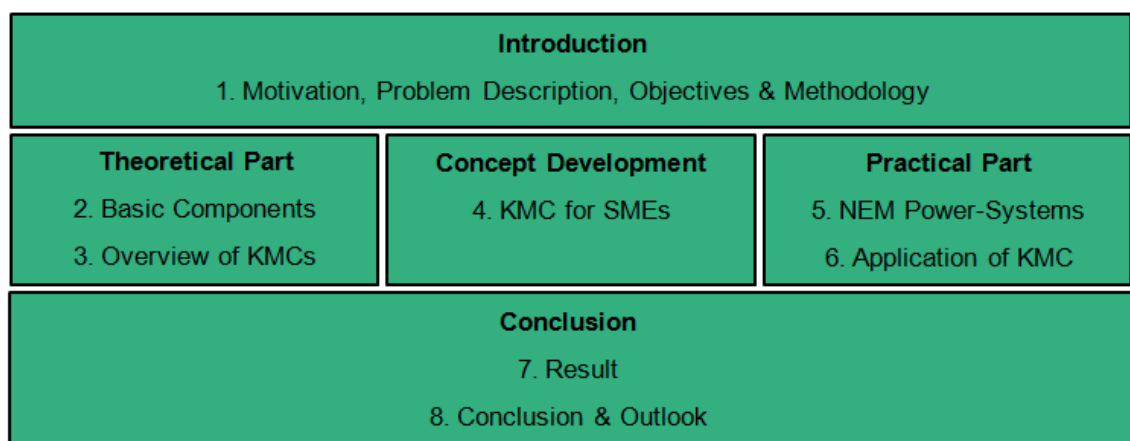


Figure 2: Structure of Work²⁶

²⁶ Source: created by the author

2. Definition of Basic Components

To create a uniform understanding of knowledge management it is useful to describe some fundamentals within this chapter.

2.1. Knowledge

Although in common parlance terms like data, information or knowledge are often used synonymously in literature a definition of knowledge is frequently given by differentiating it from data and information.²⁷ The knowledge pyramid in Figure 3 represents a hierarchic visualization of all relevant aspects.

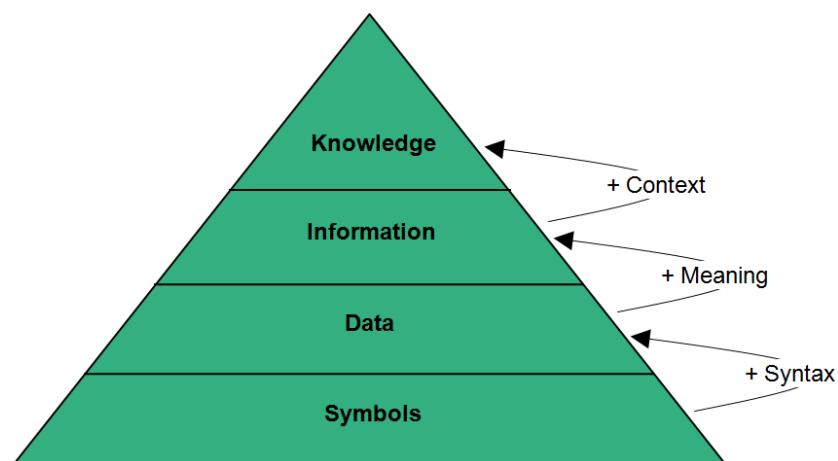


Figure 3: Knowledge Pyramid²⁸

Within this model knowledge is identified as a result of other elements following a certain process scheme. Symbols (e.g. characters) are the smallest components which become to data (e.g. numbers) in case of using an order rule (syntax). By adding a certain meaning to data information (e.g. year) is created.²⁹ Information is the representation of data in a context and can be used for the operational decision making process. In this context knowledge originates as the result of linking information (e.g. year of project start).³⁰

²⁷ See von der Oelsnitz & Hahmann (2003), p. 37

²⁸ Source: created by the author analog to Hutzschenreuter (2009), p. 436

²⁹ See Keller & Kastrup (2009), p. 11

³⁰ See North (2011), p. 35

Beside the definition of knowledge by differentiating from data and information, Probst et al. summarize its meaning by,³¹ “Knowledge is the entirety of proficiency and skills which is used by individuals for problem solving. That means all theoretical skills and rules from daily business are included. Knowledge is based on data and information, but - in contrast to these - it is always connected to individuals. Knowledge is developed by individuals and represents their expectations about cause and effect relationships.”³²

Within this work knowledge - in context of an engineering process - is understood as an intangible intelligent asset which forms a part of corporate resource to fulfill the business process task. It is context specific and implies all cognition about specifications, regulations and standards, experiences of individual or collective as well as other abilities enabling employees to take decisions and complete their tasks in the field of engineering work.³³

2.2. Types of Knowledge

Although a definition of knowledge - suitable for further application within this work - is already given in Chapter 2.1, it is important to distinguish between different types of knowledge to get a better insight into the theoretical aspects of the existing KM approaches (see Chapter 3).

Due to the multi-faceted use of the term knowledge in the field of KM, authors propose categorizations of knowledge. In the mid of the last century Russell already states knowledge being either individual or social.³⁴ Another perspective with two different types of knowledge is introduced by Polanyi. He divides between implicit (tacit) and explicit knowing.³⁵ An enhancement of the before mentioned differentiation is conducted by Willke, who adds two knowledge types (public and proprietary).³⁶ Quinn et al. propose also four different categories (cognitive knowledge, advanced skills, system understanding, self-motivated creativity).³⁷ A definition of knowledge as a process is given by Sveiby. In his work five stages are

³¹ See Neumann N. (2004), p. 43

³² Probst, Raub & Romhardt (2010), p. 23

³³ See Deng & Yu (2006), p. 1; Mertins, Heising & Vorbeck (2003), p. 2; Schindler (2002), p. 32

³⁴ See Russell (1948), pp. 3-8

³⁵ See Polanyi (1966), p. 4

³⁶ See Willke (2001), p. 63

³⁷ See Quinn, Anderson & Finkelstein (1996), p. 72

proposed being explicit knowledge, skill, experience, value judgments and social network.³⁸ Also a categorization with five different elements for knowledge in organizations is presented by Bäckér (product, societal, leadership, expert and milieu knowledge).³⁹ Von Krogh et al. define seven types of knowledge being tacit, embodied, encoded, embrained, embedded, event and procedural.⁴⁰ An entire overview of the different views is given by Maier.⁴¹

Although all approaches propose categories to provide a classification of corporate knowledge, they are not comparable to each other since less similarity does exist. This heterogeneity of classification of knowledge indicates the difficulty to combine all perspectives into a single approach.⁴²

Alternatively, knowledge types are classified by dichotomies describing a special type of knowledge and its opposite.⁴³ Romhardt distinguishes between approximately 40 dichotomies of knowledge out of different scientific disciplines.⁴⁴ Other authors define their own paired types of knowledge.⁴⁵ For a corporate use a choice of only a few dichotomies is necessary which have practical relevance, are none-complex and have a strong selectivity.⁴⁶ In the following the most relevant ones are summed up.⁴⁷

- Implicit Knowledge: "We can know more than we can tell."⁴⁸ The statement by Polanyi highlights the implicit or tacit knowledge which is context specific, bounded to an individual and hard to communicate.⁴⁹ This type of knowledge is the sum of all knowledge a human being has in his mind due to experience, history, actions or learning.⁵⁰

³⁸ See Sveiby (1997), p. 35

³⁹ See Bäckér (1998), pp. 6-7

⁴⁰ See von Krogh & Venzin (1995), pp. 417-436

⁴¹ See Maier (2007), pp. 65-66

⁴² See Maier (2007), p. 67

⁴³ See Maier (2007), p. 63

⁴⁴ See Romhardt (1998), p. 28

⁴⁵ See Schneider (1996), pp. 20-21; Schüppel (1996), pp. 76-85; Amelingmeyer (2000), p. 43; Maier (2007), pp. 63-64

⁴⁶ See Romhardt (1998), p. 56

⁴⁷ See Jantzen (2009), p. 22; Romhardt (1998), p. 56; Lindner (2010), pp. 13-15

⁴⁸ Polanyi (1966), p. 4

⁴⁹ See Nonaka & Takeuchi (2012), p. 72

⁵⁰ See Roumois (2007), p. 40

- **Explicit Knowledge:** Being the type of knowledge representing implicit knowledge in form of e.g. documents, images or videos. The purpose of explicit knowledge is to communicate.⁵¹ Since it is not necessarily bounded to an individual it can be treated by using the ICT.⁵² Each individual is aware of his explicit knowledge and has the ability to communicate about it.⁵³
- **Individual Knowledge:** The type of knowledge being connected to a single individual, whereby a transfer to others is possible by communication or presentation.⁵⁴ An employee obtains the ability to transform data into individual knowledge (see Chapter 2.1) to create a certain benefit. He represents the central carrier of the corporate knowledge basis.⁵⁵ Due to this individuality the knowledge is always characterized by a subjective interpretation and influence.⁵⁶
- **Collective Knowledge:** Being developed communally by interactions of individuals.⁵⁷ Conclusively, individual knowledge forms the basis of collective knowledge. It is more than the sum of all single individual components since major part of collective knowledge can only be achieved within a collective.⁵⁸

Individual as well as collective knowledge might be either implicit or explicit. A matrix helps illustrating the different types of corporate knowledge (see Table 1).

	Individual Knowledge	Collective Knowledge
Explicit Knowledge	facts about customer and products	manuals, guidelines, documentations
Implicit Knowledge	individual attitude to team members, experience knowledge	corporate culture and value, manners, processes

Table 1: Types of Corporate Knowledge⁵⁹

⁵¹ See Hussok (2009), p. 15

⁵² See Zahn, Foschiani & Tilebein (2000), p. 249

⁵³ See Willke (2001), p. 13

⁵⁴ See Lehner (2009), p. 56

⁵⁵ See Probst, Raub & Romhardt (2010), p. 18

⁵⁶ See Schüppel (1996), p. 56

⁵⁷ See Leonard & Sensiper (1998), p. 121

⁵⁸ See Brown & Duguid (1998), p. 91; Schuhmann & Schwaninger (1999), p. 311

⁵⁹ Source: created by the author analog to Jantzen (2009), p. 28

Out of a corporate view it is worthwhile to develop explicit knowledge - being in best case a collective one - since individual knowledge leads to a dependency on the know-how of some experts.⁶⁰ Therefore it is important to manage the knowledge and to transfer it from implicit to explicit as well as from individual to collective.⁶¹

2.3. Knowledge Management

Within the first wave of corporate KM during the 1990ies and the turn of the millennium focus is mainly set on the implementation of complex ICT solutions for a better availability of relevant knowledge for all employees. Most of these ambitious projects failed since KM is much more than only the administration of data and information.⁶² The following definitions of KM out of the former days indicate the fact of neglecting the aspect of employees and concentrating on the management of data and information. "Knowledge management is the process of acquisition, distribution and application of collective knowledge within an enterprise"⁶³ and "organizational success and failure can often depend on knowing which of the components (data, information and knowledge) you need, which you have, and what you can and can't do with each. Understanding what those three things are and how you get from one to another is essential to doing knowledge work successfully".⁶⁴ From today's perspective, the technical aspect of KM is often overestimated at that time.⁶⁵

In the currently occurring second wave of KM within enterprises it is no more predominantly focused on the ICT but on the employees since they are the real know-how carriers. Nevertheless, a well balanced KM concentrates even on three aspects being information- and communications-technology, human resource as well as organization.⁶⁶ Most of the present definitions to be found in literature just differ within the focus set on each of the different components of knowledge management whereby the supporting cooperate culture is in every case the basis of knowledge management (see Figure 4).⁶⁷

⁶⁰ See Jantzen (2009), p. 28

⁶¹ See Nonaka & Takeuchi (2012), pp. 26-28

⁶² See Mertins & Seidel (2009), p. 11

⁶³ Botkin (2000), p. 50

⁶⁴ Davenport & Prusak (2000), p. 1

⁶⁵ See Gronau (2009), p. 12

⁶⁶ See Mertins & Seidel (2009), p. 11

⁶⁷ See Wais (2006), p. 10

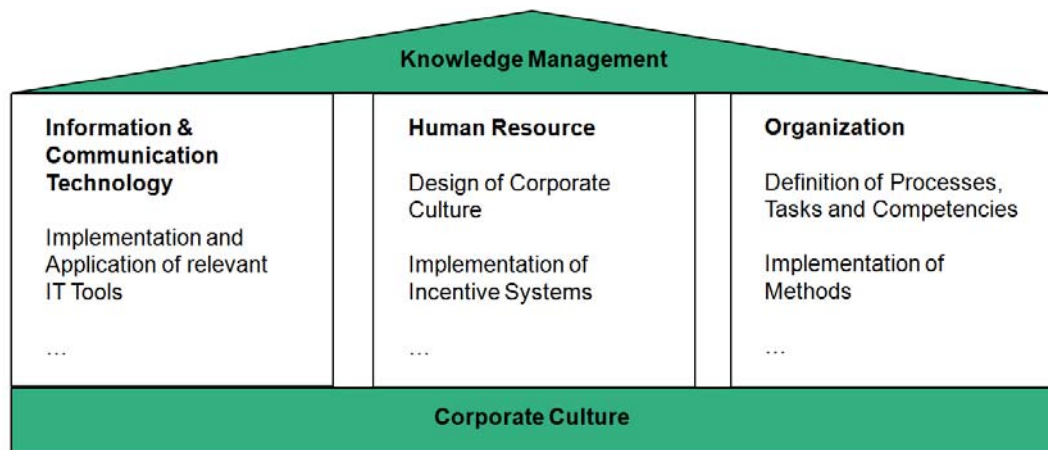


Figure 4: House of Knowledge Management⁶⁸

An expansion of the knowledge pyramid (see Figure 3) by four additional factors being ability, action, competence and competitiveness leads to the knowledge stairs according to North. This alternative illustration of the functionality of knowledge management is visualized in Figure 5.

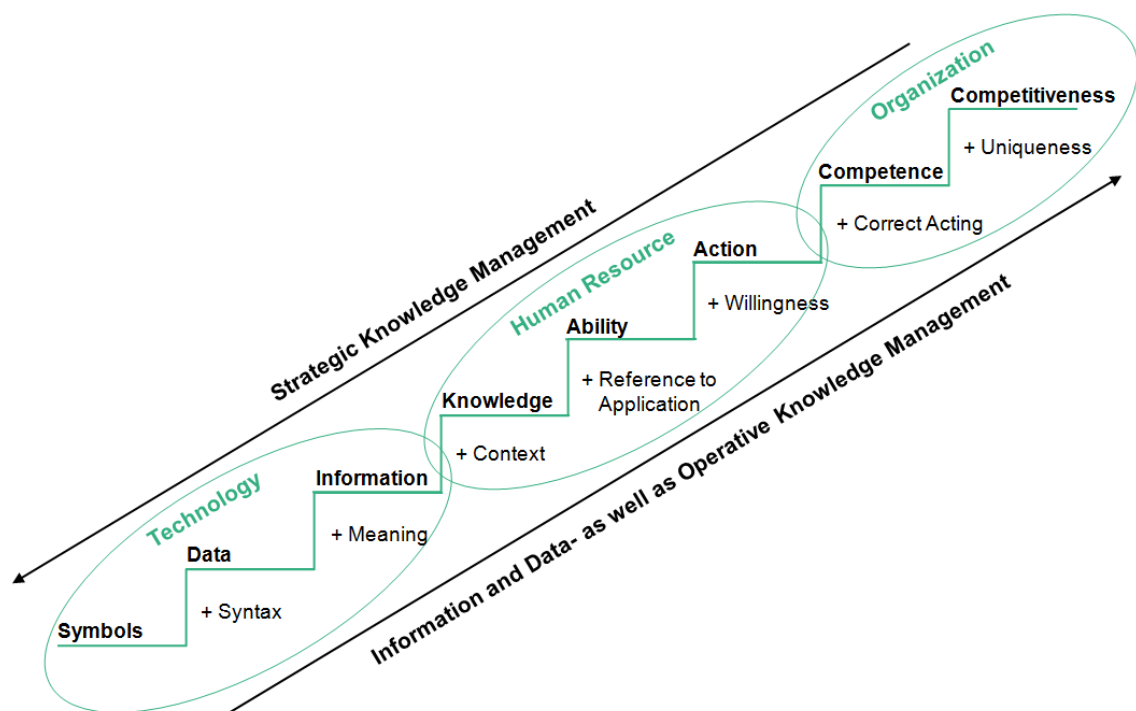


Figure 5: Knowledge Stairs⁶⁹

⁶⁸ Source: created by the author analog to Wais (2006), p. 11

⁶⁹ Source: created by the author analog to North (2011), p. 39

While the knowledge pyramid only treats the relationship of the four factors: symbol, data, information and knowledge, the knowledge stairs describes further issues resulting from the application of knowledge.⁷⁰ A reference to application of knowledge leads to ability which in case of willingness might cause an action. If these actions are correct and as a specific competence unique this might cause a higher competitiveness for the entire company.⁷¹ Three different types of KM can be developed out of this knowledge stairs being strategic knowledge management, operative knowledge management as well as information- and data management.

Major task of strategic KM is the creation and storage of knowledge potentials in relation to the corporate visions and missions. The strategic part supplies basic decisions concerning treatment and positioning of corporate knowledge resources.⁷² Present strategic values like sales growth or market share goals are enhanced by knowledge targets.⁷³ This kind of KM is illustrated in Figure 5 by moving downstairs to find out which knowledge is relevant to be competitive.⁷⁴

The operative KM includes all measures to integrate KM into the operative business.⁷⁵ Aim of the operative KM is the practical application and realization of strategic decisions and guidelines. All relevant knowledge of the corporate value chain has to be at the right place of the corporate process organization at the right time as well as in a right amount and quality.⁷⁶ An illustration within Figure 5 is an upstairs movement.⁷⁷

Information- and data management forms the basis since information provision and transfer is indispensable.⁷⁸ Especially quick access to documents and information offers a potential for optimization since up to 30% of daily business work exists of search for information.⁷⁹

⁷⁰ See Neumann N. (2004), p. 42

⁷¹ See Wais (2006), p. 11

⁷² See Albrecht (1993), p. 102

⁷³ See Probst, Raub & Romhardt (2010), p. 40

⁷⁴ See North (2011), p. 41

⁷⁵ See Al-Laham (2003), p. 48

⁷⁶ See Albrecht (1993), p. 104

⁷⁷ See Sassenberg (2005), p. 18

⁷⁸ See North (2011), p. 41

⁷⁹ See Lehner (2009), p. 6

Although within this work operative knowledge management in combination with information- and data management are directly treated, the long-term goal of this project is the creation of a knowledge-oriented corporate culture within NPS which is according to Albrecht a main objective of the strategic knowledge management.⁸⁰

2.4. Small and Medium-Sized Enterprises

Criteria have been defined by the EU for the classification of the company sizes whereby the number of employees as well as the annual turnover or the annual balance can be used for a categorisation. If one of these criteria is exceeded by an enterprise it is classified into the next higher category.⁸¹ The different threshold values for the classification of SMEs are illustrated in Table 2.

	No. of Employees	Annual Turnover	or	Annual Balance
Medium-size Enterprise	< 250	≤ € 50 million		≤ € 43 million
Small-size Enterprise	< 50	≤ € 10 million		≤ € 10 million
Micro-size Enterprises	< 10	≤ € 2 million		≤ € 2 million

Table 2: Definition of SMEs according to Threshold Values⁸²

Within the practical application of KM concepts goals differ according to the individual needs of SMEs. To enable a better overview of the variety a classification of SME types has been introduced whereby it is divided between:⁸³

- traditional small family company,
- company in saturated market with high technical know-how,
- part producing company in the supply chain without own R&D,
- strongly growing company in a rapidly changing environment and
- company offering customer services as main part of business.

⁸⁰ See Albrecht (1993), p. 102

⁸¹ See Europäische Kommission (2006)

⁸² Source: created by the author, data taken from Europäische Kommission (2006)

⁸³ See North (2011), pp. 213-219

NEM Power-System is a medium-sized enterprise since it has a number of employees within the range of 50 to 250 and an annual turnover within the range of € 10 million to € 50 million (see chapter 5.1). According to the classification of North NPS fits into the second group since it is a company in a saturated market with a high technical know-how.⁸⁴

2.5. Knowledge Management in Small and Medium-Sized Enterprises

It is undisputed that the relevance of KM increases especially within SMEs to gain advantage in these competitive times.⁸⁵ But the implementation of a concept in a SME differs enormously from an application suitable for LEs. Due to international business and higher numbers of employees in LEs other instruments of the KM are relevant in contrast to SMEs. In many cases only some components and not a complete KMC is implemented.⁸⁶ The focus within SMEs is set on analysis, search and publication of information as well as cooperation, task and process management.⁸⁷ It is not concentrated on the implementation of complex KM systems but on human resources. The employee shall only be supported by such KM tools.⁸⁸ Thinking about the house of knowledge (see figure 4) the two columns of organization and human resource represent a challenge while the ICT is often simple to implement in SMEs. The difficulty is to overcome social and cultural barriers and to motivate the employees to do intensive knowledge transfer.⁸⁹ Conclusively, SMEs shall not be seen as smaller LEs wherein the KM can be implemented identically.⁹⁰

SMEs provide convenient conditions for the application of KM due to:

- knowledge transfer can be performed much quicker and on a direct level,⁹¹
- direct communication of experience and observations,⁹²
- structural characteristics like flat organization as well as organization on a project basis,⁹³

⁸⁴ See NEM Power-Systems (2012)

⁸⁵ See Schauer & Frank (2007), p. 150

⁸⁶ See Abele, Kuhn & Liebeck (2003), p. 375

⁸⁷ See Gust von Loh (2008), p. 127

⁸⁸ See Abele, Kuhn & Liebeck (2003), p. 375

⁸⁹ See Pan, Newell, Huang & Galliers (2007), p. 404

⁹⁰ See Wong & Aspinwall (2005), p. 48

⁹¹ See Wickert & Herschel (2001), p. 331

⁹² See uit Beijerse (2000), p. 172

- identification with the organization as a whole widely spread,⁹⁴
- continuity of management increases loyalty and engagement of employee,⁹⁵
- culture being characterised by informality, open attitude and centrally determined results as well as
- tools suitable for KM being often already present on operational level.⁹⁶

Nevertheless, there are also arguments existing indicating disadvantages of SMEs in contrast to LEs concerning the implementation of KM:

- lower financial resources,⁹⁷
- lack of knowledge about access to information leading to expensive mistakes,⁹⁸
- short-term oriented actions in contrast to long-term oriented ones,
- experience hardly used and communication between teams insufficient,⁹⁹
- existing knowledge non-transparent and gain in knowledge unstructured as well as¹⁰⁰
- dependency on few experts only.¹⁰¹

In particular the last aspect is associated with a high risk since relevant know-how is concentrated onto the heads of a few experts. In LEs KM is already part of the daily business while the knowledge gap - a single leaving employee - is much smaller. In SMEs the skills, experience and knowledge of human resources are important since employees have broader scope of work. When an employee is retired or changes the company out of the SME corporate view results a higher loss of information and knowledge, respectively.¹⁰²

⁹³ See Wong & Aspinwall (2004), p. 50

⁹⁴ See Boelhauve (2008), p. 32

⁹⁵ See North (2011), p. 202

⁹⁶ See uit Beijerse (2000), pp. 173-175

⁹⁷ See Staiger & Kilian (2006), p. 35

⁹⁸ See North (2011), p. 201

⁹⁹ See Boelhauve (2008), p. 32

¹⁰⁰ See North (2011), p. 201

¹⁰¹ See Lamieri & North (2001), p. 18

¹⁰² See North (2005), p. 6; Wanka (2005), p. 24

On the European level the following reasons are mentioned for the implementation of KM into SMEs:¹⁰³

- knowledge is often implicit, informal and non-documented,
- know-how is often underestimated,
- short-term oriented knowledge solution often seems to be adequate and long-term change is therefore not required any more,
- approximately 30% of business day consists of search for information and
- only half of corporate knowledge is used economically.

By recognizing the relevance of KM there has been invested a high research effort - both in the theoretical as well as in the practical context - to increase the efficiency in daily business of SMEs.¹⁰⁴

2.6. Requirements for Knowledge Management Concept in Small and Medium-Sized Enterprises

According to the characteristics of SMEs mentioned in Chapter 2.5 some requirements for KM concepts usable in SMEs can be concluded.¹⁰⁵

- New methods have to be set up on existing structures quickly and to be applicable without need of lots of external know-how.
- Since KM concepts influence directly working processes of employees the effort for training and use of KM methods shall be low.
- Implementation of new KM tools shall be conducted into existing business processes and therewith enhance and accelerate the value chain directly.
- A low effort for implementation is a key aspect due to limited financial resources.
- The success of the relevant KMC shall be proven by practical applications within other companies.

¹⁰³ See CEN/ISSS (2004)

¹⁰⁴ See Sartori (2011), p. 209

¹⁰⁵ See Staiger & Kilian (2006), p. 35

Nunes et al. point out in a more general form that the prior characteristic of a KM approach for SMEs is an easy handling and comprehension since there is often a lack of knowledge concerning the topic of KM within SMEs.¹⁰⁶ Katenkamp also states that an ease of use is indispensable since intensive training procedures are time and money consuming. The integration of already existing tools (e.g. software, methods or processes) within the organization has also a positive impact on time and costs.¹⁰⁷

It is important to enable participation of the employees within the development and implementation process of KM to gain acceptance.¹⁰⁸ Especially the persons being important in terms of KM like management teams or senior employees have to be integrated into the process since they own organizational knowledge.¹⁰⁹ Nevertheless, KMC shall also enhance the technical and organizational infrastructure.¹¹⁰ It has to embed KM into the existing organizational structure. The aim is to support and improve the actual operational processes but not to replace or complement them necessarily.¹¹¹ Value of KMC can be created in case of addressing actual problems which in SMEs often have a direct connection to daily business work rather than concerning the overall improvement of efficiency in an enterprise.¹¹²

By using the before mentioned requirements, criteria for an evaluation process of KM approaches can be defined. Staiger et al. differentiate three main categories (effort for initialization, effort for use and success) comprising out of several indicators which are analyzed in detail.¹¹³ Within this work one concentrates on the identification of two factors only since further categories would exceed the scope of work. According to the author's view the before mentioned criteria can be subsumed under the factor "ease of use" - combining all aspects like complexity and application of the certain approach - and the factor "degree of process-orientation" since this factor gives a hint on effort for implementation due to the

¹⁰⁶ See Nunes, Annansingh, Eaglestone & Wakefield (2006), pp. 111-113

¹⁰⁷ See Katenkamp (2011), p. 115

¹⁰⁸ See Katenkamp (2011), p. 116

¹⁰⁹ See Wildner (2008), p. 968

¹¹⁰ See Trillitzsch (2004), p. 97

¹¹¹ See Wildner (2008), p. 968

¹¹² See McAdam & Reid (2001), p. 235

¹¹³ See Staiger & Kilian (2006), p. 35

structural corporate situation within SMEs.¹¹⁴ According to Gerhards et al. KM integration into daily business work is only successful in case of implementation into process and structural organization.¹¹⁵

By using the two categories of requirements - “ease of use” and “degree of process-orientation” - a positioning of each approach within a matrix according to Figure 6 is possible to identify the potential for applicability within SMEs.

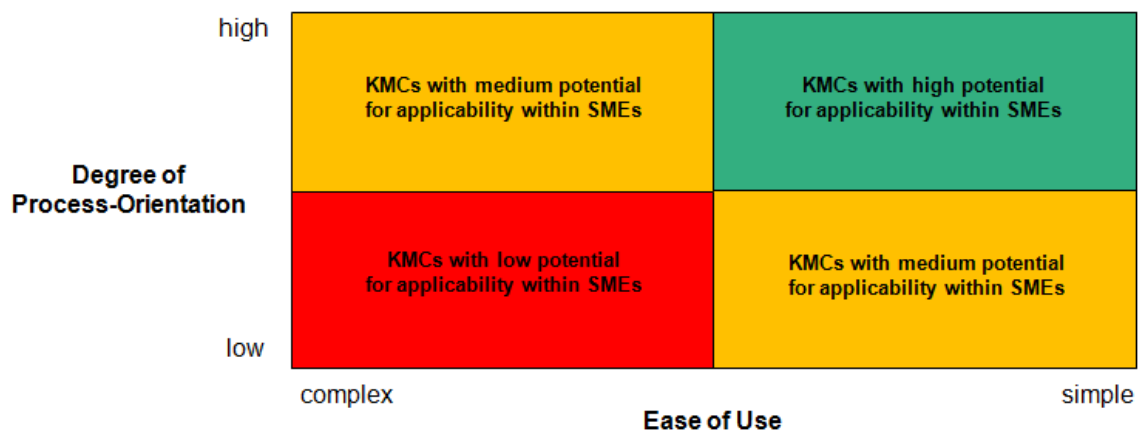


Figure 6: Evaluation Matrix for Applicability of KMCs within SMEs¹¹⁶

In Chapter 3.1 an overview of some relevant KM approaches is given. The presented concepts are analyzed in Chapter 3.2 with respect to both factors. Thereby the aspects are not assessed according to objective indicators but according to the subjective judgment of the author by using the literature review.

¹¹⁴ See Katenkamp (2011), p. 115; Nunes, Annansingh, Eaglestone & Wakefield (2006), pp. 111-113

¹¹⁵ See Gerhards & Trauner (2007), p. 26

¹¹⁶ Source: created by the author

3. Literature Review of Knowledge Management Concepts

As part of the factual-analytical strategy an expanded literature review is applied to get an insight into the existing KM concepts. Aim is to evaluate these approaches with respect to the suitability according to the requirements for SMEs.

3.1. Overview of Existing Concepts

Due to varying needs of enterprises a lot of concepts have been developed within the past two decades which strongly differ within the philosophy of application.¹¹⁷ The diversity of the different approaches is indicated by several overviews of KMCs within the literature.¹¹⁸ Heisig et al. describe in their work more than 150 concepts for KM out of scientific as well as practical context.¹¹⁹ An integrated concept suitable for all kind of individual corporate situations does not yet exist and is still a major goal of KM.¹²⁰ Even a systematic sort of the different models is difficult and it does not necessarily simplify the variety or enable a comparison.¹²¹

The purpose of this chapter is not to provide a complete overview of every existing model but to analyze some relevant concepts (see Table 3) being on the one hand side classical approaches - necessary to develop an general understanding of KMC fundamentals - and on the other hand side special approaches - supposed to be suitable for KM in SMEs.

Such an approach might address to either one or all of the relevant columns of KM (ICT, Human Resource and Organization) as described in Chapter 2.3. Conclusively, it is categorized between holistic concepts - having a balance within the measures for each of these fields - and methods dealing with partial aspects only.¹²²

¹¹⁷ See Lehner (2009), p. 66

¹¹⁸ See Hilse (2000), pp. 66-80; Neumann R. (2000), pp. 239-280; Weissenberger-Eibl (2000), p. 30; Klosa (2001), p. 63; Remus (2002), pp. 36-68; Deking (2003), p. 188; Dalkir (2005), pp. 25-77

¹¹⁹ See Heisig & Orth (2005), pp. 1-124; Heisig (2009), pp. 4-31; Katenkamp (2011), p. 116

¹²⁰ See Wildner (2008), p. 5

¹²¹ See Wildner (2008), p. 42

¹²² See Riempp (2004), p. 79

Year	Author	Description
1995	von Krogh / Venzin ¹²³	Activity Model
1997	Nonaka / Takeuchi ¹²⁴	Spiral of Knowledge
1997	Reinhardt / Pawlowsky ¹²⁵	Integrative Knowledge Management
1997	Probst et al. ¹²⁶	Blocks of Knowledge Management
1998	Bullinger et al. ¹²⁷	TOM Model
1998	North ¹²⁸	Company Knowledge Market
1998	Davenport / Prusak ¹²⁹	Knowledge Management Process Model
1999	Bach / Österle ¹³⁰	Business Knowledge Management
2001	Frauenhofer IPK ¹³¹	Business process-oriented Knowledge Management

Table 3: Overview of Knowledge Management Concepts¹³²

The relevant characteristics of these models are summarized in the following and the possibility of an application for KM within the framework of SMEs is critically analyzed in Chapter 3.2 by an evaluation of the criteria proposed in Chapter 2.6.

3.1.1. Activity Model [von Krogh / Venzin]

In contrast to the view of North, who defines competence as a correct action (being illustrated within the knowledge stairs in Figure 5), von Krogh et al. understand competence as a combination of knowledge and tasks being the corporate potential to generate market performance.¹³³ The key to develop potential competitive advantage according to these authors is a KM approach using four stages (see Figure 7). The initial task is the identification of existing knowledge. The second step - treating the development of further knowledge - leads directly to the third stage being generation of competences. A target-oriented use of these

¹²³ See von Krogh & Venzin (1995), pp. 417-436

¹²⁴ See Nonaka & Takeuchi (2012), pp. 181-221

¹²⁵ See Pawlowsky & Reinhardt (1997), pp. 145-155

¹²⁶ See Probst, Raub & Romhardt (2010), pp. 25-33

¹²⁷ See Bullinger, Warschat, Wörner & Prieto (1998), pp. 7-23

¹²⁸ See North (2011), pp. 272-275

¹²⁹ See Davenport & Prusak (2000), pp. 25-106

¹³⁰ See Bach, Vogler & Österle (1999), pp. 37-84

¹³¹ See Heisig (2001), pp. 14-36

¹³² Source: created by the author analog to Lehner (2009), p. 66; Remus (2002), p. 37

¹³³ See von Krogh & Venzin (1995), p. 429

competences (e.g. by entering new markets or differentiating in existing markets due to product or process innovations) is part of the last stage, innovation management.¹³⁴

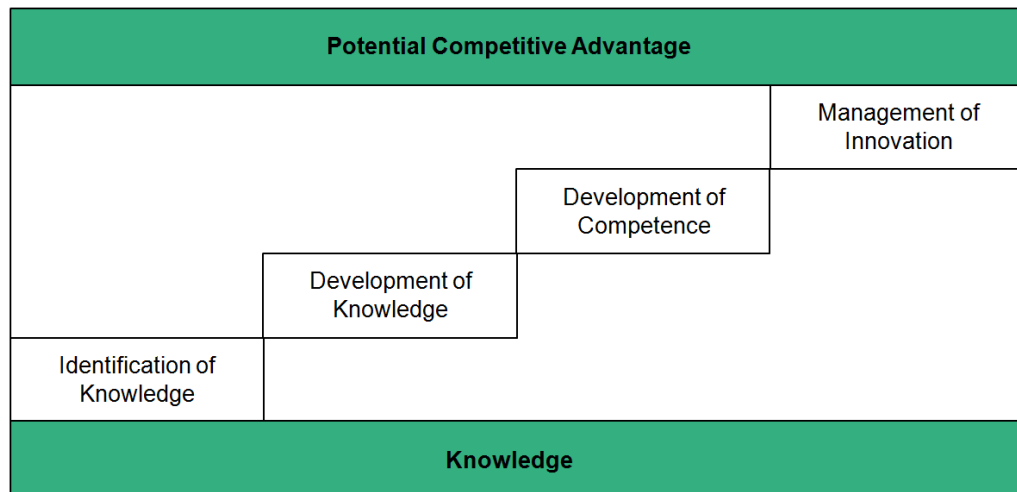


Figure 7: Competence Development due to Knowledge Management¹³⁵

The activity model of von Krogh et al. corresponds to the assumptions of Teece who also divides between creation and use of knowledge assets.¹³⁶ But this author clearly states that not the presence of competence is a sufficient argument for realization of competitive advantage but the use of knowledge.¹³⁷ A further aspect mentioned within this work is named dynamic capability indicating the temporal factor. Even von Krogh realizes that the durability of competence is not permanent, "Competence is not an asset, it is an event".¹³⁸

The activity model is not a holistic KM concept but an integration of several aspects of KM into four main activities. Although practical examples illustrate these main steps, only few instruments for a practical application are given. The aspects of corporate structural situation and human resource are neglected. The management team is encouraged to enhance the ICT situation but no explicit tools are proposed.¹³⁹

¹³⁴ See von Krogh & Venzin (1995), p. 431

¹³⁵ Source: created by the author analog to von Krogh & Venzin (1995), p. 425; Fearnly (2004), p. 74

¹³⁶ See Teece (1998), p. 62

¹³⁷ See Kopetzky (2006), p. 25

¹³⁸ See von Krogh & Roos (1996), p. 424

¹³⁹ See Glückstein (2000), p. 121

3.1.2. Spiral of Knowledge [Nonaka / Takeuchi]

Nonaka et al. assume that creation of knowledge is achieved by a continual transformation between implicit and explicit knowledge, the so called spiral of knowledge. By sequentially following processes of socialization, externalization, combination and internalization (see Figure 8) the individual knowledge is changed into a collective one.¹⁴⁰

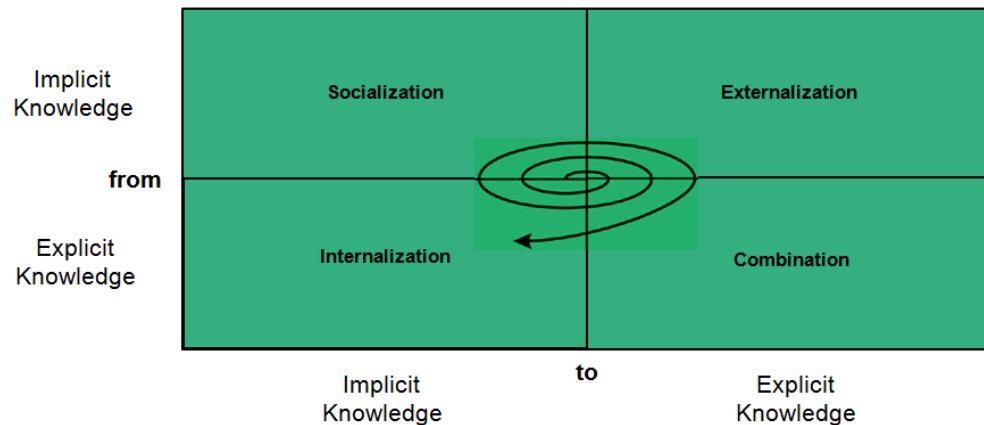


Figure 8: Spiral of Knowledge¹⁴¹

The meaning of socialization is a direct transfer of implicit knowledge from one employee to another (e.g. discussions or meetings). Externalization describes a transformation from implicit to explicit knowledge which creates access for the employees of the entire company (e.g. documentation) and might be the most important form of knowledge creation.¹⁴² The third transformation process defines the combination of already existing explicit knowledge to produce new explicit knowledge. This process is often supported by the ICT. Internalization (explicit to implicit) is a learning process being equal to “learning by doing” (e.g. forming one’s own opinion concerning a certain affair).¹⁴³

Within the approach of Nonaka et al. the focus is set on knowledge generation which produces an imbalance concerning the remaining aspects of KM.¹⁴⁴ Topics like identification or maintenance are not treated within this model. Two out of the

¹⁴⁰ See Lehner (2009), p. 68

¹⁴¹ Source: created by the author analog to Nonaka & Takeuchi (2012), p. 84

¹⁴² See Lehner (2009), p. 68

¹⁴³ See Trillitzsch (2004), p. 56

¹⁴⁴ See North (2011), p. 199

three columns of KM (organization and human resource) are intensively treated whereas the ICT is not mentioned within this concept such that the practical application is difficult.¹⁴⁵

3.1.3. Integrative Knowledge Management [Reinhardt / Pawlowsky]

The model of integrative KM by Reinhardt et al. transfers knowledge management into a concept of organizational learning.¹⁴⁶ The authors understand the task of KM as systematic identification of knowledge, sharing of knowledge and combining of knowledge to generate new knowledge. Out of these insights they optionally propose changing of business activities. Application of measurement tools shall enable the control of processes.¹⁴⁷

Learning process does represent a modification of corporate knowledge systems. On the one hand side learning depends on the characteristics of corporate knowledge situation while on the opposite side also the knowledge system depends on business learning processes. Conclusively, the KMC is based on a learning cycle being separated into four phases of learning processes. An illustration of the integrative knowledge management is given in Figure 9.

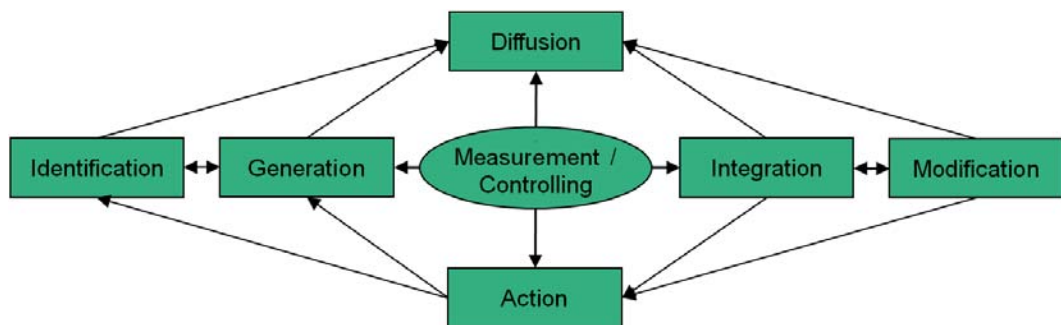


Figure 9: Integrative Knowledge Management¹⁴⁸

The identification and generation of relevant corporate knowledge is part of the first phase. On strategic level the identification is called environmental screening which is used to gain information about markets and strategies. On individual level the observation represents the identification process. According to Reinhardt et al. new

¹⁴⁵ See Glückstein (2000), p. 121

¹⁴⁶ See Glückstein (2000), p. 104

¹⁴⁷ See Pawlowsky (1998), pp. 15-16

¹⁴⁸ Source: created by the author analog to Pawlowsky & Reinhardt (1997), p. 148

knowledge can be created either out of combination of external and internal knowledge or out of transformation from implicit to explicit knowledge. The second phase is called diffusion describing the analyses of communication lines and methods as well as identification of communication barriers. The focus within the third phase is set on integration and modification of knowledge. It has to be checked, if the corporate knowledge system has to be modified (e.g. in form of adding or removing knowledge). The action phase deals with behavioral consequences concluded out of the newly gained knowledge.¹⁴⁹

The integrative knowledge management does not help a lot for daily operative KM but focuses on the generation of a learning architecture supporting knowledge creation and transfer.¹⁵⁰

3.1.4. Blocks of Knowledge Management [Probst et al.]

Probst et al. propose eight blocks whereof six of them form the core process (internal circle) and the remaining two elements build a frame for controlling purpose (external circle).¹⁵¹ An illustration of the blocks of KM is given in Figure 10.

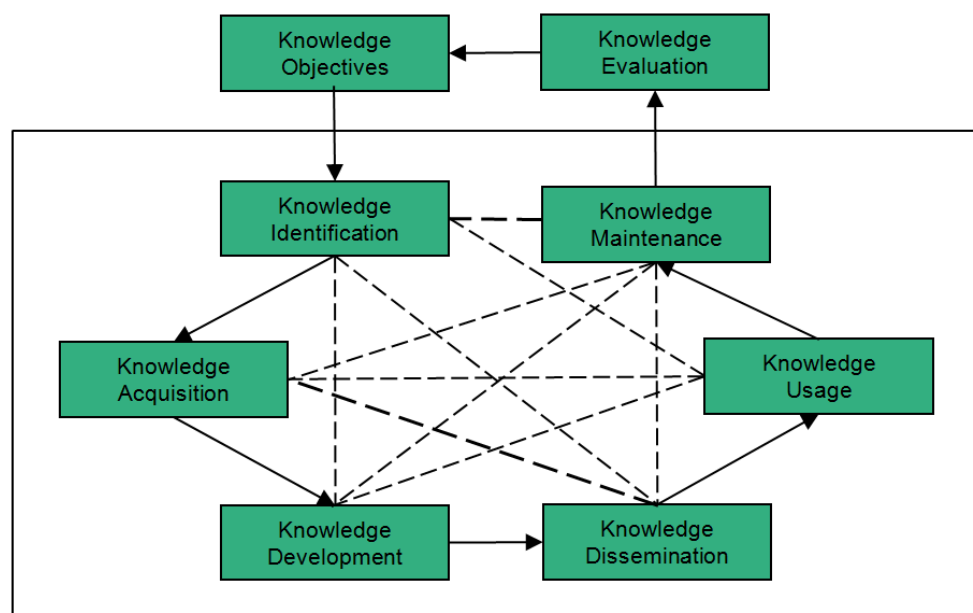


Figure 10: Blocks of Knowledge Management¹⁵²

¹⁴⁹ See Pawlowsky & Reinhardt (1997), pp. 145-155

¹⁵⁰ See North (2011), p. 190

¹⁵¹ See Probst, Raub & Romhardt (2010), p. 28

¹⁵² Source: created by the author analog to Probst, Raub & Romhardt (2010), p. 32

At the beginning of the KM cycle a certain direction for KM activities is proposed by defining knowledge objectives whereby they might have normative (acting on corporate culture), strategic (describing future need for competence) or operational (concerning the execution) character. They determine which know-how where within the organization has to be build up.¹⁵³

One task of KM is the identification of knowledge being responsible for corporate success to gain an advantage towards the competitors.¹⁵⁴ The knowledge identification creates the required transparency of internal and external knowledge since a lack of transparency leads to inefficiency, uninformed decisions and redundancies.¹⁵⁵ Aim of KM is the localization of existing knowledge and creation of access for the employees.¹⁵⁶

Since the required knowledge can often not be generated internally, the acquisition of external knowledge is necessary.¹⁵⁷ Additionally the required knowledge can be developed internally (e.g. new skills, new products or more efficient processes).¹⁵⁸

The dissemination of isolated individual and organizational knowledge creates access for all employees.¹⁵⁹ The core question to answer within this process is: Who should know what and moreover in what amount? The use of the corporate knowledge (e.g. in form of productive application) leads to corporate success and is the major purpose of KM.¹⁶⁰

Since gained knowledge is not directly applicable for the overall future an efficient storage of experience, information or documents is a crucial point. A wrong handling of data might lead to loss of knowledge.¹⁶¹

Evaluation of the initially defined normative, strategic and operational objectives by conducting adequate methods is the final step of the knowledge cycle proposed by

¹⁵³ See Probst, Raub & Romhardt (2010), p. 31

¹⁵⁴ See Lehner (2009), p. 74

¹⁵⁵ See Bodrow & Bergmann (2003), p. 47; Probst, Raub & Romhardt (2010), p. 29

¹⁵⁶ See Kusterer (2008), p. 34

¹⁵⁷ See Bodrow & Bergmann (2003), p. 47

¹⁵⁸ See Probst, Raub & Romhardt (2010), p. 29

¹⁵⁹ See Bodrow & Bergmann (2003), p. 48

¹⁶⁰ See Probst, Raub & Romhardt (2010), p. 30

¹⁶¹ See Kusterer (2008), p. 36

Probst and his co-authors. The controlling process is essential for modification of the individual components of the blocks of KM.¹⁶² A continuous improvement cycle is caused by this external circle and within practical use the process is not a pure cycle but a network of all these components.¹⁶³

The concept by Probst et al. has proven successfully within practical application. The cooperation of research and industry leads to practical-oriented modifications such that every component out of the knowledge cycle can be implemented solely to enable access to KM.¹⁶⁴ Another advantage of this approach is the strong relationship to the classical management process. Definition of targets, application of tools within a certain processes scheme and finally controlling to enable an evaluation of the results is quite familiar to managers.¹⁶⁵ Nevertheless, within this concept the ICT - being one column of KM - is not treated very intensive because Probst et al. concentrate on aspects of organization and human resource.¹⁶⁶

3.1.5. TOM Model [Bullinger et al.]

The concept of Bullinger et al. is strongly orientated onto the house of knowledge management (see Figure 4). In a nutshell, it enables overall analyses of the three columns: ICT (T), organization (O) and human resource (M).¹⁶⁷ Basis of this approach is the assumption that an introduction of KM causes changes within the entire company. The focus is not only set on the implementation of ICT but also on organizational aspects as well as measures concerning the human resource.¹⁶⁸ Strategic and operational KM shall link these three dimensions which are all relevant in case of aiming at a long-term knowledge-based corporate culture.¹⁶⁹ Nevertheless, the weighting of each of these components differs with respect to individual corporate situation.

¹⁶² See Probst, Raub & Romhardt (2010), p. 31

¹⁶³ See Althoff, Dengel, Bergmann, Nick & Roth-Berghofer (2005), p. 340

¹⁶⁴ See Lehner (2009), p. 243

¹⁶⁵ See North (2011), p. 184

¹⁶⁶ See Gust von Loh (2008), p. 118; Glückstein (2000), p. 122

¹⁶⁷ See Bullinger, Warschat, Wörner & Prieto (1998), p. 7

¹⁶⁸ See Nickelsburger (2007), p. 34

¹⁶⁹ See Decker, et al. (2005), p. 103; Katenkamp (2011), p. 124

The technology - one of the three components of KM - describes an adequate information and communication structure according to corporate situation.¹⁷⁰ KM tools for creation, storage or transfer of knowledge have to be implemented into existing operational and organizational structures.¹⁷¹ The last dimension is related to corporate culture supporting a continual knowledge transfer. Each modification of one of these elements might cause opposition. Typically barriers out of the practical experience are summed up within Figure 11.¹⁷²

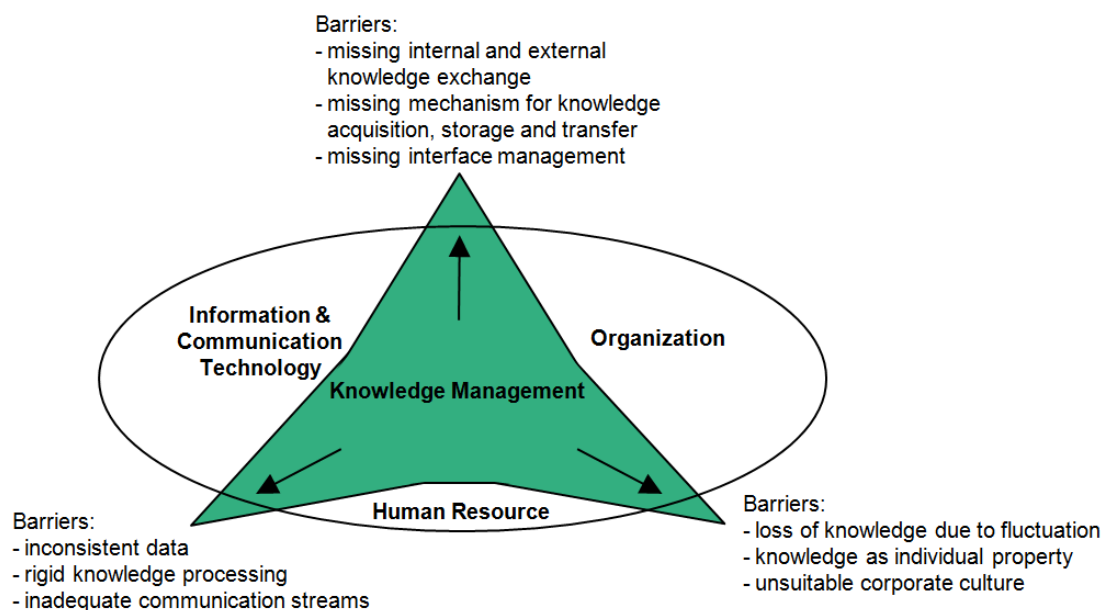


Figure 11: TOM Model¹⁷³

Although this model is an overall approach analyzing all relevant aspects of the KM environment evaluation of these components enables just an estimation of the maturity level of KM and the development of further measures.¹⁷⁴

3.1.6. Company Knowledge Market [North]

To enable an effective knowledge generation and transfer within an organization North proposes an internal knowledge market because just a holistic approach of KM leads to corporate success.¹⁷⁵ Since knowledge is a limited resource, it obtains

¹⁷⁰ See Richter (2007), p. 40

¹⁷¹ See Gerhards & Trauner (2007), p. 27

¹⁷² See Bullinger, Warschat, Wörner & Prieto (1998), p. 8

¹⁷³ Source: created by the author analog to Bullinger, Warschat, Wörner & Prieto (1998), p. 8

¹⁷⁴ See Gerhards & Trauner (2007), p. 25

¹⁷⁵ See North (2011), p. 272

a market value within the economical sense. Thus, a market-oriented control is possible. By introducing an internal knowledge-based economy trading within the organization shall be encouraged and lead to short-term successes of a business unit as well as long-term competence building of the entire organization.¹⁷⁶ To be competitive within the economic market it is essential to establish certain basic conditions. Rules for the internal market have to be defined as well as required structures and processes established to enable knowledge sharing (see Figure 12).¹⁷⁷ Since the knowledge market concept is an integrated approach, all relevant aspects (e.g. integration of KM into corporate culture or consideration of human resource) of KM are treated.¹⁷⁸

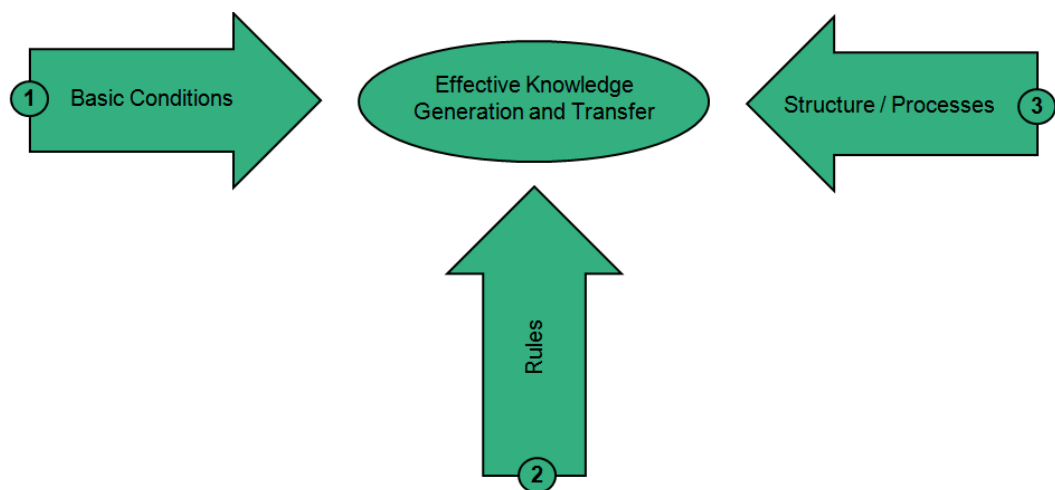


Figure 12: Requirements for Knowledge Creation and Transfer¹⁷⁹

The theoretical character of this concept already indicates that a practical implementation is quite complex which is also underlined by an enlargement of business processes by integration of so called knowledge integration processes being required.¹⁸⁰

3.1.7. Knowledge Management Process Model [Davenport / Prusak]

In analogy to the concept of North, Davenport et al. also see companies as knowledge markets with buyers (employees seeking knowledge to solve a

¹⁷⁶ See Lehner (2009), p. 79

¹⁷⁷ See Steiger (2000), p. 79

¹⁷⁸ See Lehner (2009), p. 80

¹⁷⁹ Source: created by the author analog to North (2011), p. 273

¹⁸⁰ See Krallmann, Frank & Gronau (2002), p. 382

problem), sellers (employees owning substantial knowledge about process or subject) and brokers (employees who create connections between those who need and those who have knowledge).¹⁸¹ Like economic markets, the knowledge market also works with pricing and payment mechanisms whereby the authors identify three different kinds of payment operations being reciprocity, reputation and altruism. An employee - owning knowledge - takes time and effort to share his knowledge in case of expecting favor to be returned when he seeks knowledge. This phenomenon is called reciprocity. If employees have certain knowledge and are willing to share it they might also be rewarded by gaining a reputation. Others might share knowledge altruistically. No matter what reason or incentive for knowledge sharing, a requirement for the functionality of knowledge markets is a corporate environment of trust.¹⁸² An illustration of the concept is given in Figure 13.

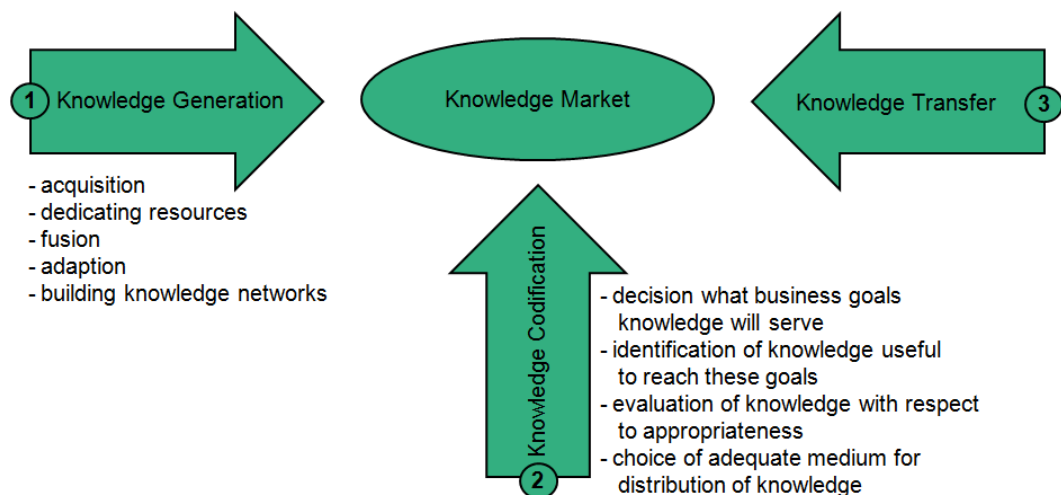


Figure 13: Knowledge Management Process Model¹⁸³

Three processes are suggested to establish a knowledge market within the KM process model being knowledge generation, codification and transfer. Quite similar to the concept of Probst et al. the knowledge generation deals with activity increasing the corporate knowledge whereby five methods are mentioned by Davenport et al. being acquisition, dedicating resources, fusion, adaption and

¹⁸¹ See Choo (2003), p. 205

¹⁸² See Davenport & Prusak (2000), pp. 30-33

¹⁸³ Source: created by the author analog to Davenport & Prusak (2000), pp. 25-106

building knowledge networks.¹⁸⁴ For the codification of corporate knowledge a scheme of four elements is proposed (see Figure 13).¹⁸⁵ Since companies behave as knowledge markets, the development of market places for trading and sharing of knowledge is indispensable to enable knowledge transfer.

Although this concept takes into account all columns of KM and is strongly focused on the enhancement of knowledge-intensive business processes, valid statements concerning the adequate course of action as well as detailed recommendations for the use of methods for a certain target and process type are missing.¹⁸⁶

3.1.8. Business Knowledge Management [Bach / Österle]

The business knowledge management concept proposed by Bach et al. aims at KM characterized by an availability of information and a systematically development out of the individual business process situation.¹⁸⁷ The focus is set on the conception of an integrated information system and the establishment of roles and knowledge processes. The approach consists of three different layers being knowledge base, knowledge structure and business process (see Figure 14).¹⁸⁸ The basis of the business knowledge management is the knowledge transfer within and between the business processes. The knowledge base comprises KM carriers and roles, documents and systems as well as KM processes in the sense of service processes to business processes. The final level - knowledge structure - handles the categories of knowledge and their relationship.¹⁸⁹

The corresponding modeling method by Bach et al. is called PROMET I-NET which aims at the design of an intranet-based KM solution. This tool is structured into four phases: initialization, analyses, conception and realization.¹⁹⁰ Within the literature the approach of Bach et al. is identified as being more content management system than knowledge management concept due to the strong focus on explicit knowledge.¹⁹¹ This deficiency is reduced by proposed enhancements within the

¹⁸⁴ See Davenport & Prusak (2000), pp. 52-67

¹⁸⁵ See Davenport & Prusak (2000), pp. 68-87

¹⁸⁶ See Remus (2002), p. 42

¹⁸⁷ See Bach, Vogler & Österle (1999), p. 26

¹⁸⁸ See Maier (2007), p. 241

¹⁸⁹ See Schulze (2000), p. 24

¹⁹⁰ See Bach, Vogler & Österle (1999), pp. 117-129

¹⁹¹ See Cissek (2010), p. 151

second book of Bach et al., wherein instruments improving the use of implicit knowledge are presented.¹⁹²

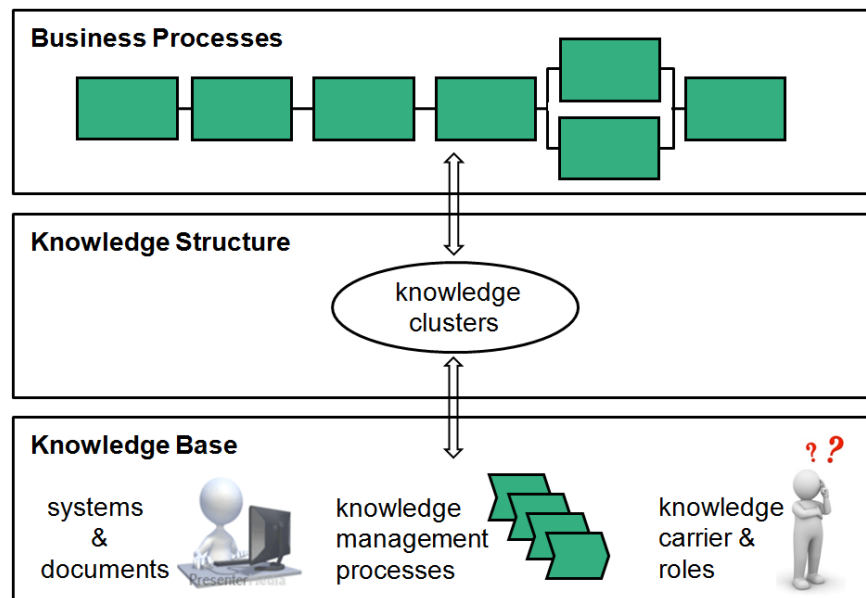


Figure 14: Business Knowledge Management¹⁹³

3.1.9. Business Process-Oriented Knowledge Management [Frauenhofer IPK]

The business process-oriented knowledge management (BPOKM) developed by the Fraunhofer Institute for Production System and Design Technology provides a conceptual framework consisting of three different layers (see Figure 15).

The first level deals with value-adding business processes since they represent the application field of knowledge. Analyses of the relevant content of knowledge - so called knowledge domains - are conducted on basis of the business processes.¹⁹⁴

The second layer describes the core processes of KM. A survey of Heisig et al. empirically validates - out of the eight blocks of KM proposed by Probst et al. - the four most relevant KM activities being knowledge creation, knowledge storage, knowledge distribution and knowledge application.¹⁹⁵ These KM core processes have to form an integrated cycle. The excellence performance of a single

¹⁹² See Bach, Österle & Vogler (2000), pp. 51-119; Mertins, Heising & Vorbeck (2003), p. 19

¹⁹³ Source: created by the author analog to Bach, Vogler & Österle (1999), p. 26

¹⁹⁴ See Heisig (2001), pp. 14-36

¹⁹⁵ See Heisig (2001), pp. 97-123

component is not sufficient since an integrated cycle using all four activities in a good manner is required to be integrated into the business processes.¹⁹⁶

The final level defines the design fields of KM being the major dimensions for success of the KMC. These dimensions are in detail: corporate culture, leadership, human resource, information technology, organization and roles as well as control. Measures applied within these design fields shall ensure the success of KM. Figure 15 illustrates the before mentioned layers within the business process-oriented knowledge management.¹⁹⁷

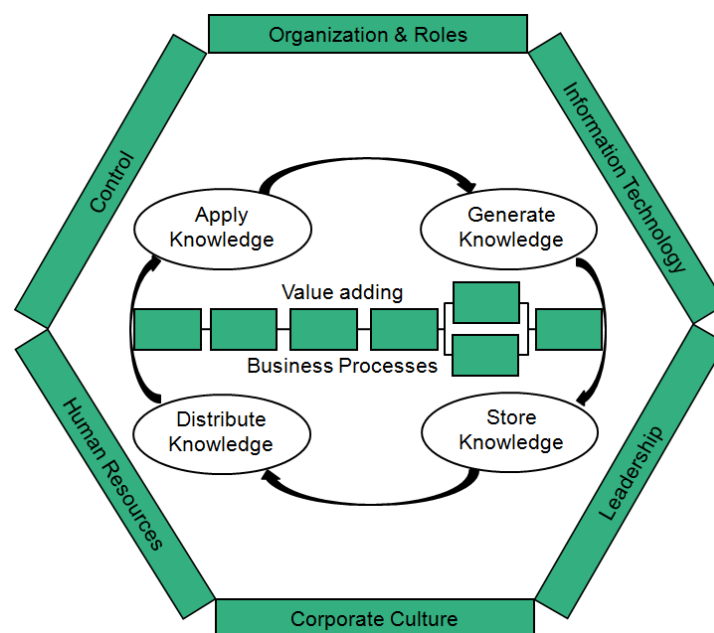


Figure 15: Business Process-Oriented Knowledge Management¹⁹⁸

This approach represents an integrated solution for KM since all relevant aspects like knowledge activities as well as knowledge framework conditions are analyzed. The process modeling is conducted by use of a proposed method (Integrierte Unternehmensmodellierung) with a high level of detail, since each process task is analyzed individually.¹⁹⁹

¹⁹⁶ See Mertins & Seidel (2009), p. 11

¹⁹⁷ See Mertins, Heising & Vorbeck (2003), p. 10

¹⁹⁸ Source: created by the author analog to Mertins, Heising & Vorbeck (2003), p. 11

¹⁹⁹ See Remus (2002), pp. 44-46

3.2. Critical Analysis of Existing Concepts

The focus of each of the before mentioned models depends on the broad and heterogeneous application field since some approaches help structuring partial aspects and others the overall task of corporate KM.²⁰⁰ Nearly all of the proposed KM concepts underline the process character of interlinked business activities whereby the level of consideration varies.²⁰¹ Beside the typical classification into holistic and partial concepts Remus divides KM models according to their aim being generation of process transparency, knowledge process redesign, KM introduction and application of KM. Nevertheless, these categories are not without any overlapping since the model proposed by Fraunhofer IPK fits into the category of KM introduction and application as well as knowledge process redesign.²⁰²

Recommendation concerning operative actions within a strategic framework is missing within the models because a direct connection between KM and the corporate targets is not explicitly mentioned. Without Davenport et al., who propose redesign strategies, the remaining concepts deal on the operative level and give advises for modification of the design field of KM (e.g. ICT, corporate culture).²⁰³

Nomenclature used within the concepts is none-homogeneous since synonyms for core activities exist (e.g. knowledge generation: creation, development, production, acquisition).²⁰⁴ Even the number of these KM tasks is not identical and ranges from two or three up to eight.²⁰⁵ The focus on each of these core activities varies from one approach to another. The concept of Nonaka et al. focuses on the generation of knowledge while Bach et al. highlight the development and distribution of explicit knowledge.²⁰⁶

Another difference between the KM approaches is the level of detail for analyzing and modeling the actual corporate situation. Within the process analysis of the model by Bach et al. relevant knowledge transfers between business processes are

²⁰⁰ See Lehner (2009), p. 67

²⁰¹ See Salvendy (2001), p. 215

²⁰² See Remus (2002), p. 71

²⁰³ See Remus (2002), p. 72

²⁰⁴ See Mertins, Heising & Vorbeck (2003), p. 17

²⁰⁵ See Bach, Vogler & Österle (1999), pp. 37-84; Davenport & Prusak (2000), pp. 25-106; Probst, Raub & Romhardt (2010), pp. 25-33

²⁰⁶ See Bach, Vogler & Österle (1999), pp. 37-84 ; Nonaka & Takeuchi (2012), pp. 181-221; Mertins, Heising & Vorbeck (2003), p. 17

identified, while in the approach of Fraunhofer IPK the reality is simplified by collectives.²⁰⁷

The characteristics being relevant for the analysis within this work (see Chapter 2.6) differ according to the considered KMC. All approaches propose a certain procedure for the implementation and application process whereby one of the first phases is the identification of the actual situation. The analysis is conducted by different methods varying according to the concept and to the degree of complexity.²⁰⁸ Furthermore, workload for the different concepts depends on KM activities, research objectives (e.g. processes, IT situation) and applied tools. Thus, the ease of use strongly varies.

An entire analysis of the overall organization is complex for a practical application. Since this has been realized by many authors focus onto value-adding and knowledge-intensive business processes is proposed (e.g. Bach et al., Fraunhofer IPK).²⁰⁹ Especially concepts out of the millennium change emphasize this high degree of process-orientation. The findings of the analysis are summarized within the Figure 16 whereby each of the before mentioned KMC is positioned within the evaluation matrix.

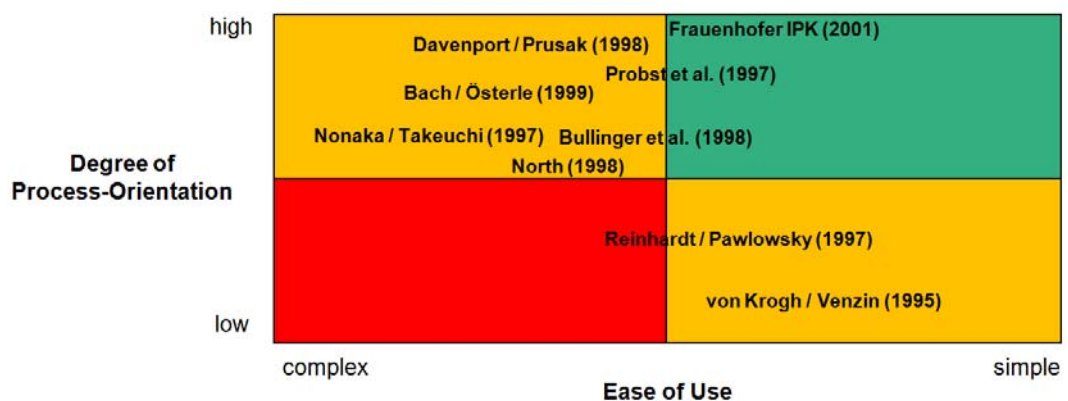


Figure 16: Positioning of KMCs within Evaluation Matrix²¹⁰

²⁰⁷ See Bach, Vogler & Österle (1999), pp. 37-84; Heisig (2001), pp. 14-36; Gronau (2009), p. 69

²⁰⁸ See Gronau (2009), p. 70

²⁰⁹ See Gronau (2009), p. 69

²¹⁰ Source: created by the author

According to criteria defined within this work the positioning matrix indicates that none of the analyzed concepts is 100% suitable for an application within SMEs. The approaches by Fraunhofer IPK, Probst et al. and Bullinger et al. are positioned within or near by the green quadrant which indicates usability within SMEs. Nevertheless, there is still enough potential for enhancement since none of the analyzed concepts are characterized by simple ease of use in combination with high degree of process-orientation. The business process-oriented knowledge management by Fraunhofer IPK is identified as the most promising KM concept for the required application within this work and is taken as basis for further development.

3.3. Instruments for Knowledge Management

For the application of KM within the framework of one of the before mentioned approaches the use of tools is required. Since a variety of KM methods for corporate use exist one challenge is the identification of an adequate tool for the specific situation within an individual SME. Different overviews indicate the diversity.²¹¹ Especially the IT provides many different tools which shall support the KM work.²¹² The organization needs a basis for the integration of all these small tools which is in best case an already existing data management system. Especially in SMEs it is worth to use existing systems due to the high price of a purchased overall solution. A simple portal solution (e.g. virtual community or intranet) costs about € 200.000.²¹³

To enable a better overview of the existing KM tools a sort with respect to the application in accordance to the blocks of KM is proposed in the literature. The list of methods and tools applicable for KM is given in Table 4 but does not have the right to completeness since only the most relevant instruments are mentioned. Although some tools can be applied for more than one block of KM they are listed in the following just once. A detailed description of these KM methods is given in the literature and is not part of this work.²¹⁴ The instruments recommended for use in the framework of the practical application are described in Chapter 7.3.

²¹¹ See uit Beijerse (1999), pp. 108-109; Gust von Loh (2008), pp. 129-132; Maier (2007), p. 218

²¹² See Gronau (2009), pp. 7-10

²¹³ See Hesseler (2005), p. 20

²¹⁴ See Gust von Loh (2008), pp. 129-132; Young (2010), p. 3

Knowledge Generation	Knowledge Storage
Debriefing	Knowledge Bases (Wikis, etc.)
Brainstorming	Document Management System
After Action Reviews	Blogs
Lesson Learned	Knowledge Portal
Communities of Practice	Documentation
Interaction	Structuring of Folders
Internal and External Training	
Knowledge Distribution	Knowledge Application
Intranet	Collaborative Physical Workspace
Knowledge Maps	Collaborative Virtual Workspace
Yellow Pages	
Storytelling	
Mentoring	
Coaching	
Knowledge Cafés	
Newsletter	

Table 4: Overview of Instruments for Knowledge Management²¹⁵

Alternatively categorization is proposed in the literature to overcome the variety of KM methods.²¹⁶ Mertins et al. proposes a subdivision of KM tools into eight groups whereby diverse is examined with respect to the core activities of KM (see Table 5).

Categories	Knowledge Generation	Knowledge Storage	Knowledge Distribution	Knowledge Application
Search Engines	x		x	x
Portals		x	x	x
Visualizing Tools				x
Skill Management		x	x	
Complete KM Suites	x	x	x	x
Toolkits	x	x	x	x
Learn and Teach	x			
Virtual Teams	x	x	x	

Table 5: Categorization of Instruments for Knowledge Management²¹⁷

²¹⁵ Source: created by the author analog to Young (2010), pp. 3-5

²¹⁶ See Mertins, Heising & Vorbeck (2003), pp. 115-118; Wang, Kovacs, Wozny & Fang (2006), pp. 47-48

²¹⁷ Source: created by the author analog to Wang, Kovacs, Wozny & Fang (2006), pp. 47-48

4. Modified Knowledge Management Concept for Small and Medium-Sized Enterprises within Structural and Mechanical Engineering Business

Based on findings out of the literature review a modification for an existing KMC is proposed. The changes enable a better application within SMEs out of the SMEB. According to the positioning matrix in Figure 16 a simplification of business process-oriented knowledge management by Fraunhofer IPK leads to a suitable approach. The positioning within the evaluation matrix for the concept proposed by the author is visualized within Figure 17.

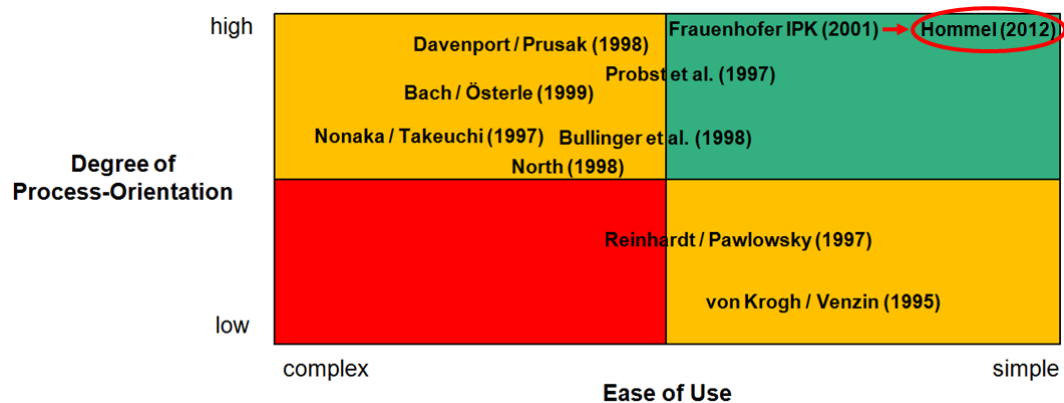


Figure 17: Positioning of modified KMC within Evaluation Matrix²¹⁸

4.1. Knowledge Management Framework

Within the following the proposed approach is described in detail. The overall structure of the concept is similar to the one of the BPOKM since in analogy to the original model three layers for KM are conducted. The illustration within Figure 18 gives an overview of the proposed KMC. Nevertheless, differences occur within some minor aspects.

- The first layer is oriented to the business processes whereby another definition of business process compared to Fraunhofer IPK is chosen within this work.

²¹⁸ Source: created by the author

- The second layer defines the core activities of KM being identical to the ones proposed by Fraunhofer IPK.
- The third layer represents the corporate environment for KM. The primary focus here - due to emphasis on SMEs - is simplification of the concept of Fraunhofer IPK.

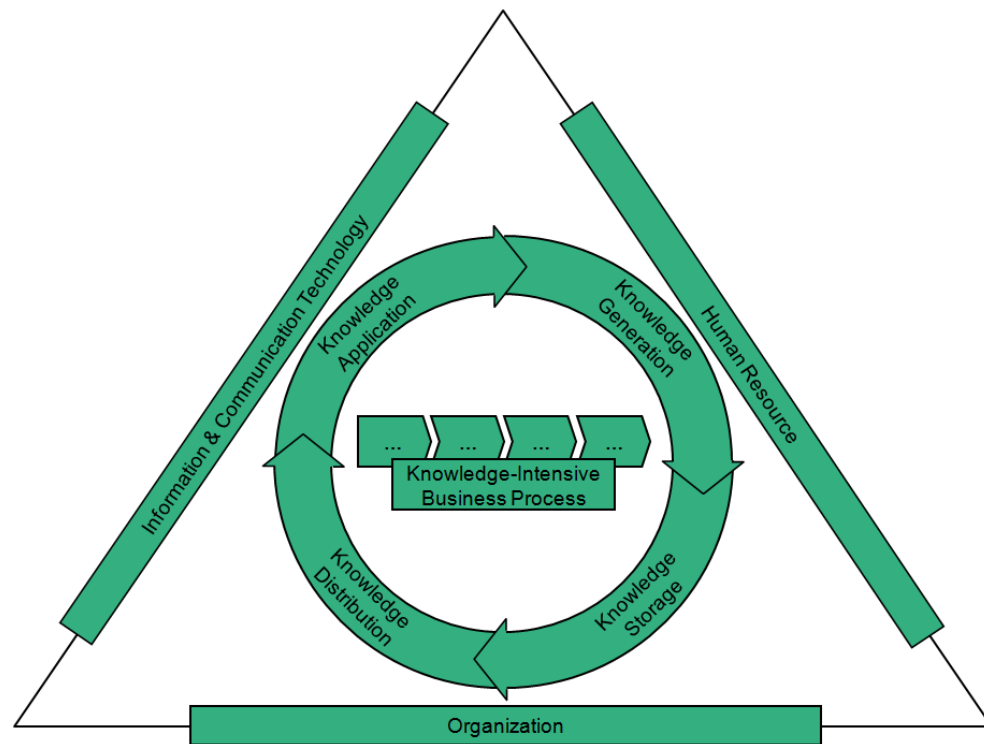


Figure 18: Modified Knowledge Management Concept²¹⁹

In the following the three layers are described more in detail whereby the focus is set on identification of the differences between the original and the modified concept.

4.1.1. Business Process

According to a definition of Österle an aim of KM is to provide all employees with relevant information which is needed to execute tasks related to certain business processes.²²⁰ The important question is: What is an adequate definition of business process?

²¹⁹ Source: created by the author analog to Mertins, Heising & Vorbeck (2003), p. 11

²²⁰ See Österle (2000), p. 24

Core aspect of the BPOKM is the so-called value-adding business process since aim of the implementation of a KM solution is to increase efficiency and profitability. Mertins et al. define business processes as the subsumption of cross-functional tasks which are needed to create a specific customer's service or product. Knowledge is one of the resources applied within these tasks.²²¹ Examples are the sales and marketing process or the product development process.

Two main advantages result out of the process-oriented KM application. The first argument is that employees are familiar with the operative processes and are therefore able to identify the optimization potential. The second point deals with an easier implementation of measures since employees recognize a possibility to optimize their daily business work. Conclusively, the decoupling of KM activities from operative business tasks would not lead to success.²²²

Nevertheless, the treatment of the business processes is very complex if the analysis is applied in detail. Since KM concepts for SMEs should be characterized by an ease of use, a rough level of detail for the evaluation of business processes is proposed. Within this work an application of the modified BPOKM for SMEB is given whereby the engineering process is identified as the relevant process worth to be analyzed. The engineering process in general is project-related and practically realized by a pass of different departments. The application fields of knowledge are the departments and the interfaces between different departments. Thus, a definition of the business processes is proposed on the macro (department) level whereas the original concept deals more on a micro (process) level. An illustration of the difference between both approaches is depicted in Figure 19.

²²¹ See Mertins & Seidel (2009), p. 16

²²² See Mertins & Seidel (2009), p. 17

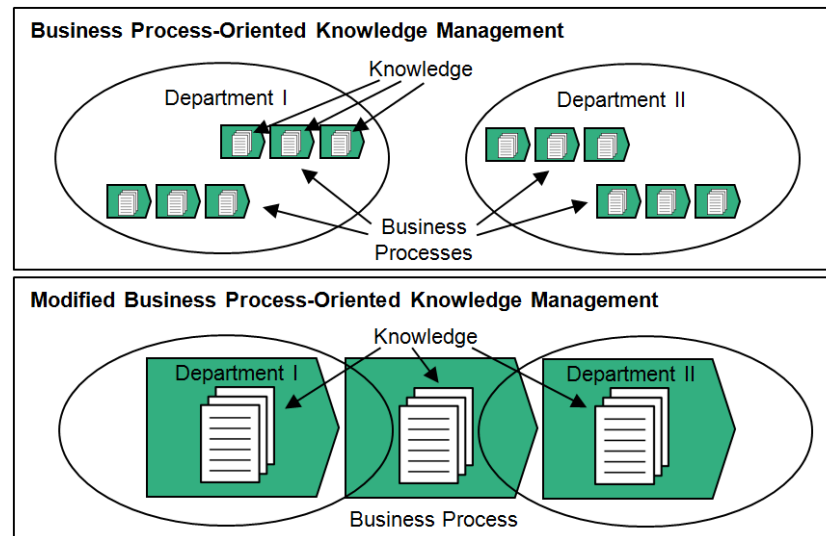


Figure 19: Business Process²²³

4.1.2. Core Activities of Knowledge Management

All concepts - analyzed in Chapter 3.2 - emphasize different KM core activities. To find out which of the eight KM tasks proposed by Probst et al. are relevant, a survey has been conducted during a research work of Fraunhofer IPK.²²⁴ Thereby four of these core activities have been assessed as necessary being application (96%), distribution (91%), generation (84%) and storage (78%) of knowledge.²²⁵ These results build the basis for the assumption of the proposed model. If these four core activities are essential for KM than they represent the absolute minimum of design criteria to analyze and no further simplification is possible at this layer of the concept.

The KM tasks are related to supply and demand of knowledge within the business process. All four core activities form a knowledge cycle (see Figure 20). It is important to develop new knowledge within the company, to store it and to make it available at the right place and at the right time. Thus, it can be applied target-oriented for a certain business task. KM combines all methods and tools supporting these four core activities to enable a smooth pass of these activities. The cycle always repeats analog to a life-cycle.²²⁶

²²³ Source: created by the author

²²⁴ See Probst, Raub & Romhardt (2010), pp. 25-33

²²⁵ See Mertins, Heising & Vorbeck (2003), p. 6

²²⁶ See Mertins, Heising & Vorbeck (2003), p. 18

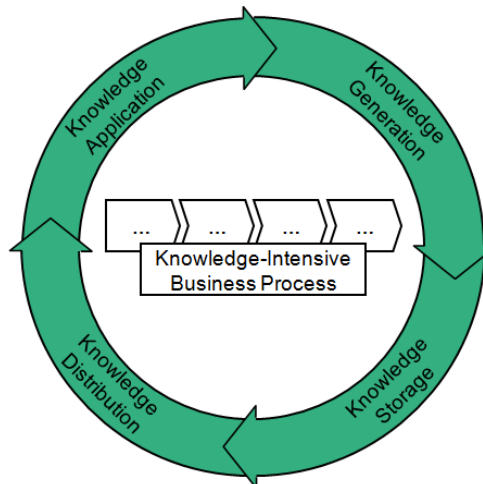


Figure 20: Core Activities²²⁷

The core task of knowledge generation describes on the one hand side activities dealing with acquisition of external knowledge by e.g. consultancy or recruiting and on the other hand side creation of new knowledge within the company.²²⁸ An important KM method to integrate implicit knowledge is lesson learned. Another aspect of KM is the storage of data, since otherwise the loss of knowledge threatens.²²⁹ The stored information has to be distributed throughout the enterprise to create explicit collective knowledge.²³⁰ Gaining access to the corporate knowledge enables an application of these information which leads to corporate success.²³¹

4.1.3. Corporate Environment for Knowledge Management

Within this part of the concept knowledge management is linked to the general organizational environment. The BPOKM divides six corporate design fields being ICT, leadership, corporate culture, human resource, control as well as organization and roles.²³² Due to simplicity the modified concept of this work deals with a reduced number of relevant environmental factors. A broader view according to TOM concept of Bullinger et al. is proposed such that only aspects of ICT, human

²²⁷ Source: created by the author

²²⁸ See Bodrow & Bergmann (2003), p. 47; Probst, Raub & Romhardt (2010), p. 29

²²⁹ See Kusterer (2008), p. 36

²³⁰ See Bodrow & Bergmann (2003), p. 48

²³¹ See Probst, Raub & Romhardt (2010), p. 30

²³² See Mertins, Heising & Vorbeck (2003), p. 11

resource and corporate culture are treated.²³³ The difference between both concepts is illustrated in Figure 21 whereby on the left hand side the original and on the right hand side the modified concept is depicted.

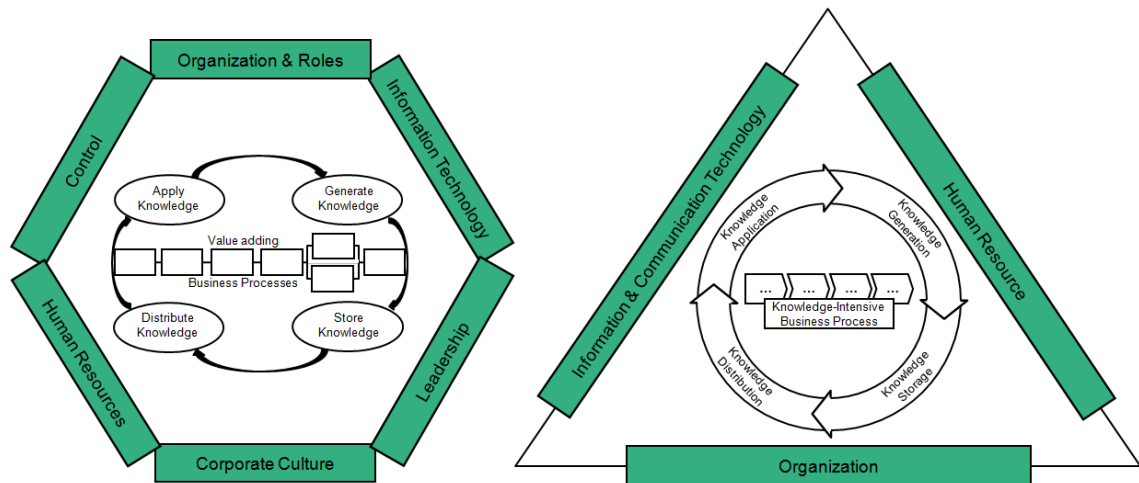


Figure 21: Corporate Environment²³⁴

KM implementation needs to take into account the current state of each of these three design fields. According to Heisig it is essential for a successive KM implementation that adequate measures in all of these three components are provided.²³⁵ Due to practical experience it has been realized that a lot of potential within currently implemented corporate ICT systems does exist but is not yet used. In former times the focus was set on the integration of too complex ICT software which often leads to a fail of the complete KM project. Nowadays, the employees are integrated stronger within the implementation process and the organizational framework is considered much more.

Another important factor of success is represented by the human resources since they are carriers of knowledge, skills and competences. Analyses of key qualifications have to be conducted and need for developments have to be identified within this aspect of corporate environment.

²³³ See Bullinger, Warschat, Wörner & Prieto (1998), p. 7

²³⁴ Source: created by the author

²³⁵ See Heisig (2007), p. 457

The term organization describes both, organizational and operational structure. The success of KM depends on how current structures and processes enable smooth application of the KM core activities.²³⁶

4.2. Implementation Procedure

The following implementation strategy represents a reduced form of the procedure proposed by Heisig et al. whereby only relevant aspects for SMEs are considered.²³⁷ The definition of processes differs in this work from the view of Heisig et al. (see Chapter 4.1.1) therefore his initial step (choice of corporate area) is neglected.²³⁸ The proposed concept handles an overall business view since in SMEs department-oriented application considers the complete organization. In accordance to the original BPOKM the modified concept distinguishes three design steps which can be summarized by the phases: strategy, analysis as well as solution and implementation of KM (see Figure 22).

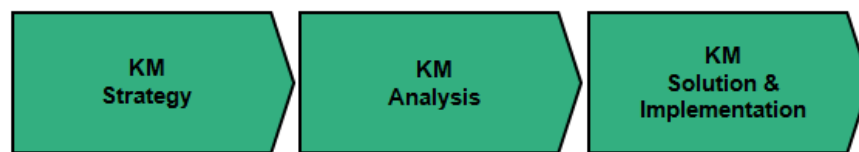


Figure 22: Knowledge Management Implementation Procedure²³⁹

4.2.1. Knowledge Management Strategy

The first phase focuses on definition of KM Strategy. Identification of business processes - to be improved by applying KM methods - represents the initial design step. Different criteria for the choice of an adequate corporate process exist whereby in general knowledge-intensive processes are preferred.²⁴⁰ Since the proposed approach shall be applied within SMEs out of the SMEB the knowledge-intensive process - to be analyzed by using KM methods - is identified as being the engineering process which is project-driven and described by a department-oriented workflow.²⁴¹

²³⁶ See Kohl & Orth (2010), p. 189; Mertins & Seidel (2009), p. 19

²³⁷ See Heisig (2001), pp. 14-36

²³⁸ See Abdecker, Hinkelmann & Maus (2002), p. 54

²³⁹ Source: created by the author analog to Kohl & Orth (2010), p. 180

²⁴⁰ See Kohl & Orth (2010), p. 180

²⁴¹ See Jarke, Nissen, Rose & Schmitz (2010), p. 84

Knowledge-intensive processes are characterized by “tasks with changing requirements”, “relevant knowledge often related to individuals” and “identification of relevant knowledge often advantageous and retrospective”. Another criterion beside the knowledge-intensity is the presence of strategic activities which might be coupled with KM. Kohl et al. mention examples like the implementation of quality- or process management wherein implementation of KM is only a partial aspect of a complete project. This might lead to increasing acceptance since KM is not a stand-alone project.²⁴²

After choice of relevant business process a modeling is required which enables visualization, description and analysis of corporate workflows. The graphic representative of the engineering process is the foundation of further analyses concerning the treatment of knowledge.²⁴³ Definition of so called knowledge domains helps to subsume different aspects of relevant knowledge.²⁴⁴ Further treatment of knowledge domains as resources enables allocation to tasks and individuals as well as focusing on relevant aspects only.²⁴⁵

Within the proposed approach the initial phase of KM strategy consists of three design steps being the definition of business processes, strategic targets and knowledge domains. An illustration of the design steps within the first stage of the implementation procedure for the proposed approach is given in Figure 23.

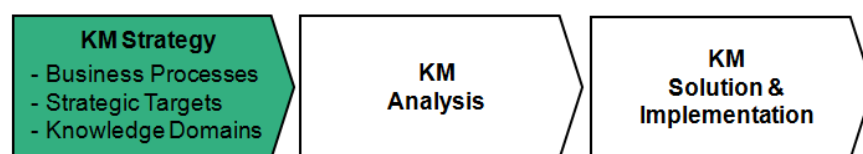


Figure 23: Knowledge Management Strategy²⁴⁶

²⁴² See Kohl & Orth (2010), p. 180

²⁴³ See Kohl & Orth (2010), p. 181

²⁴⁴ See Mertins & Seidel (2009), p. 17

²⁴⁵ See Kohl & Orth (2010), p. 174

²⁴⁶ Source: created by the author

4.2.2. Knowledge Management Analysis

The second phase aims at the analysis of the corporate KM framework to identify potentials for improvement and to develop an adequate solution to enhance the corporate KM situation. A survey helps to get a first insight into current KM state.²⁴⁷ It is essential to identify deficiencies within the organizational application of knowledge and to derive fields with need for action. Treatment of knowledge within the chosen business process has to be defined and evaluated. Within the analysis the three layers describing the KM framework being business process, core activities and corporate environment are examined. Furthermore, knowledge domains and operational goals of KM are analyzed.²⁴⁸

While a definition of strategic goals is part of the first stage, within the second stage operational goals shall be identified. If KM treats the enhancement of the identified operational deficiencies the acceptance of the employees can be won.²⁴⁹ Finally, validation of the KM survey results and a more detailed analysis is conducted by a KM focus group interviews. This method enables an integration of process-relevant knowledge carriers within the KM process. A collective development of adequate solutions shall improve the acceptance.

As a result of this analysis stage, a knowledge activity profile for the engineering process shall describe further actions which are treated within the last phase. Figure 24 gives an overview of the steps being part of the analysis stage of the proposed implementation model.



Figure 24: Knowledge Management Analysis²⁵⁰

²⁴⁷ See Mertins & Seidel (2009), p. 33

²⁴⁸ See Kohl & Orth (2010), p. 181

²⁴⁹ See Mertins & Seidel (2009), p. 26

²⁵⁰ Source: created by the author

4.2.3. Knowledge Management Solution and Implementation

After analyzing the survey results within the third phase KM solutions shall be proposed and presented for management decisions in the third step.²⁵¹ Hereby it is important to evaluate the different KM methods under consideration of the usability within the relevant SME. After the choice of adequate tools an implementation roadmap shall be developed which defines further progress for the implementation process.²⁵² The solutions have to be implemented within the existing business processes which might be either small modification within the current business process workflow or implementation of new IT tools. The design step of KM implementation takes the most time compared to the other phases.²⁵³ The steps of the third stage of the implementation procedure are visualized within Figure 25.

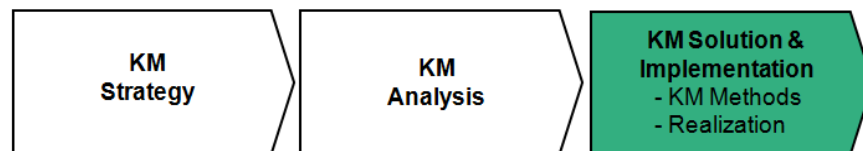


Figure 25: Knowledge Management Solution and Implementation²⁵⁴

²⁵¹ See Mertins, Heising & Vorbeck (2003), p. 24

²⁵² See Mertins & Seidel (2009), p. 27; Kohl & Orth (2010), p. 188

²⁵³ See Mertins & Seidel (2009), p. 29

²⁵⁴ Source: created by the author

5. NEM Power-Systems

After theoretical treatment of KMCs the practical applicability of the proposed approach shall be checked in a case study for a specific SME out of the SMEB.

5.1. Description of Company

In 1997 the Dutch NEM Energy B.V. - being a globally leading engineering company for heat recovery steam generating equipment in power plants - acquired the tangible (e.g. inventory, design documents), intangible (e.g. patents, know-how) as well as human resources of the German Stoiber & Morlock in Recklinghausen.²⁵⁵

The company gained experience for more than 50 years within the field of design and supply of shut-off and control dampers necessary in power and environment industry. In continuation of the business activities of Stoiber & Morlock, NEM Power-Systems was founded as the centre of competence within the NEM group for damper systems and bypass stacks.²⁵⁶ The establishment of the German subsidiary enables the NEM group to enhance their product portfolio by a critical purchase component. NEM Power-Systems supplies the NEM Energy B.V. as well as the competitors of the parent group with their products which indicates that NPS is operating in a certain sense independently.

Today, NPS employs 55 people and is one of the world leaders for the design of dampers. NPS offers all types of dampers suitable for power plants, flue gas cleaning industry as well as special fields like marine- or off-shore application where tight shut-off or control within flue gas application is required. The product portfolio varies from single dampers to total bypass or exhaust gas systems which corresponds to project revenues from € 50.000 to € 13 million.

The individual requirements according to customer's project-related specifications prevent NPS from standard designs. Instead the company is demanded to develop customized components. Both factors - the wide range of products as well as the product modification according to the project's needs - highlight the need for knowledge since for an adequate project handling the availability of technical know-how as well as project specific information is essential.

²⁵⁵ See NEM Energy B.V. (2012)

²⁵⁶ See NEM Power-Systems (2012)

5.2. Analysis of Organization

To get a better insight into the corporate situation in the following the corporate structure as well as the project life-cycle of NPS is described more in detail.

5.2.1. Corporate Structure

Since the NEM Energy B.V. sees “quality as a condition for winning and retaining the trust of its customers” it is considered as an important and permanently established aspect. Thus, all business units are responsible for meeting at least minimal quality requirements according to the EN ISO 9001 norms.²⁵⁷

Due to the certification according to EN ISO 9001 the structure of NEM Power-Systems is characterized by process-orientation. The IKZ15 - being the NPS quality management manual - describes these processes.²⁵⁸ Within the manual the corporate structure is defined as illustrated in Figure 26.

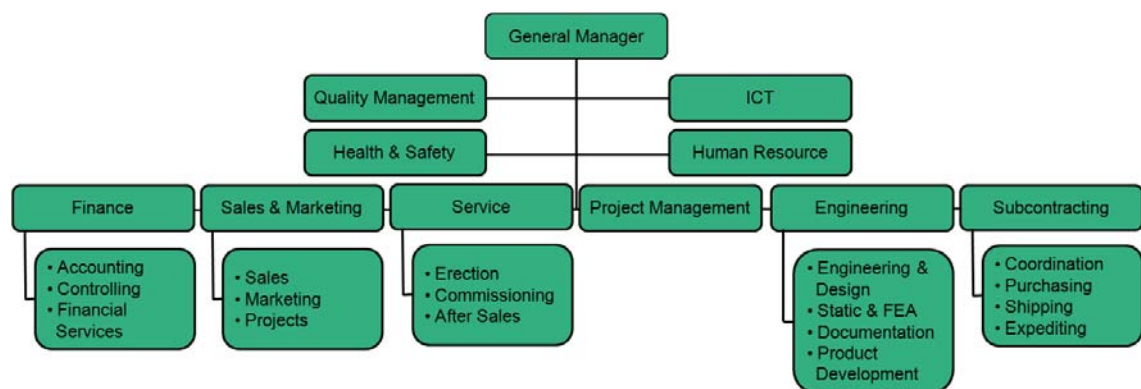


Figure 26: Corporate Structure of NEM Power-Systems²⁵⁹

While Finance, Sales, Engineering and Subcontracting are guided by departmental managers the remaining staff positions are directly under the control of the general management. Thus, the organizational structure with regard to personnel management of NEM Power-Systems can be described as a low hierarchy consisting of four heads of department and a general manager on top of the enterprise.

²⁵⁷ See NEM Energy B.V. (2009)

²⁵⁸ See NEM Power-Systems (2009)

²⁵⁹ Source: created by the author analog to NEM Power-Systems (2009)

5.2.2. Project Cycle and Departments

Since the focus within this work is set on the engineering process of NPS, in the following the core departments within this process are described in detail. These core departments are sales, project management and engineering. An illustration of the project cycle within NEM Power-Systems is given in Figure 27.

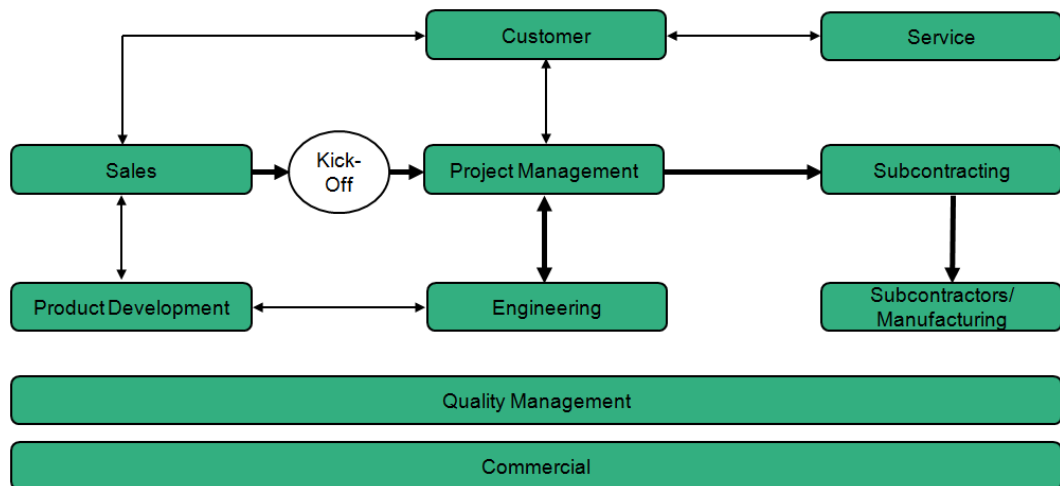


Figure 27: Project Cycle of NEM Power-Systems²⁶⁰

Preparation for a project begins with a request from a customer who defines certain needs and requirements. In cooperation with engineering or product development the feasibility according to the customer's specification is proven and a technical solution is developed. As a result of these investigations a proposal is written afterwards which in ideal case is accepted by the customer by sending an order. After acceptance by NPS this order is considered to be a contract.

Within a kick-off meeting all relevant documents are delivered from sales to project management. The project manager is responsible for all further project activities to ensure that the final product satisfies the proposed requirements and expectations of the customer and is delivered on time. Intensive communication with customers as well as intensive cooperation with engineering department is essential.

²⁶⁰ Source: created by the author analog to NEM Power-Systems (2009)

The engineering department is responsible to transform the product desired by the customer into a technically feasible and functional product design. Within NPS the engineering department is the largest division and can be subdivided into the parts calculation, design, product development and documentation. The calculation team starts the design process of a new project in cooperation with the product development team. After their analyses are finalized the design team begins producing the manufacturer drawing. In parallel further documents like e.g. operation manuals are developed by the documentation team. During this process an intensive communication between the project management and the engineering is existent since a lot of information is required from both sides. Finally, a complete set of static calculations, drawings and further documents have been delivered to the project manager.

The final part of the project cycle involves the department subcontracting which is responsible for coordination, purchasing, shipping and expediting of the manufacturing process. A lot of information is delivered from project management to subcontracting to enable a smooth process flow. Since NPS does not manufacture on its own, contractors mostly from south-east Asia are engaged to do manufacturing work.

5.3. Knowledge Management Situation

The current KM situation within NPS is described with respect to the core activities of KM. The focus within this analysis is set on the instruments of KM already in use within this enterprise. Some of these tools are applied for different purpose such that a categorization into more than one activity is possible. The following evaluation results out of individual observations, experience and knowing out of the author's daily business work. In the following for each of the core activities the KM tools applied within NPS are summarized and a short comment shall indicate the quality of use.

5.3.1. Knowledge Generation

Since generation of knowledge may take place internally as well as by external help both alternatives have to be considered in Table 6. The activity of knowledge

generation is closely related to knowledge distribution because the generation is often conducted collectively such that distribution is accompanied.²⁶¹

Instrument	Comment
External Trainings	underdeveloped, often on initiative of employee
External IT Service Provider	good cooperation
Cooperation with External Experts	on request
Attendance of Fairs	underdeveloped, only one regular fair visit
Offer of Bachelor Thesis	approximately one student per year
Inter-departmental Cooperation	underdeveloped, none regular meetings

Table 6: Instruments for Knowledge Generation of NEM Power-Systems²⁶²

Hilger et al. state that the generation of knowledge for SMEs occurs flexible and with low system but there is in general no need for more systematics. The same can be observed within NPS since although a lot of tools currently exist for this core activity the use is unstructured and there is still potential for enhancements. Instruments like circle of quality, cooperation with the parent group, mentoring, strategic human resource development, lesson learned or e-learning platforms are examples given in literature applied within other SMEs.²⁶³

5.3.2. Knowledge Storage

The KM instruments of knowledge storage might be seen from two perspectives. On the one hand side it describes the ICT instruments used to store the explicit knowledge and on the other hand side it also means all actions to prevent a loss of know-how. The methods applied within NPS are subsumed in Table 7.

Instrument	Comment
Document Management	underdeveloped, since Microsoft Explorer is used
Project Documentation	underdeveloped, since unstructured
Hand Over	underdeveloped, since unstructured

Table 7: Instruments for Knowledge Storage of NEM Power-Systems²⁶⁴

²⁶¹ See Hilger, Kohl & Krenn (2010), p. 39

²⁶² Source: created by the author

²⁶³ See Hilger, Kohl & Krenn (2010), pp. 38-41

²⁶⁴ Source: created by the author

To overcome the problem of document management an implementation of a document management system is currently in progress but not yet rolled out throughout the overall company. Another crucial point - to mention within the treatment of this KM activity for NPS - is the enhancement of employee loyalty since in the recent past several knowledge carriers left the company. But this aspect exceeds KM and directs more to topics like corporate culture or incentive management. For the sake of completeness, the loss of know-how due to leaving employees is an existing problem within NPS and the lack of qualified engineers throughout Germany does even increase the critical situation. Experiences of unsuccessful staff recruitments do underline this fact.

5.3.3. Knowledge Distribution

Within this category all methods and tools are subsumed which are used for the transfer of knowledge from one to another employee. A list of these instruments is given in Table 8.

Instrument	Comment
Intranet	underdeveloped, since rarely used by employees
Wiki	underdeveloped, since rarely used by employees
Team Meetings	underdeveloped, since unstructured
Minutes of Meeting	documentation of all relevant meetings
Lesson Learned	underdeveloped, since unstructured
Specifications & Data Sheet	underdeveloped, since unstructured
Newsletter & Internal Memo	underdeveloped, since too rare
Product Data Base	underdeveloped, since difficult access
RAK (Company Standard)	well applied

Table 8: Instruments for Knowledge Distribution of NEM Power-Systems²⁶⁵

There are more useful KM methods mentioned in the literature like info boards, product information systems, regular employee meetings, workshops of internal experts or regulations for knowledge transfer between different departments. Hilger et al. mention the lack of time within SMEs as the main argument for a none-use and none-maintenance of instruments like intranet and wiki. This absolutely

²⁶⁵ Source: created by the author

corresponds to the argumentation of the employees of NPS which the author observes within his daily business work.²⁶⁶

Although a variety of KM tools are applied within NPS the comments within Table 8 indicate that there exists potential for an optimization and there is a high need for a systematization of the knowledge distribution.

5.3.4. Knowledge Application

Table 9 gives an overview of the KM measures used within NPS to apply knowledge for decision making processes or actions.

Instrument	Comment
Quality Management	no use for knowledge application
Wiki	underdeveloped, since rarely used by employees
Experience out of Preliminary Projects	underdeveloped, since unstructured

Table 9: Instruments for Knowledge Application of NEM Power-Systems²⁶⁷

Since there does not yet exist any systematic KM within NPS the activity of knowledge application is not present within this organization. Suggestion systems, ideas management and data bases are applied by LEs for a systematic use and transformation of knowledge into new products and problem solving.²⁶⁸

Since according to the author's view the application of the knowledge is not a major deficiency within NPS and the implementation of adequate KM systems are complex, the enhancement of this activity does not owe highest priority. The only exception is the last aspect mentioned in Table 9 since the use of experience offers a high potential for enhancement.

5.4. Description of Problem

Project-driven SMEs are characterized by success factors like flexibility, innovativeness and customer orientation. Project-related feasibility checks within the stage of proposal preparation require engineering activities already in the sales

²⁶⁶ See Hilger, Kohl & Krenn (2010), pp. 42-43

²⁶⁷ Source: created by the author

²⁶⁸ See Hilger, Kohl & Krenn (2010), p. 45

phase where time and cost constraints are very tight.²⁶⁹ This overlapping of work streams indicates the high importance of adequate department interfaces especially with respect to knowledge transfer.

Standardized and out-of-the-box solutions, which might enable increase of efficiency and offer a potential for optimization, do not work for NPS without renunciation of flexibility which means that customer needs cannot completely be fulfilled anymore.

But NPS has gained knowledge throughout previous projects being a core asset which has to be reused extensively within new projects. It is essential to make the collected information and experience available throughout the company. In ideal case, an adaptation or extension of know-how leads to evolvement of new innovations and experience.²⁷⁰

Regarding the current KM situation of NPS as described in Chapter 5.3, it becomes obvious that the core activities of generation, storage and distribution of knowledge have to be analyzed more in detail. The focus is set on the knowledge distribution since at this stage of the work this activity seems to be the most promising one with regard to an optimization and an increase of efficiency within the organization.

In the following the most relevant deficiencies concerning KM are summarized. Up to this part of this work these findings result out of experience and observations collected by the authors during his daily business work at NPS being

- cooperation of different departments leading to high interface importance,
- insufficient use of gained project knowledge for new projects,
- none transparency of expert knowledge,
- none adequate storage of documented knowledge,
- none adequate distribution of knowledge as well as
- loss of knowledge due to leaving experts.

²⁶⁹ See Jarke, Nissen, Rose & Schmitz (2010), p. 84

²⁷⁰ See Jarke, Nissen, Rose & Schmitz (2010), p. 84

6. Application of Modified Knowledge Management Concept

Within the following chapter the proposed KM concept is applied for an analysis of the SME described in Chapter 5. The focus is set on the first two phases of the implementation procedure (KM strategy and KM analysis). Due to time constraints the last phase of solution and implementation of KM is only treated in Chapter 7.3 by proposing recommendations for further progress of a KM project within NPS.

6.1. Knowledge Management Strategy

Within the strategy phase the relevant business process is chosen. Thereafter strategic goals and knowledge domains are proposed which are evaluated with respect to suitability for NPS within the further analyzes phase.

6.1.1. Business Process

For NPS the engineering process is defined as the relevant knowledge-intensive business process to be analysed in the following. The engineering process can be developed out of the NPS project cycle (see Figure 27) since it is part of it. An illustration of the engineering process of NPS is given in Figure 28.

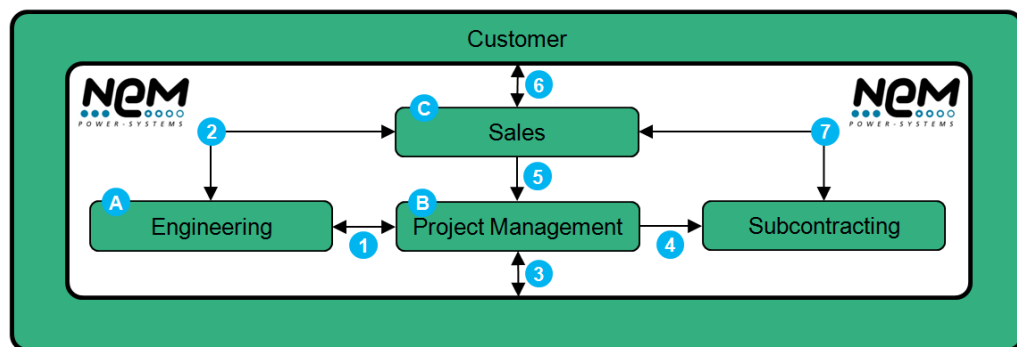


Figure 28: Knowledge-Intensive Business Process of NEM Power-Systems²⁷¹

²⁷¹ Source: created by the author

The relevant business process consists of three departments:

- A: engineering,
- B: project management and
- C: sales.

Since the interfaces of these departments have also an impact on KM situation they are also integrated into the following analysis. Within the engineering process seven interfaces can be identified:

- 1: engineering - project management,
- 2: engineering - sales,
- 3: project management - customer,
- 4: project management - subcontracting,
- 5: project management - sales,
- 6: sales - customer,
- 7: sales - subcontracting.

In the analyzing phase these relevant components (departments A to C and interfaces 1 to 7) are evaluated with respect to the current knowledge situation. Hereby the “need for knowledge” as well as the “availability of knowledge” for all departments and interfaces is determined.

6.1.2. Strategic Target

For definition of strategic target of KM suitable for NEM Power-System four typical goals taken from literature are proposed

- creation of added-value,
- increase in efficiency,
- improvement of networking and
- strengthening of innovation.²⁷²

²⁷² See Pascherer & Wirl (2006), p. 18

Identification of the relevant KM strategic target for NPS is conducted within the analyzing phase.

6.1.3. Knowledge Domain

It is desirable to know everything within the organization but due to information overload and practicability of analysis one defines so called knowledge domains.²⁷³

The amount of relevant knowledge domains is limited. Within the literature so-called standard knowledge domains are mentioned suitable for almost every SME.²⁷⁴ The standard knowledge domains - developed within a practical research study with 15 enterprises - are

- knowledge of own company,
- knowledge of current projects,
- knowledge of products,
- technical and methodical knowledge,
- knowledge of standards and laws and
- knowledge of customers and markets.²⁷⁵

The choice of the proposed standard knowledge domains fits also for NEM Power-System. Within the analyzing phase these six categories are evaluated with respect to “need” and “availability” within the company.

6.2. Knowledge Management Analysis

Aim of the knowledge management analysis is the determination of the current knowledge situation within NPS whereby the status quo - with respect to all relevant components of the proposed KMC - is evaluated. In detail, the actual situation of the core activities like generation, storage, distribution and application of knowledge as well as the corporative environment for KM is identified for NPS.

²⁷³ See uit Beijerse (2000), p. 166

²⁷⁴ See DIN SPEC 91281 (2012), p. 19

²⁷⁵ See Kohl & Orth (2010), p. 182

Knowledge management is a completely new topic within NPS such that there does not yet exist any relevant data usable for this analysis. Thus, in the following data has to be generated which can be applied for analyzing purpose. Possible instruments for this analysis are proposed in the literature under the field of descriptive methods.²⁷⁶ It is divided between observational, qualitative and survey methods.

The so called participant naturalistic observation has already been applied within Chapter 5.3 since the author describes personal experiences out of his daily business work.²⁷⁷ One type of qualitative method is the case study method which is also applied in this work by the practical application of the proposed model (see Chapter 5 and 6). Another qualitative method used within this work is the interview (see Chapter 7.2). The remaining qualitative methods being archival study, field study and action research are not suitable for the analyzing purpose of the KM situation of NPS.²⁷⁸ To increase the academic standard the third category of descriptive methods - being the survey method - is also applied (see Chapter 6.2.1). This research method is suitable for data collection to validate the observational findings.²⁷⁹

6.2.1. Knowledge Management Mail Survey

By reviewing the existing survey methods - being mail survey, telephone survey and personal interview - the mail survey has been identified as the most adequate one for NPS analyzing purpose. One major advantage is fact of low bias effects which in the present case is even minimized by conducting an anonymous evaluation.²⁸⁰ Another pro argument for this type of survey is time efficiency since time is a critical aspect within the completion of this project.

Within the certain case of the NPS KM survey a questionnaire (see Appendix 1) is sent per e-mail to all employees (n = 28) out of the three relevant departments. The Fraunhofer IPK proposes the so called "Wissensmanagement-Fitness-Check"

²⁷⁶ See Jackson (2012), pp. 79-103

²⁷⁷ See Jackson (2012), pp. 81-82

²⁷⁸ See Jackson (2012), pp. 86-91

²⁷⁹ See Jackson (2012), p. 92

²⁸⁰ See Jackson (2012), p. 96

which is applied in an enhanced form within this work.²⁸¹ Within an approximated time period of 20 minutes the participants have to answer 47 questions whereby only questions of closed-end type and rating-scale type are used to minimize the complexity of further evaluation. One week later all participants complete their document and send it back to the author. Thus, the return rate is 100%.

The mail survey instrument is important to involve and sensitize employees for the topic of KM. On the one hand side they gain the opportunity to develop a KM solution by participating in form of presenting their view and on the other hand side they concentrate on this topic for a short while and try to reflect their daily business work situation.²⁸²

6.2.2. Evaluation of Knowledge Management Mail Survey Results

The evaluation of the 28 questionnaires is conducted depending on the type of question. In general two types of questions exist. Primarily, closed-end questions are used whereby the participant has to choose in some cases one in others three options out of multiple-choice possibilities. The second question type requires a like-rating.

The closed-end questions are evaluated by determination of a percentage ratio whereby the number of participants choosing a certain object (x) is related to the total number of all participants (n = 28). The definition of the percentage ratio is given in Formula 1 by

$$\bar{x}_{ratio} = \frac{x}{n} \cdot 100\% .$$

Formula 1: Percentage Ratio²⁸³

The determination of a single value for the questions with a like-rating is gained by using the statistical tool of arithmetic mean which is described by Formula 2 being

²⁸¹ See ProWis (2012)

²⁸² See Mertins & Seidel (2009), p. 36

²⁸³ See Healey (2012), pp. 26-29

$$\bar{x}_{arithm} = \frac{1}{n} \sum_{i=1}^n x_i ,$$

Formula 2: Arithmetic Mean²⁸⁴

whereby the sum of all individual ratings (x_i) is divided by the number of participants ($n = 28$). The determination of ratios or arithmetic means for each of the 47 questions is presented in Appendix 1.

For reasons of simplicity within the main part of this work, the like-rating results are also presented in a ratio style. The questions to answer by a like-rating obtain a rating possibility from 1 to 6 whereby 1 indicates in general the most negative and 6 the most positive evaluation. After calculation of the arithmetic mean of the like-rating questions, a ratio of these values is determined with respect to $n = 6$ indicating perfect state (100%). Thus, illustrations within Chapters 6.2.3 to 7.1 show results of ratio value type.

An enhanced method is applied for the analysis of the four core activities and the three components of the corporate environment in Chapter 6.2.6 and Chapter 6.2.7 since within the survey these factors of the KM situation are treated with three, four or five questions, respectively. The analysis is conducted in two steps.²⁸⁵

- In a first phase an overall percentage mean value of all related questions for each core activity is evaluated. This general result allows for an evaluation of the overall corporate situation for each of the components. This method is called global analysis.
- In a second phase a more detailed view is set on each single question. If a certain answer does significantly vary from the average this is an indication for a deficiency within the corporate situation concerning this individual topic. Therefore this method is called local analysis.

²⁸⁴ See Reimann, Filzmoser, Garrett & Dutter (2011), p. 70; Singh (2007), p. 138

²⁸⁵ See Gondek & Hommel (2011), p. 11

An application of the described evaluation methods leads to the results for each of the relevant components of the modified BPOKM. In the following the results are presented and analyzed.

6.2.3. Strategic Targets

The in Chapter 6.1.2 proposed strategic targets have been evaluated within the KM survey. The employees should decide which of the four possibilities they see as the strategic KM target of NPS. Figure 29 illustrates the result.

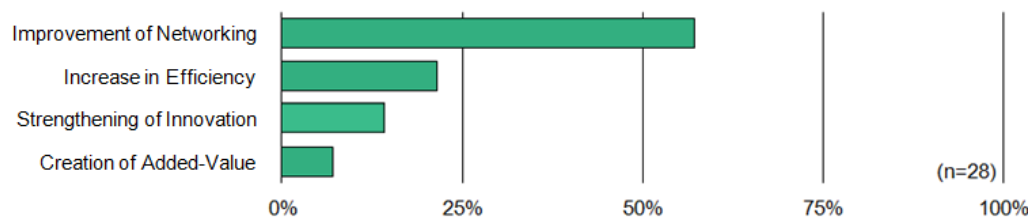


Figure 29: Strategic Target of NEM Power-Systems²⁸⁶

The result is quite clear since more than 50% of the asked persons decided for an “improvement of networking”. This goal coincides with the observations of the author mentioned in Chapter 5.4 wherein the cooperation of different departments leading to high interface importance is recognized as a crucial aspect within NPS. The survey result confirms this statement.

It is quite interesting to realize that the strategic target identified for NEM Power-Systems differs completely to the one of LEs. The aim of KM within Siemens is defined as cost reduction and strengthening of competitive advantage.²⁸⁷ This observation validates the fact that the KM differs between LEs and SMEs.

A further interesting aspect is that the identified strategic target of knowledge management does not correspond to the corporate strategic targets defined by the NPS management. Within the framework of a restructuring of NPS a new definition of the vision and mission has been conducted. The creation of added-value is hereby the first of five pillars being within the focus of NPS. Since the definition of the corporate strategy is still under development progress and not yet

²⁸⁶ Source: created by the author

²⁸⁷ See Reineke (2004), p. 3

communicated to the employees indicates that the participating survey members own currently a different view for importance of targets.

6.2.4. Operational Targets

In general the definition of an overall operational target seems to be quite clear being availability of the right knowledge at the right place at the right time.²⁸⁸ But since this goal describes an ideal scenario which is hard to reach, in the following different sub-goals are defined to enhance parts of the current knowledge situation. Within the KM survey the employees should decide which three of the proposed operational targets are the most relevant ones for NPS. The result of for this question is presented in Figure 30.

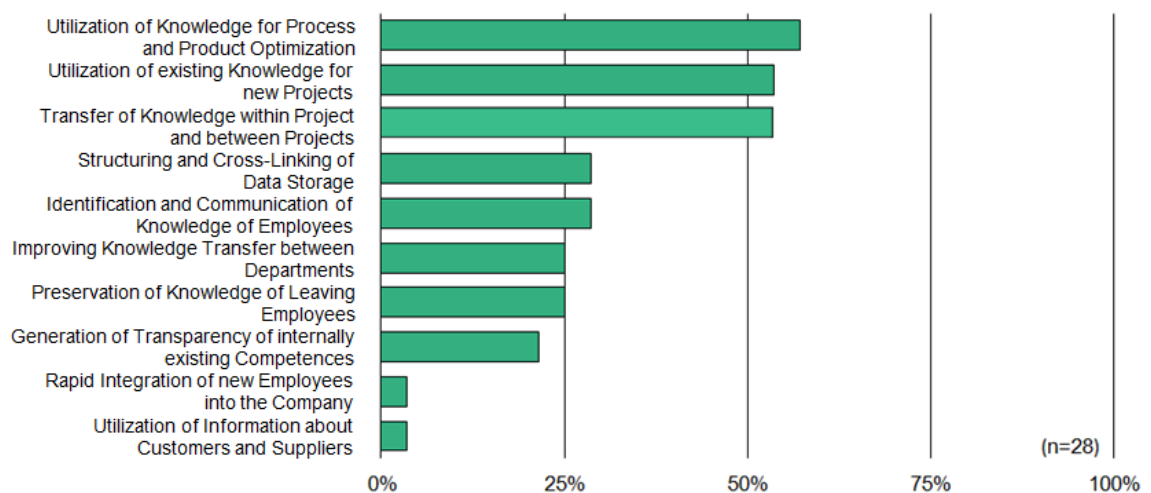


Figure 30: Operational Targets of NEM Power-Systems²⁸⁹

Out of the proposed possibilities for operational KM targets three components have a high importance. More than 50% of the participants of the survey see “utilization of knowledge for process and product optimization”, “utilization of existing knowledge for new projects” and “transfer of knowledge within projects and between projects” as the major aspects for NPS. The result confirms the observations of Chapter 6.2.3 since these goals coincide with the strategic target of “improving the networking”.

²⁸⁸ See Zucker & Schmitz (2000), p. 98

²⁸⁹ Source: created by the author

The identification of operational targets of KM for NPS allows for a comparison with the goals defined for Siemens being “generation of new knowledge”, “knowledge lead due to sharing of experiences”, “identification of potentials of synergies”, “best practice sharing” as well as “standardization of processes”.²⁹⁰ Although operational targets of LEs have a much more general character aspects like optimization of processes and knowledge sharing are also treated.

6.2.5. Business Process

According to the definition of the engineering process in Chapter 6.1.1 the participants of the survey should choose the department which obtains the highest need for knowledge. Another question to answer treats the availability of knowledge. The results of both questions are shown in Figure 31.

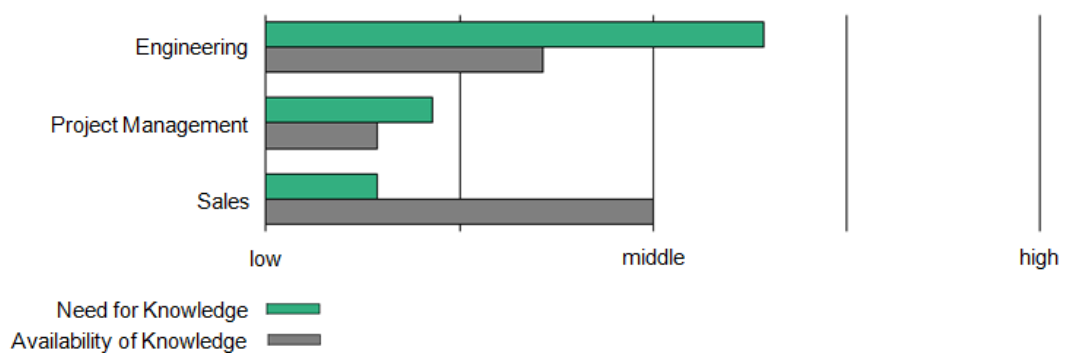


Figure 31: Evaluation of Departments of NEM Power-Systems²⁹¹

It becomes evident that engineering strongly differs from the other departments since the need for knowledge is significantly higher. With respect to availability of knowledge the sales department is dominating. The employees should answer the same questions regarding the interfaces. Figure 32 indicates the result for the seven interfaces within the NPS engineering process.

²⁹⁰ See Reineke (2004), p. 6

²⁹¹ Source: created by the author

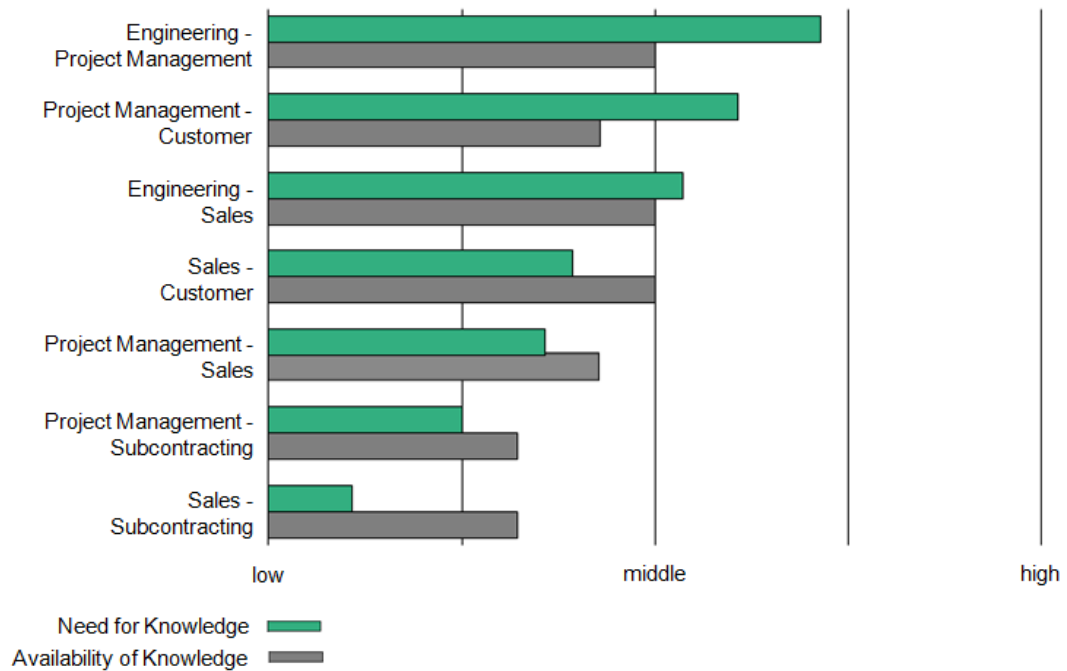


Figure 32: Evaluation of Interfaces of NEM Power-Systems²⁹²

Since interpretation of illustrations in Figure 31 and Figure 32 is not directly possible, judgment concerning the KM situation of the departments and interfaces is conducted by use of a matrix. All components of the business process are positioned within an evaluation matrix according to Figure 33.

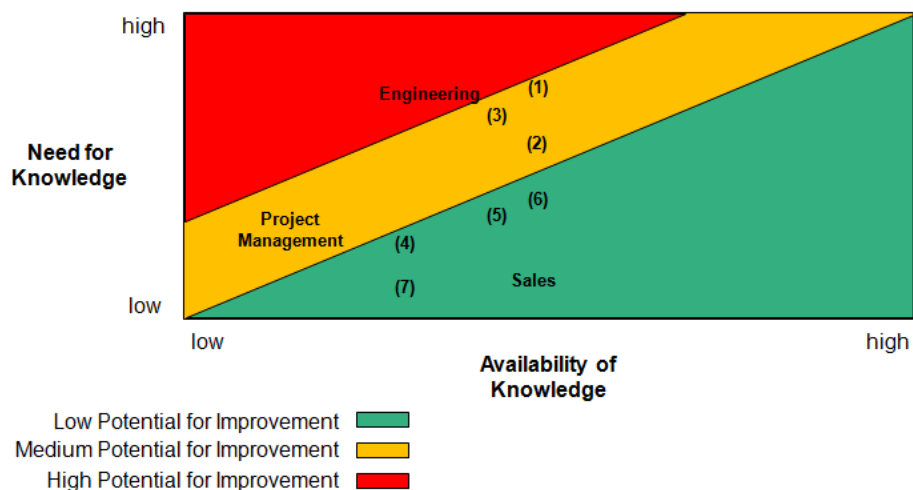


Figure 33: Positioning of Business Process Components within Evaluation Matrix²⁹³

²⁹² Source: created by the author

²⁹³ Source: created by the author

A high need for knowledge implies a high risk since the availability of knowledge is required for a smooth workflow. If need in general is higher than availability this indicates a critical state. In contrast to this a high availability of knowledge with only a low need describes an optimal state regarding the KM situation. In a nutshell, higher need compared to availability describes scenarios obtaining potential for improvement.

The positioning within the evaluation matrix of all relevant components of KM indicates that two departments (engineering and project management) and three interfaces (engineering - project management, engineering - sales and project management - customer) offer at least medium potential for improvement. Thus for further analyses and measures focus is set on these elements.

6.2.6. Core Activities

Within the KM survey each of the four core activities is treated within three questions (see Appendix 1). By use of the global analysis for each of these activities a single mean value is evaluated which represents the current overall corporate situation for this specific topic. The result of the global analysis is given within Figure 34.

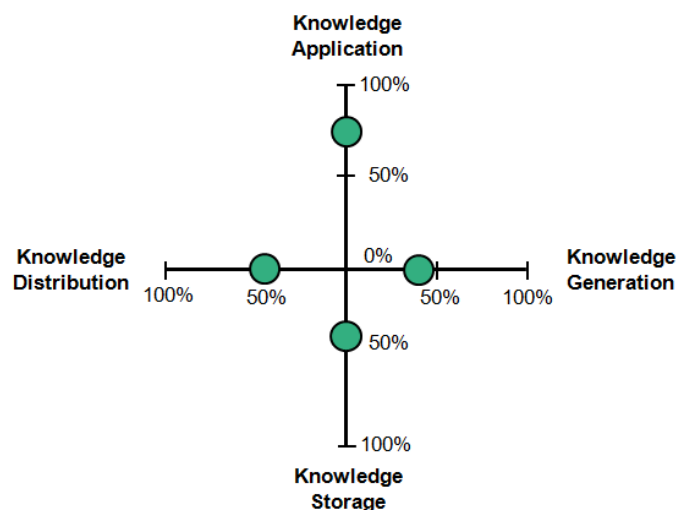


Figure 34: Core Activities of NEM Power-Systems²⁹⁴

²⁹⁴ Source: created by the author

Knowledge generation (38%), knowledge storage (44%) and knowledge distribution (52%) offer a high potential for improvement since their mean values are positioned within a medium range. Within NPS only the application of knowledge (70%) is well applied according to the results of the survey. These observations agree with the strategic and operational targets of KM identified in Chapters 6.2.3 and 6.2.4 since an improvement of networking is strongly related to the distribution and storage of knowledge.

The local analysis of core activities indicates some particularly apparent positive and negative aspects (see Appendix 1):

- poor exchange of experience at the end of a projects (29%),
- poor documentation and storage of knowledge at the end of a project (34%),
- existing willingness to share knowledge (66%) and
- target-oriented application of knowledge (79%).

Although the willingness of knowledge sharing exists it is not consequently used in the certain case of project reviews and lesson learned. The situation within NPS is untypical and has to be judged very positive since in general specific incentive instruments have to be implemented to support the knowledge sharing.²⁹⁵

6.2.7. Corporate Environment

The global as well as the local analyses are applied in the same manner for the evaluation of the components of the corporate environment. Figure 35 illustrates the result of the global analysis.

The environmental condition within NPS offers a reasonable foundation for the implementation of KM since ICT (60%), human resource (63%) and organization (71%) are above the average of 50%. For sure there is still enough potential for further improvements but since these values are acceptable the main focus of improvement should be set on other aspects at the beginning.

²⁹⁵ See Ekbja & Hara (2006), p. 237

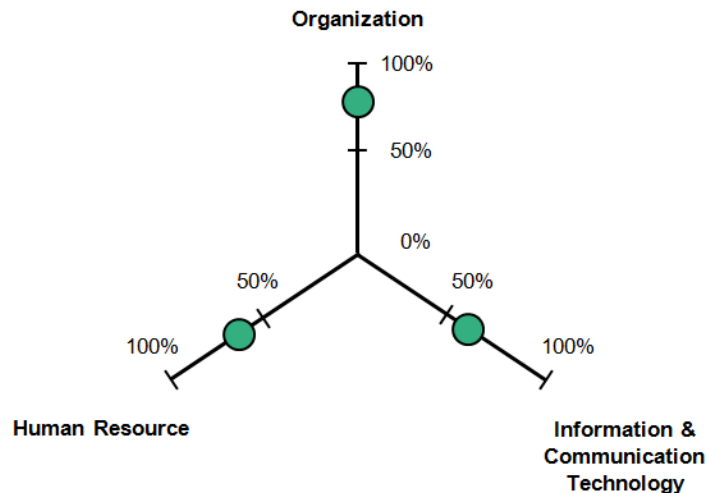


Figure 35: Corporate Environment of NEM Power-Systems²⁹⁶

Even local analysis does not indicate any significant negative aspects concerning the three components of corporate KM environment. The facts to highlight out of Appendix 1 with respect to ICT, human resource and organizational situation of NPS are

- poor introduction into ICT systems for (new) employees (48%),
- poor structure of document folders complicates work (54%),
- high motivation of employees to share knowledge (72%) and
- transparent task responsibility (83%).

The findings of the previous chapters are confirmed by these facts. The overall corporate situation for KM is positive which is underlined by motivated employees to share knowledge. Missing processes for project reviews or lesson learned as well as the ICT situation do not support KM.

6.2.8. Knowledge Domains

The in Chapter 6.1.3 defined standard knowledge domains are evaluated with respect to their need and their availability within NEM Power-Systems. The results of the KM survey are summarized within Figure 36.

²⁹⁶ Source: created by the author

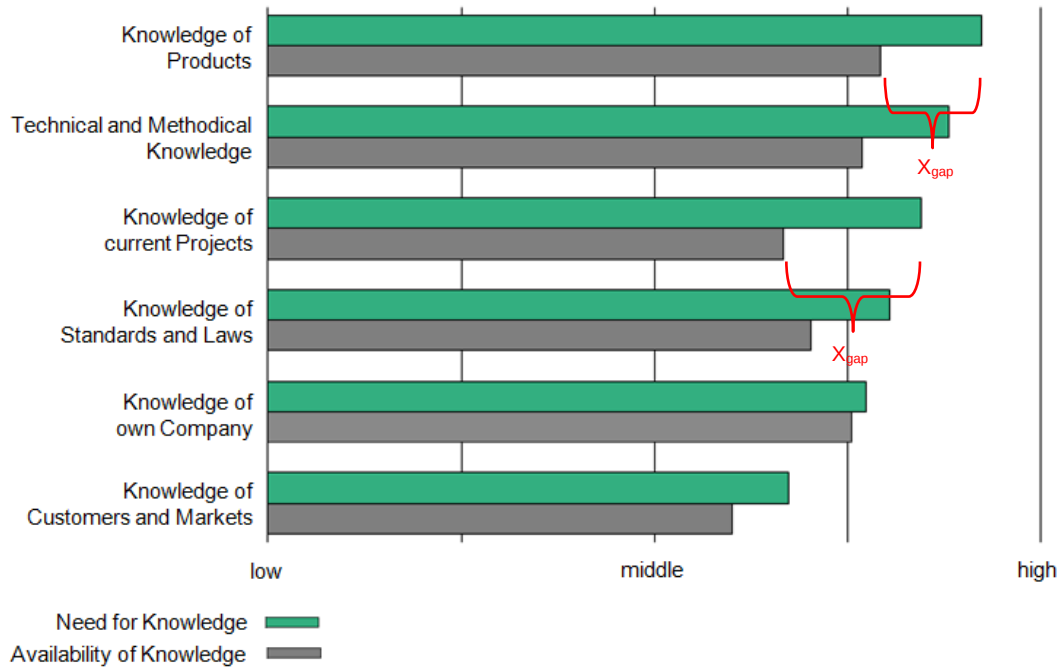


Figure 36: Knowledge Domains of NEM Power-Systems²⁹⁷

The need for all of the six domains is above-average. The three most relevant components with respect to need are knowledge of products (91%), technical and methodical knowledge (86%) and knowledge of current projects (81%). The same situation holds for the availability of the knowledge domains. Availability is also above-average but not that high compared to need. For a simple evaluation it is necessary to identify the knowledge gap which defines the discrepancy between need and availability according to Formula 3

$$\bar{x}_{gap} = \bar{x}_{need} - \bar{x}_{availability} .$$

Formula 3: Knowledge Gap²⁹⁸

The application of an evaluation matrix as in Figure 33 is not useful in this case since the results for all knowledge domains are too equal. Alternatively, the knowledge gap is calculated for each of the component and evaluated. The two knowledge domains with the highest knowledge gap are “knowledge of current projects” (21%) and “knowledge of products” (16%). The first component reflects

²⁹⁷ Source: created by the author

²⁹⁸ See Choo & Bontis (2002), p. 261

the observations of the previous analyses but the second point leads to a new finding.

It is a fact that products of NPS are characterized by a high degree of complexity, a variety of different types and constantly enhancement due to product development. The survey result indicates that the employees do not own enough knowledge about the NPS products which they should offer, design or handle in a project. This is an important aspect to improve by KM.

7. Results of Application

The KM survey provides relevant information about the corporate situation of NPS. In Chapter 6.2 all stages of the proposed BPOKM approach are evaluated. The major findings and implications out of the analysis as well as individual observations serve as a basis for a group focus interview. This analyzing tool is used for the identification of adequate KM solution methods. These discoveries result in recommendations for NEM Power-Systems leading to an improvement of the corporate KM situation.

7.1. Findings and Implications

At the run time of the KM project within NPS immense changes within the corporate situation as well as structure have taken place which enable also findings not being identified out of the KM survey. In the following two types of findings are mentioned being on the one hand side results developed out of the analysis procedure of the proposed model as well as findings gained by conversations with the management team and individual observations.

7.1.1. Out of Survey

To get an insight into the importance of KM for NPS within the survey the participants should estimate which part of daily business work they apply in knowledge searching. The result is presented in Figure 37.

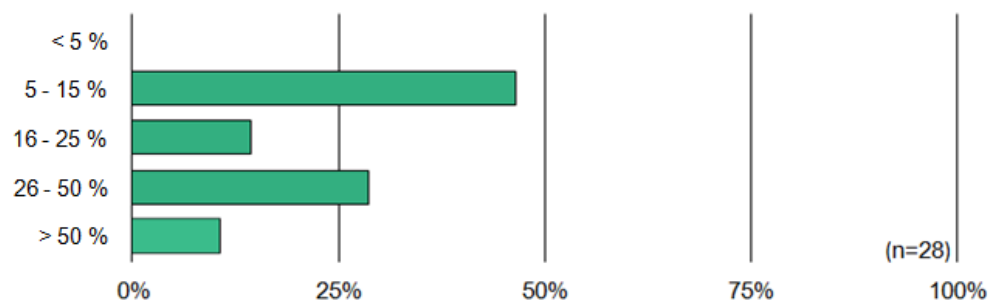


Figure 37: Part of Daily Business Work for Knowledge Searching of NEM Power-Systems²⁹⁹

²⁹⁹ Source: created by the author

Although nearly half of all participating employees choose a range of 5% to 15%, the overall average value out of this survey for the part of daily working time used for knowledge searching is calculated to 26%. Meaning one quarter of the daily business working time is used for knowledge searching which indicates a high potential for improvement in case of optimization of the tools and processes concerning the KM. This finding confirms the statement given in literature.³⁰⁰

Since the distribution of knowledge is a critical aspect for NPS the identification of knowledge sharing media is important. The survey participants should identify the three most important tools for knowledge transfer being illustrated in Figure 38.

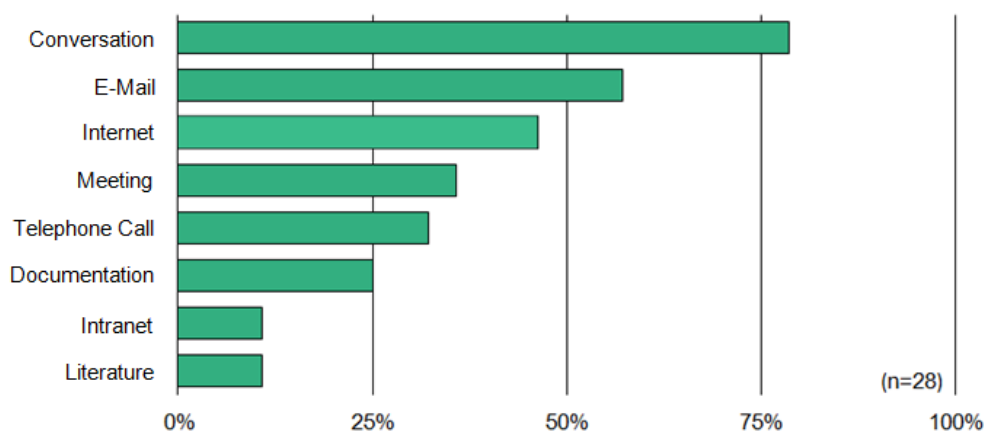


Figure 38: Applied Media for Knowledge Transfer of NEM Power-Systems³⁰¹

The results in Figure 38 indicate that a direct storage within an ICT system as well as the creation of all knowledge explicitly is not applied since the knowledge transfer of NPS is dominated by verbal communication. More than three quarter of the survey participants choose conversation as one of the three most relevant communication medias. Thus, the importance and effectiveness of face-to-face communication should not be underestimated.³⁰²

³⁰⁰ See Lehner (2009), p. 6

³⁰¹ Source: created by the author

³⁰² See Mertins, Heising & Vorbeck (2003), p. 114

Another important observation out of Figure 38 is the fact that typical tools of KM are underdeveloped since documentation and intranet - being media to store and share knowledge - rank under the last three options. This finding does confirm the observations of the author in Chapter 5.3 where the enormous potential for improvement of the applied tools of KM has already been mentioned.

The findings of the analysis for NEM Power-Systems in Chapter 6.2 are summed up and visualized in Figure 39. Therein the traffic light symbol helps identifying the potential for improvement whereby orange and red light indicate medium or high potential, respectively. The need for action for the aspects characterized by a green light is moderate.

Knowledge Management Targets	Improvement of Networking		
	Optimization of Process & Product	Application of existing Knowledge for new Projects	Transfer of Knowledge within Project & between Projects
Corporate Environment	 ICT		→ poor document handling
	 Human Resource		→ poor ICT introduction
	 Organization		
Core Activity	 Generation		
	 Storage		→ poor project review
	 Distribution		→ poor project documentation
	 Application		
Business Process Elements	 Engineering		 Eng / PM
	 Project Management		 Eng / Sales
	 Sales		 PM / Customer
Knowledge Domain	 Knowledge of current Projects		
	 Knowledge of Products		

Figure 39: Findings for NEM Power-Systems³⁰³

³⁰³ Source: created by the author

In a nutshell, the KM analysis of NEM Power-Systems results in the following facts.

- One quarter of daily business working time is applied for knowledge searching.
- Current KM environment offers high improvement potential for departments engineering and project management as well as interfaces engineering - project management, engineering - sales and project management - customer.
- Underdevelopment of distribution, storage and application of knowledge concerning past and current projects is existent.
- Existing tools for knowledge distribution are not applied well (e.g. wiki, intranet).
- Suboptimal structuring and handling of documentation.
- Current project and product knowledge of the employees is not sufficient for their daily business work.

Beside these specific deficiencies of knowledge treatment within NPS more general problems known from other SMEs are existent:³⁰⁴

- know-how is concentrated onto a few heads only,
- chance of workshops held by internal experts is not used,
- new employees are not enough introduced into the corporate (ICT) environment,
- although certification according to ISO 9001 exists the employees are not familiar with all processes of the quality management manual.

The evaluation of the results indicates that the main goals of KM for NPS are availability of process-relevant (project-related) knowledge and improvement of knowledge transfer which are typical KM aims for SMEs.³⁰⁵ Nevertheless, the corporate situation for KM within NPS has to be judged very positive since employees of NEM Power-Systems have recognized that knowledge sharing offers high benefit. They are willing and motivated to share knowledge which is a major step towards knowledge management. This basis is not typical since in general

³⁰⁴ See Hilger, Kohl & Krenn (2010), pp. 43-44

³⁰⁵ See Nikodemus (2005), p. 147

specific incentive instruments have to be implemented to support the knowledge sharing.³⁰⁶ One thing missing is the right structure and correct application of KM tools and a support of the management team for KM to reach the identified target of improving the networking situation within NPS.

7.1.2. Out of Observation

Within the last month drastically changes within the corporate situation of NPS have taken place. The in Chapter 5.2.1 described low hierarchical management situation changes in so far that the manager of the sales department was retired. The general manager is currently changing his position into an advisory role while the engineering manager is taking over the management. Additionally, initiated by the NEM Energy B.V. an external management consultant entered the enterprise to restructure the corporate environment. Due to these facts an enormous change within the corporate culture can actually be observed. The management consultant temporarily compensates the sales manager to reorganize the departmental situation. He has introduced weekly department meetings and has already invited two times all sales employees for a collective coffee break. These actions encourage the departmental information transfer and enables open discussions of the employees. Due to these minor changes and without any modifications of the existing tools or structures a completely different departmental culture has been developed which is open for or even promotes communication. Hereby a new working environment has been created which eliminates the immense pressure, is open-cultured and supports communication.

This example indicates on the one hand side the importance of corporate culture and on the other hand side - even more important - the management attention concerning the topic of KM because both aspects have a strong impact onto the corporate knowledge management environment. Surprisingly, this finding has not been identified out of the KM survey since the employees described the aspect organization - wherein the corporate culture is included - as quite positive (71% within the global analyses in Chapter 6.2.7). Thus, the employees have not even realized the fact that management situation is currently one major reason for the suboptimal knowledge management situation.

³⁰⁶ See Ekbia & Hara (2006), p. 237

7.2. Knowledge Management Focus Group Interview

The findings of the previous chapters are presented to some employees (see Appendix 2) within a KM focus group interview. The focus for choice of employees is set according to their function within the enterprise. The selected persons represent key personal conducting work with a high degree of communication within and between different departments. Within the focus group interview the proposed BPOKM approach as well as the results of the KM survey is presented. The slides of this presentation are attached in Appendix 2. Within an open discussion it is clarified if the findings do reflect the individual observations of the employees. Furthermore possible recommendations for NEM Power-Systems are concluded which shall improve the current situation. The results of the knowledge management focus group interview conducted within NEM Power-Systems are presented in Figure 40 and the minutes of meeting in Appendix 2.

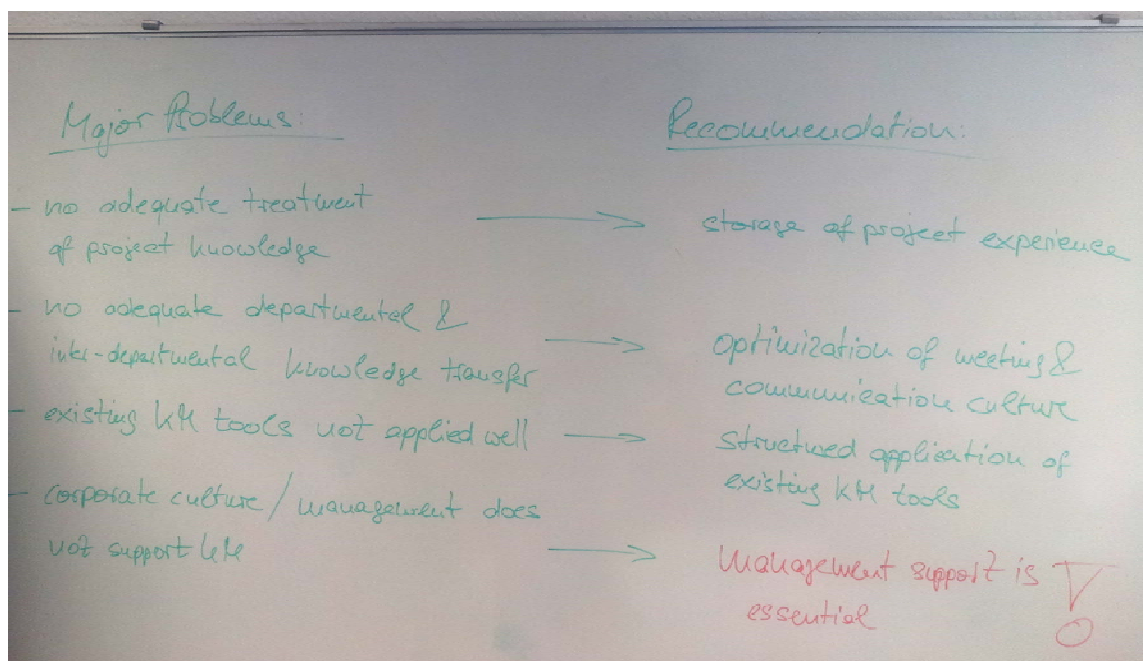


Figure 40: Flip Chart of Knowledge Management Focus Group Interview³⁰⁷

The recommendations obtained out of both - analysis of the findings combined with a literature review as well as discussion within the focus group - are presented in the following.

³⁰⁷ Source: created by the author

7.3. Recommendations for NEM Power-Systems

Within literature two different strategies for KM are proposed being codification and personalization strategy. Codification strategy is strongly related to the ICT and treats knowledge as an object which is explicitly stored in data bases.³⁰⁸ Aim of the personalization strategy is the support of knowledge communication. In contrast to the codification strategy it is focused on employees being carriers of knowledge. The transfer of knowledge is conducted via face-to-face communication and it is concentrated on generation and application of knowledge.³⁰⁹ ICT is only used for a support of communication structure. Thus, main focus is set on the modification of the organizational structure.³¹⁰ Figure 41 illustrates the main aspects of both strategies with respect to the KM environment.

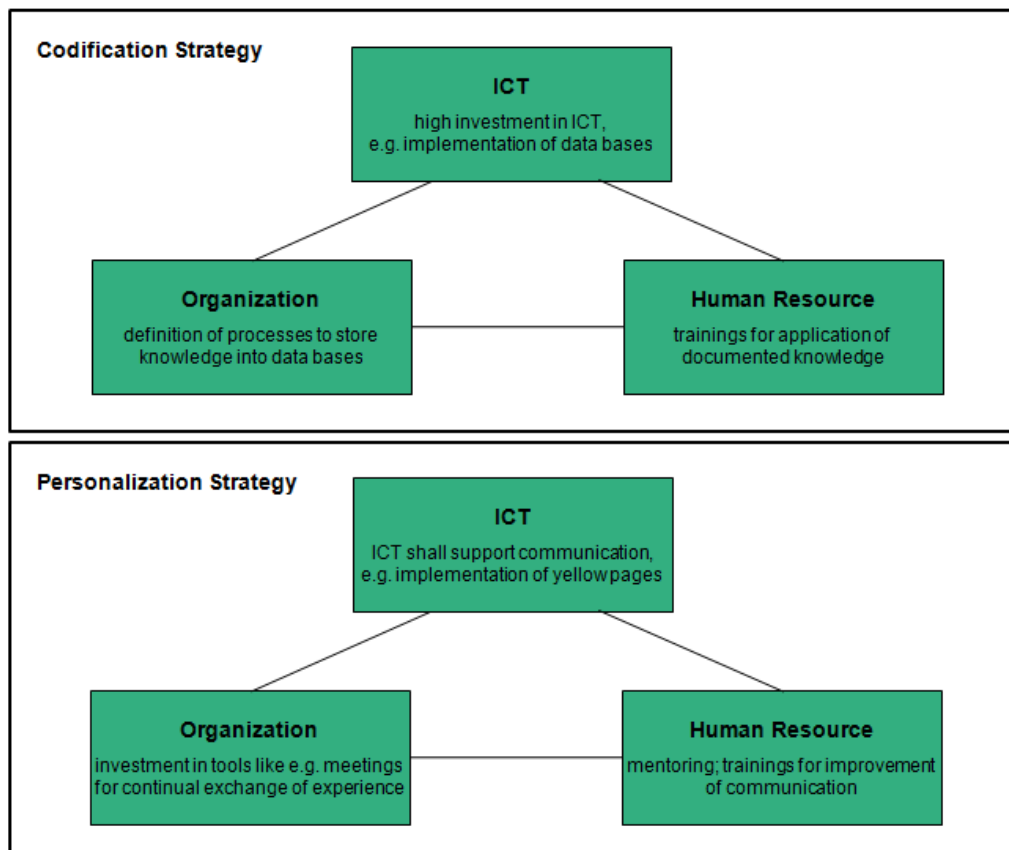


Figure 41: Existing Knowledge Management Strategies³¹¹

³⁰⁸ See Hansen, Nohria & Tierney (1999), pp. 106-116

³⁰⁹ See Bick (2004), p. 21

³¹⁰ See Maier & Hädrich (2001), p. 498

³¹¹ Source: created by the author analog to Gerhards & Trauner (2007), p. 30

Effective Enterprises are characterized by focusing on one of these strategies whereby the other one is used for support.³¹² According to Hansen et al. a complete neglect of one of these strategies leads to failure.³¹³ Out of the before mentioned findings a choice of personalization strategy is useful. Although the application of KM tools within NPS currently offers a high potential for optimization the focus should be set on improvement of communication as it is suggested within the personalization strategy. Major deficiencies result out of communication problems and the corporate culture aspect which is much stronger related to human resources than to ICT.

Out of the findings a lot of aspects leading to an improvement of the current knowledge management situation can be concluded and sorted according to the aspects of the corporate environment.

ICT:

- structured application of existing KM tools like e.g. lesson learned
- maintenance of intranet and wiki
- prompt introduction of document management system

Organization:

- overcome of interface and communication problematic
- regular meetings on project, department and interface level
- treatment of project experience has to be improved
- consideration of “communication time” within budget planning
- differentiation between short-term and long-term knowledge

Human Resource:

- trainings by internal experts e.g. to enhance product knowledge of all relevant employees or to improve the use of computational tools
- management team has to support an open culture enabling knowledge management

³¹² See Gerhards & Trauner (2007), p. 30

³¹³ See Hansen, Nohria & Tierney (1999), p. 112

Since knowledge is not static the innovative knowledge of today might become core knowledge of tomorrow. Therefore it is essential to defend the competitive position of NEM Power-Systems which requires continual knowledge generation. The ability to accumulate knowledge from experience out of projects with customized products and reapply this knowledge is a major competence that may provide strategic advantage.³¹⁴

Although knowledge is dynamic, the strategic knowledge framework in Figure 42 offers the possibility to freeze the current state and illustrate where NPS is situated today. The company is ranging under the Top 3 suppliers for damper products within exhaust gas systems within a saturated market with high technical know-how.³¹⁵ Due to this fact and the findings of this work the author evaluates the company as a viable competitor which currently only applies core knowledge (see Figure 42).

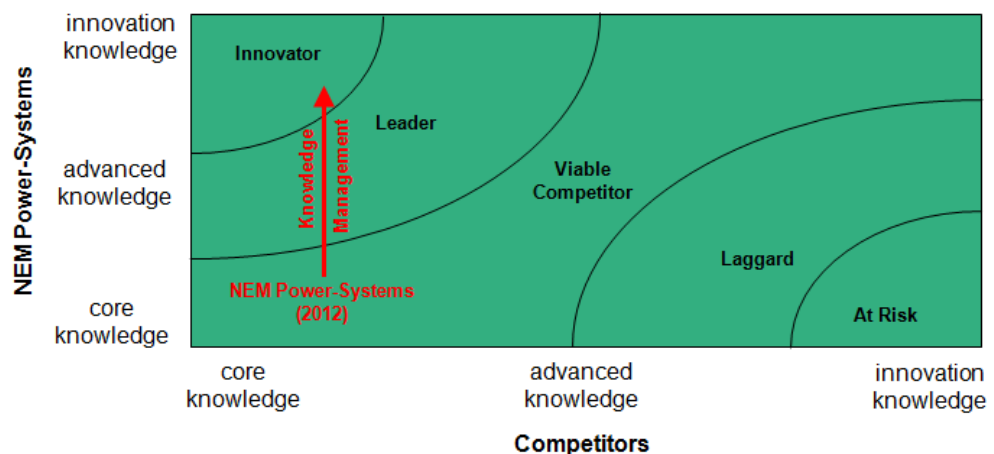


Figure 42: Strategic Knowledge Framework³¹⁶

In case of using the before mentioned potentials for improvement of KM situation it may be possible to enhance the positioning. A middle-term oriented aim of NPS has to be an improvement of generation, distribution and storage of knowledge leading to advanced and innovative knowledge which offers the chance to become an innovator.

³¹⁴ See Choo & Bontis (2002), p. 261

³¹⁵ See NEM Power-Systems (2012)

³¹⁶ Source: created by the author analog to Choo & Bontis (2002), p. 261

7.4. Further Actions for NEM Power-Systems

Since the actual situation within NPS (see Chapter 7.1.2) currently offers an immense opportunity for structural modifications and optimizations further meetings with the external management consultant as well as the new general manager are planned.

The operational targets of KM identified for NPS in Chapter 6.2.4 indicate two urgent aspects being optimization of process and product as well as application of project knowledge. These points are also reflected by the suggestions within Chapter 7.3. Further discussion is based on explicit recommendations for NEM Power-Systems given in the following.

7.4.1. Optimization of Meetings and Communication

Communication between the employees is essential for the internal workflow and the value chain processes since only in case of an efficient cooperation added value is created. Especially within SMEs the informal communication culture dominates whereby the work is often coordinated on call. Hereby informal defines every action beside the formal regulated workflow since often defined processes do not give any information about real communication lines and knowledge flows, respectively.³¹⁷

For improvement of cooperation and communication within NPS the realization of regular meetings is required. Finke even proposes the execution of so called workshops. Experience of the author, who had already organized monthly interface meetings for engineering - sales, indicate on the one hand side the enormous efficiency of those events and on the other hand side that workshops are not needed because meetings are sufficient. Due to high business workload these meetings have not taken place since more than a year now.

The **creation of a meeting culture** is absolutely necessary to overcome the deficiency of knowledge gaps and communication lacks. Thus, the author advises:

³¹⁷ See Finke (2009), p. 101

- department meetings for engineering, project management and sales,
responsibility: department manager,
frequency: once a week,
topics: sharing of positive and negative experiences within the last week of business work, solving of existing problems within collective discussion,
- interface meetings for engineering - project management and engineering – sales,
responsibility: key person out of department,
frequency: once a month,
topics: positive observations of the cooperation, existing problems at the interface, development of adequate improvement measures, definition of priorities and planning of implementation,
- project meetings for each NEM Power-Systems project,
responsibility: project manager,
frequency: according to demand,
topics: sharing of positive and negative experiences within the last period of project work, solving of existing problems within collective discussion.

Ferdinand von der Kampen stated within the focus group interview (see Appendix 2) that communication and meeting intensity is strongly influenced by the management of NPS. Constantly realization of these meetings requires management acceptance and support. A possible solution for a steady implementation of these tools is the modification of the quality management manual (IKZ) which defines all processes within NPS. Management has to consider that open discussion within the framework of meetings is an important part of a productive communication culture and supports treating one another respectfully and in a friendly manner.³¹⁸ The communication culture has a strong impact on corporate culture which currently has enough potential for improvement within an open direction (see Appendix 1).

³¹⁸ See Finke (2009), p. 104

7.4.2. Treatment of Project Experience

Bernd Schäfers notices within the focus group interview that differentiation between short- and long-term knowledge is important and all participants agree that long-term knowledge is worth to store (see Appendix 2). Project experience has definitively to be part of long-term knowledge since these information helps to enhance products, optimize time and avoid mistake repeat. In other words, this type of knowledge is essential to become an innovative company (see Figure 42).

The complete cycle of core activities of KM has to be applied on this knowledge domain meaning generation, storage, distribution and application of knowledge. Currently project experiences are suboptimal treated since only a controlling report at the end of project is generated. A lot of collected relevant information vanishes since only the project manger has gained this knowledge. No further structured distribution or storage of the experience is conducted. Success or failure of projects are neither adequately analyzed nor communicated.

A chance for improvement of experience transfer within and between projects offers the **implementation of debriefing**.³¹⁹ This kind of measure is part of an adequate project management and is integrated within many process definitions but not consequently applied. Often a simple and functioning method is missing for systematic collection, preparation, distribution and application of know-how.³²⁰ Debriefing is a KM tool applied at the end of a project to collect positive and negative experience of all project team members. In case of long-lasting projects this kind of review meetings can also be conducted during the course of the project at least every six month.

Starting with request of mood within the team, the positive and negative aspects are identified. Out of recognized potential for improvement within the collective discussion results a definition of measures. This information enables input for “best practice” and for “lessons learned”. Voigt et al. show possible debriefing results being illustrated in Figure 43. The employees have to see these project reviews as chance for optimization to gain an open and effective discussion. Finally, measures

³¹⁹ See Schnauffer, Staiger, Voigt & Reinhardt (2004), p. 25

³²⁰ See Voigt & von Garrel (2009), p. 61

for improvement have to be implemented within the corporate structure which requires the acceptance and support of the management team of NPS.³²¹

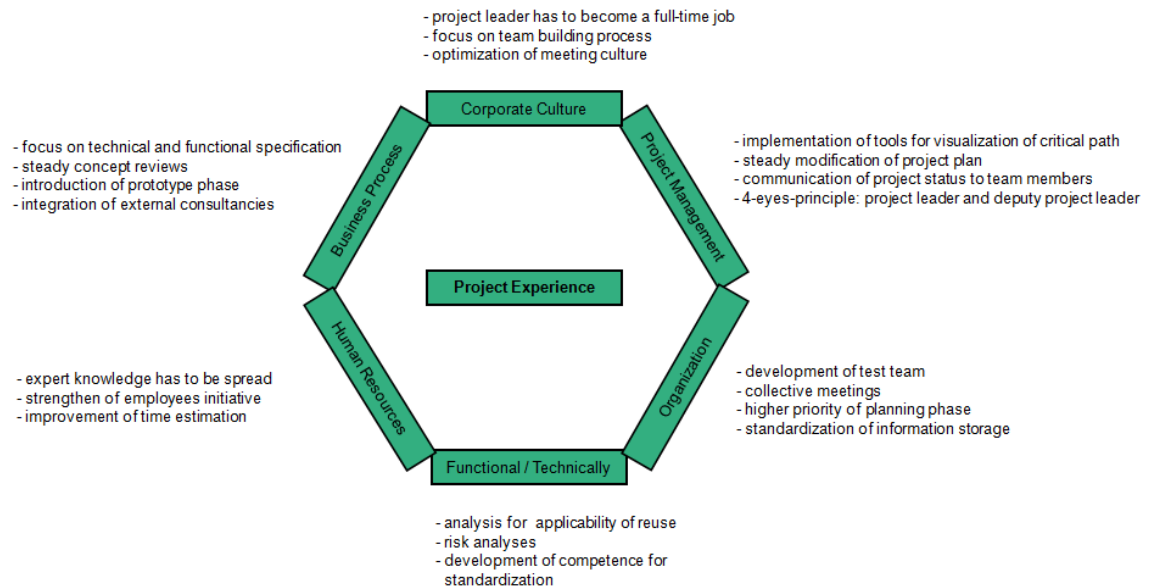


Figure 43: Example of Debriefing Results³²²

An optimal treatment of the project experience knowledge requires application of the complete knowledge life-cycle of the four KM core activities since project review meeting only generated knowledge. Within a second step the know-how has to be stored whereby on the one hand side the knowledge settles within the head of the meeting-participating employees but on the other hand side the knowledge has to be saved in an explicit form. Minutes of meeting have to be documented and furthermore best practice has to be implemented within corporate documentation (e.g. quality management manual).³²³

Aim of KM is the optimal distribution of the project experience within the enterprise such that all involved employees have the opportunity to apply the gained knowledge. Thus, documents as well as experience carriers have to be known which requires suitable strategies. Within the literature different examples are given:³²⁴

³²¹ See ProWis (2012)

³²² Source: created by the author analog to Voigt & von Garrel (2009), p. 64

³²³ See Voigt & von Garrel (2009), pp. 65-66

³²⁴ See Voigt & von Garrel (2009), p. 65

- search functions within document management system,
- centralized provision of documents e.g. project profile,
- communication via regular project manager meetings,
- preparation of internal publication or
- mailing list for distribution of experience documentation.

The continual application of once collected project experience has also to be supported by some measures:³²⁵

- integration of experience within internal trainings of employees,
- application of quality management manual which is enhanced by best practice or
- active search in case of occurring problems within the existing debriefing documentation.

Obviously the integration of the proposed KM methods into the corporate structure of NEM Power-Systems comes along with costs since additionally workload exists and additionally time is required. But management has to evaluate from an economical perspective if these costs are lower compared to the benefit gained out of the improvements due to knowledge management. Aim of this work is to achieve awareness that even despite operational pressure from daily business the internal process change is required to improve the overall corporate situation.

³²⁵ See Voigt & von Garrel (2009), p. 66

8. Conclusion

Since within the previous chapter results of the practical application of the proposed knowledge management concept as well as an outlook for further actions for NEM Power-Systems have already been presented, in the following the conclusion with respect to the overall research work is described. Hereby the author clearly highlights contributions as well as limitations and gives an outlook for further enhancements of the proposed theoretical framework.

8.1. Summary of Research

The focus within this work is set on the development of a knowledge management concept suitable for small and medium-sized enterprises out of structural and mechanical engineering business. The research work is based on identification of relevant requirements for KMCs applicable in SMEs which have been figured out to be “ease of use” and “degree of process-orientation”. These characteristics represent the foundation for the further literature review of existing KM concepts. By use of an evaluation matrix relevant approaches are analyzed to identify the one with the most potential for an application within this work. Since according to these special criteria only one method with high potential for successive knowledge management exists, the BPOKM is chosen for following progress. Further simplification of concept of the Fraunhofer IPK leads to a modified BPOKM approach applied within this work.

The treatment of the concept is conducted by definition of the theoretical framework as well as the implementation procedure. The theoretical basis of the model consists of three different layers being “business process”, “core activities” and “corporate environment” for knowledge management. In contrast to the original concept of Fraunhofer IPK the first and the third layer are modified to enable a better applicability for SMEs. The implementation procedure composes out of three steps being “strategy”, “analysis” as well as “solution and implementation”.

The practical applicability of the proposed theoretical approach is shown by a case study of NEM Power-Systems. Starting with strategy phase the relevant aspects like “business process”, “strategic and operational targets” as well as “knowledge domains” are identified for NPS. By use of a mail survey - conducted within this

work - the three layers of the proposed BPOKM concept are analyzed in detail within the second phase of the implementation process. The survey results are presented within a group focus interview to relevant key persons to discuss possible solutions and to gain acceptance among employees. The third phase of the implementation procedure is treated by development of recommendations for further actions within NEM Power-Systems out of these findings. Thereby, in a first step general solutions concerning the overall corporate situation are mentioned and in a second step it is focused on two main deficiencies. For these two aspects explicit solutions for the management team of NEM Power-Systems are given.

8.2. Contributions of Research

Since requirements for KMCs differ between SMEs and LEs and applications of KMCs depend on individual corporate situation it is essential that KMC is characterized by ease of use for adequate application purpose. None of the existing concepts does completely fulfill this requirement. Thus, an existing model is simplified to fulfill this condition. The simplicity of the proposed model is characterized by a systematic and structured procedure for application.

The results of the practical use have already been evaluated as interesting, transparent and comprehensible by the management team of NEM Power-Systems. Even implementation of some of the mentioned aspects for improvement is in discussion. Concluding the proposed modified business process-oriented knowledge management approach has successfully been applied within one company out of the structural and mechanical engineering business.

8.3. Limitations of Research

Although the applicability of the approach is shown for NEM Power-Systems this fact does not allow for a general statement. It is necessary to have more practical examples to give a valid message about the quality of the modified BPOKM concept.

The practical application of the implementation procedure has indicated that the solely use of mail survey and focus group interview is not sufficient for the overall analyses. Due to individual observations of the author an additional fact has been identified which has not been recognized out of the two analyzing tools. Thus, it is

indispensable that employees implementing KM have a deep insight into the overall cooperate situation and introduce their individual observations.

According to the findings within the practical application of the proposed concept one aspect of the corporate environment has an enormous influence being corporate culture. Within the TOM model this special factor is only subsumed under the general aspect of organization. Consequently, it is useful to enhance the simplified model according to the original model wherein the organization is treated in four different aspects with corporate culture being one of them.

8.4. Directions of Future Research

Further developments can be categorized into short-term and long-term actions. Within a next step it has to be concentrated on the elimination of the before mentioned limitations and deficiencies. Hereby it is proposed to modify the third layer of the concept such that corporate environment is evaluated by use of six components according to the original model of Fraunhofer IPK. This refined treatment of the corporate situation allows for a clearer definition of deficiencies.

A visionary and long-term oriented view allows for identification of further aspects which have to be implemented for improvement of the proposed KMC.

- Coupling of knowledge management targets with corporate mission and vision: Practical application shows that KM targets - chosen according to the result of the mail survey - strongly deviates from the “five pillars” defined by NEM Power-Systems to achieve the strategic vision. In future times, KM has to be understood as operational tool to support the strategic corporate targets.
- Adequate measurement tools: A typical problem of management tools is the question for a quantitative benefit. The special challenge is a proof of cause-effect relationship which is difficult to evaluate due to the complexity. Although some theoretical approaches already treat the measurement of key indicators for intellectual corporate capital it is not yet possible to identify the effect of single KM measures. Intensive research work is required to generate tools for an adequate success evaluation of KM activities.

- Improvement of technical-oriented KM tools: Since the development in the ICT is immense, future trends offer new opportunities for the application of KMCs. Exemplarily the inventory of Web 2.0-technology enables new possibilities.
- Integration of KM into quality management: Often quality management - aiming at optimization of product and processes - is already implemented within companies. Next to process definitions sometimes also indicators are applied enabling controlling and improvement of corporate performance. A combination of both management tools offers the opportunity of synergy effects.
- Cooperation of different enterprises to share KM knowledge: Currently existing online platforms like ProWis offer the possibility to gain experience within the practical application of KM. Hereby the practical examples from other SMEs help for the implementation within the own company.

Concluding, although the proposed business process-oriented knowledge management concept has successfully been applied within NEM Power-Systems, there are several facets which offer an immense potential for further improvement. Since most items concentrate on general aspects or on theoretical research, they are not necessarily required for further improvement of the NEM Power-System results. This does not mean that by the end of this work the topic of KM vanishes out of the heads of NPS management and employees since the implementation of the proposed methods is indispensable to generate a corporate benefit. It might also be interesting to repeat the mail survey as well as the focus group interview within one year to identify possible changes.

Appendix 1: Knowledge Management Mail Survey

Name	Function
Behrend, Jan	Project Manager
Debus, Eugen	Design Engineering
Dittmann, Martin	Project Engineer Sales
Goepel, Guido	Project Engineer Sales
Grabowski, Adam	Design Engineering
Hartwig, Michael	Design Engineering
Jost, Jürgen	Documentation Engineering
von der Kampen, Ferdinand	Project Engineer Sales
Knott, Monika	Design Engineering
Küstlers-Chapotat, Dominik	Structural Engineer
Lehmann, Ludger	Design Engineering
Mrowka, Piotr	Design Engineer
Natzke, Gunther	Design Engineer
Nieratschker, Alexander	Design Engineer
Peer, Rudi	Project Manager
Preuß, Eberhard	Proposal Engineer
Schneider, Monika	Design Engineer
Schulz, Sven	Design Engineer
Schwarzer, Gunnar	Senior Engineer
Schäfers, Bernd	Project Manager
Seipp, Henning	Proposal Engineer
Siemon, Karsten	Structural Engineer
Sädttler, Mike	Design Engineer
Wandelt, Klaus	Proposal Engineer
Watzenig, Marc	Contract Engineer
von der Weiden-Embers, Ralf	Project Manager
Wiegand, Harald	Project Engineer Sales
Zoumba, Salif	Contract Engineer

Table 10: Overview Participants of Mail Survey³²⁶

³²⁶ Source: created by the author

Wissensmanagement im Unternehmen NEM Power-Systems

Umfrage zur Bestimmung des Ist - Zustandes

Ziel dieser Arbeit ist die wissenschaftliche Behandlung des Themas Wissensmanagement und eine damit einhergehende Optimierung des Umganges mit Wissen im Unternehmen NEM Power-Systems. Die Bereiche Vertrieb, Engineering und Projektmanagement werden hierbei eingehend analysiert, da diese Abteilungen in der Organisation einen maßgeblichen Anteil am wissensintensiven Wertschöpfungs-Prozess haben und somit das größte Potential für etwaige Optimierungsprozeduren aufweisen. Mittels der folgenden Umfrage gilt es die aktuelle Situation des Umganges mit Informationen und Wissen in den zuvor genannten Abteilungen zu beleuchten, um anschließend Verbesserungsmöglichkeiten aufzuzeigen.

Ich bitte Sie um ca. 20 Minuten Ihrer Zeit.

- Diese Umfrage erfolgt in Absprache und mit Zustimmung der Geschäftsleitung von NEM Power-Systems.
- Bitte beantworten Sie jede Frage nach bestem Wissen und Gewissen, denn nur so können Schwachstellen identifiziert werden.
- Alle Informationen werden vertraulich behandelt und eine Auswertung erfolgt anonymisiert.
- Bitte speichern Sie dieses Word-Dokument lokal auf Ihrem Rechner; füllen es aus; speichern es erneut und senden es in elektronischer Form per Mail an: j.hommel@nem-ps.com
- Abgabe bitte bis spätestens: 19.06.2012
- Für Rückfragen stehe ich gerne zur Verfügung.

Vielen Dank für Ihre Mitarbeit!



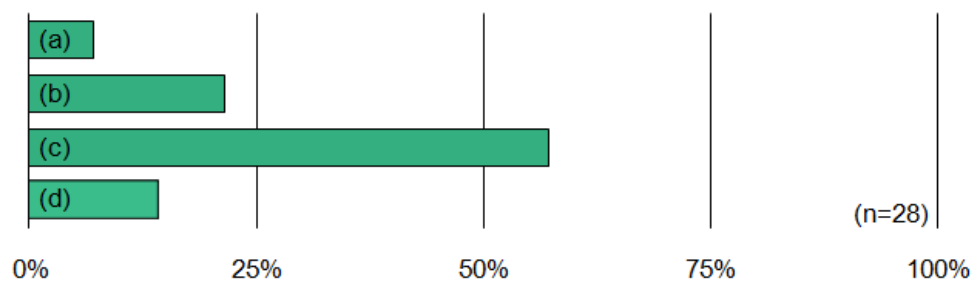
Allgemeine Informationen

Welches sollte Ihrer Meinung nach das Hauptziel des Wissensmanagements sein?

(nur 1 Antwort)

- (a) Schaffung von Mehrwert im Unternehmen durch die intensive Nutzung des Wissens aller Mitarbeiter
- (b) Effizienzsteigerung durch mehrmaliges Benutzen von vorhandenem Wissen, Lerneffekte und Vermeidung von Redundanzen
- (c) Bessere Vernetzung, um das richtige Wissen zum richtigen Zeitpunkt am richtigen Ort zu haben
- (d) Stärkung der Innovationskraft durch Aktivierung des Wissens aller Mitarbeiter und durch intensive Einbindung in den Produktentwicklungsprozess

Result of survey:

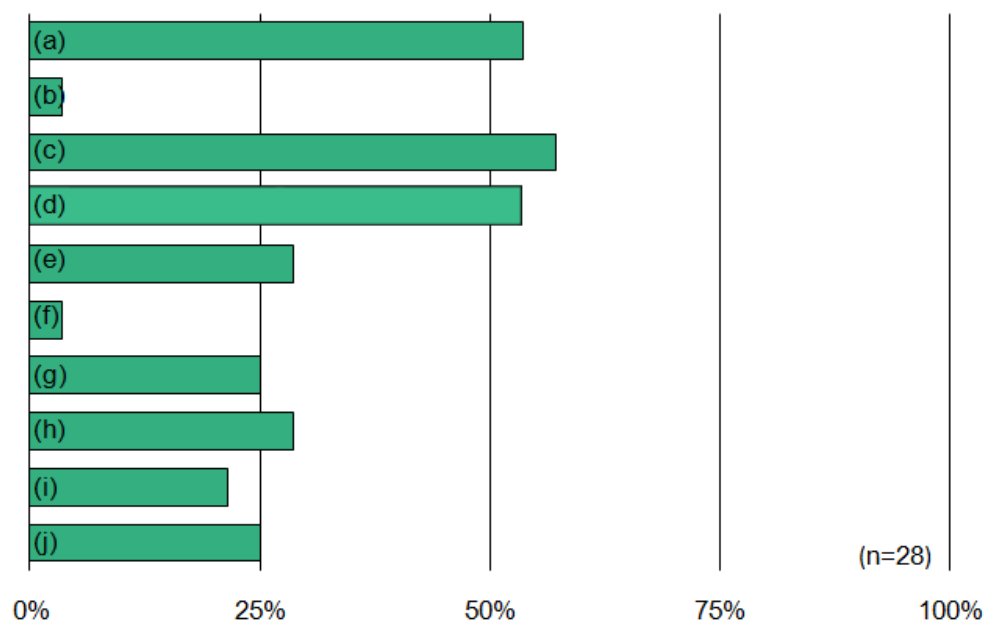


Welches sind die größten Herausforderungen im Umgang mit Wissen für das Unternehmen NEM Power-Systems?

(max. 3 Antworten)

- (a) Nutzung bestehenden Wissens für neue Projekte
- (b) Schnelle Integration von neuen Mitarbeitern in das Unternehmen
- (c) Nutzung von Wissen für Prozess- und Produktoptimierung
- (d) Transfer von Wissen im Projekt und zwischen Projekten
- (e) Erfassung und Kommunikation des Wissens der Mitarbeiter
- (f) Nutzung der Informationen von und über Kunden und Lieferanten
- (g) Sicherung des Wissens ausscheidender Mitarbeiter
- (h) Strukturierung und Vernetzung der Datenablage
- (i) Schaffung von Transparenz über die intern vorhandenen Kompetenzen
- (j) Verbesserung des Wissenstransfers zwischen den Abteilungen

Result of survey:

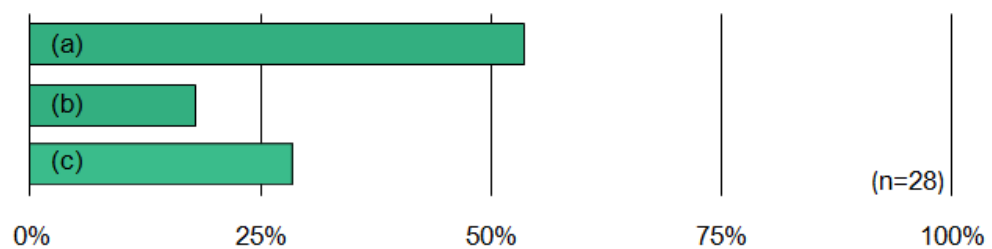


In welchem Bereich des Unternehmens sind Sie tätig?

(nur 1 Antwort)

- (a) Engineering
- (b) Projektmanagement
- (c) Vertrieb

Result of survey:

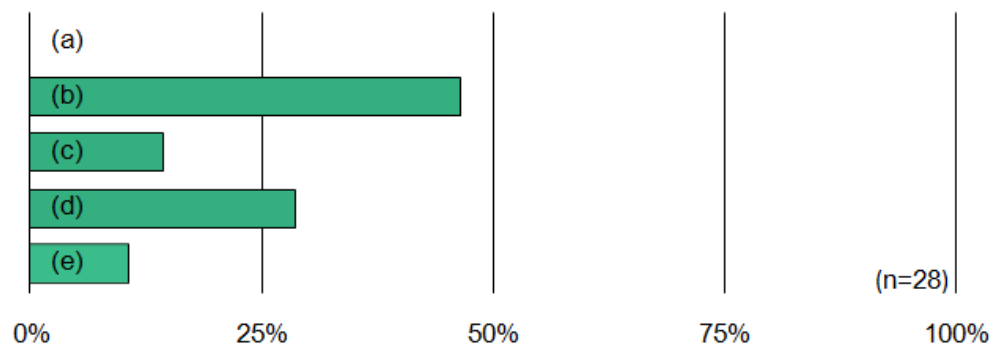


Welchen prozentualen Anteil nimmt die Beschaffung der für Ihre tägliche Arbeit relevanten Informationen ein?

(nur 1 Antwort)

- (a) < 5 %
- (b) 5 - 15 %
- (c) 16 - 25 %
- (d) 26 - 50 %
- (e) > 50 %

Result of survey:

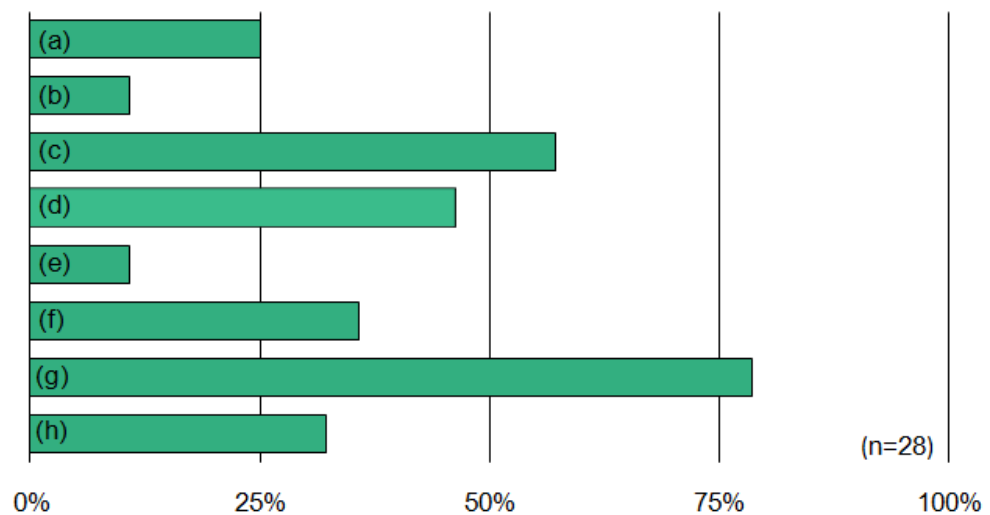


Welches sind die Kommunikationsmedien mittels derer Sie den Hauptanteil der Informationen im Rahmen Ihrer täglichen Aufgaben erhalten?

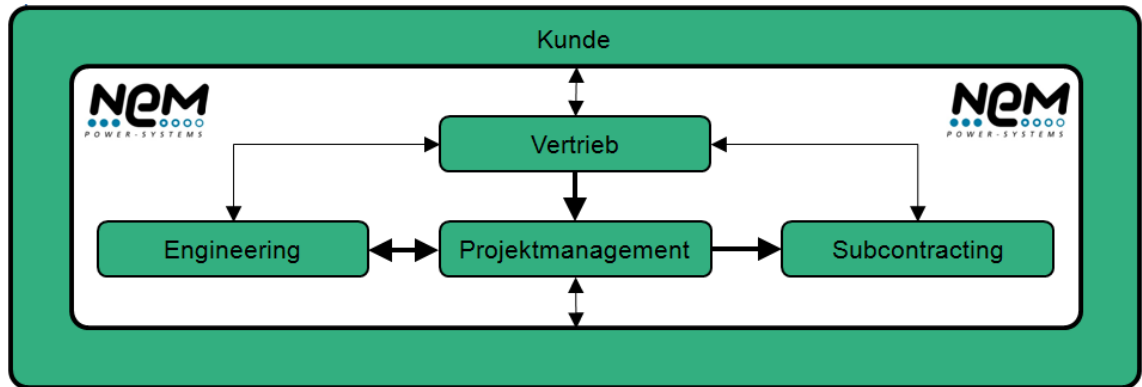
(max. 3 Antworten)

- (a) Dokumentation
- (b) Literatur
- (c) e-Mail
- (d) Internet
- (e) Intranet
- (f) Meeting
- (g) persönliches Gespräch
- (h) Telefon

Result of survey:



Nachfolgende Abbildung illustriert den Projektdurchlauf vom Vertrieb bis zum Subcontracting im Unternehmen NEM Power-Systems in vereinfachter Form und zeigt die wesentlichen Schnittstellen dieser Abteilungen auf.

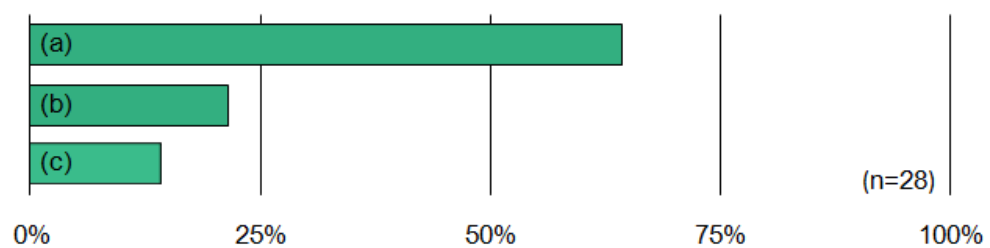


In welcher Abteilung ist aus Ihrer Sicht der Bedarf an Wissen maximal?

(nur 1 Antwort)

- (a) Engineering
- (b) Projektmanagement
- (c) Vertrieb

Result of survey:

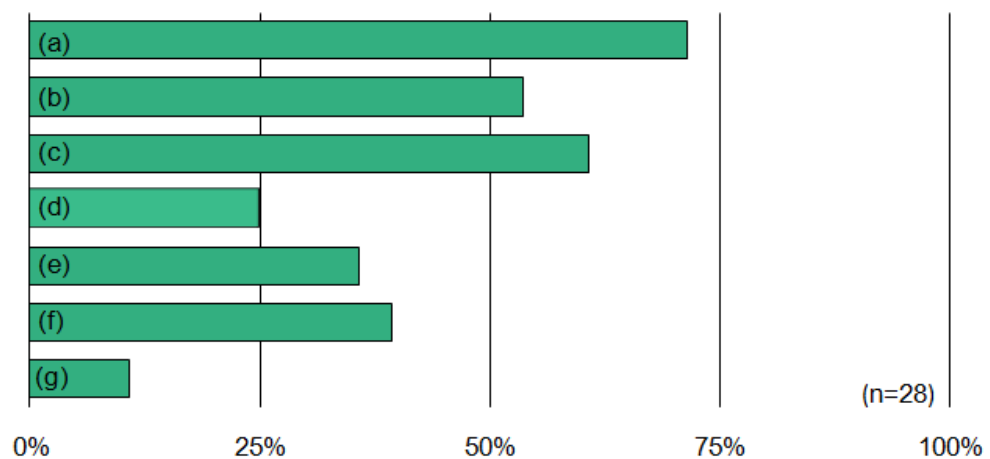


An welchen Schnittstellen ist aus Ihrer Sicht der Bedarf an Wissen maximal?

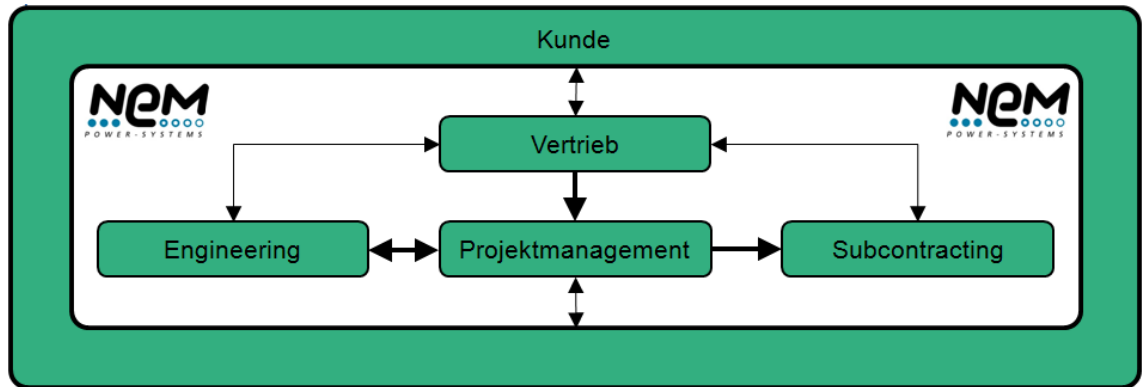
(max. 3 Antworten)

- (a) Engineering / Projektmanagement
- (b) Engineering / Vertrieb
- (c) Projektmanagement / Kunde
- (d) Projektmanagement / Subcontracting
- (e) Projektmanagement / Vertrieb
- (f) Vertrieb / Kunde
- (g) Vertrieb / Subcontracting

Result of survey:



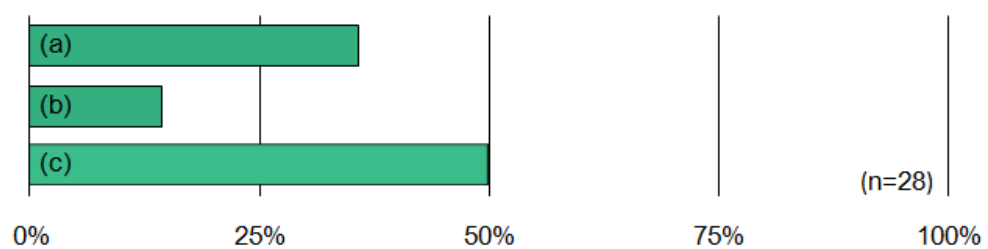
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In welcher Abteilung ist aus Ihrer Sicht die Verfügbarkeit von Wissen maximal?
(nur 1 Antwort)

- (a) Engineering
- (b) Projektmanagement
- (c) Vertrieb

Result of survey:

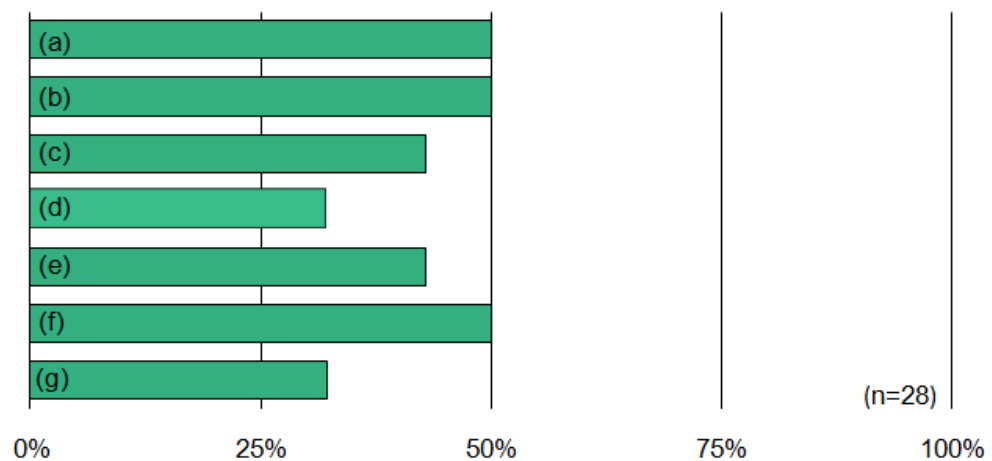


An welchen Schnittstellen ist aus Ihrer Sicht die Verfügbarkeit von Wissen maximal?

(max. 3 Antworten)

- (a) Engineering / Projektmanagement
- (b) Engineering / Vertrieb
- (c) Projektmanagement / Kunde
- (d) Projektmanagement / Subcontracting
- (e) Projektmanagement / Vertrieb
- (f) Vertrieb / Kunde
- (g) Vertrieb / Subcontracting

Result of survey:



Rahmenbedingungen für Wissensmanagement

Technologie

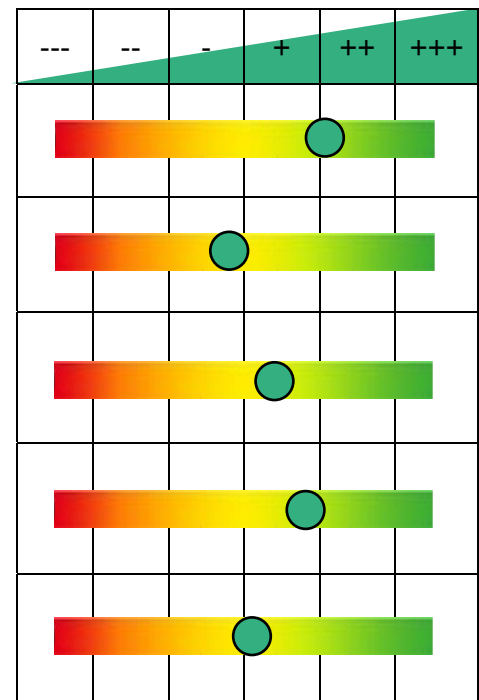
Erfolgt ausreichende Unterstützung durch vorhandene IT-Systeme in Ihrer Arbeit?

Werden Sie ausreichend in die bestehenden IT-Systeme eingewiesen?

Ist die Datenqualität (Aktualität, Vollständigkeit, Zuverlässigkeit) zufriedenstellend?

Ermöglicht die Nutzung der IT-Systeme den schnellen Zugriff auf relevante Informationen?

Ist das Arbeiten in den gemeinsamen Verzeichnisstrukturen zufriedenstellend?



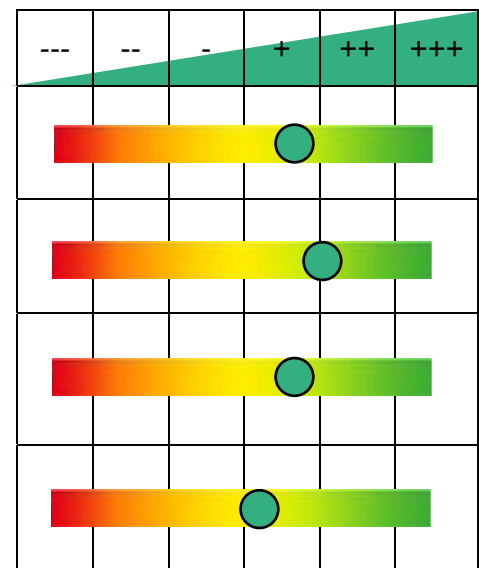
Mensch

Sind die Kompetenzen der Mitarbeiter ausreichend transparent?

Sind die Mitarbeiter ausreichend hoch motiviert ihr Wissen zu teilen?

Fördert Ihre Führungskraft die abteilungsübergreifende Zusammenarbeit?

Bringt Ihre Führungskraft Ihnen Anerkennung entgegen, wenn Sie Wissen aktiv teilen?

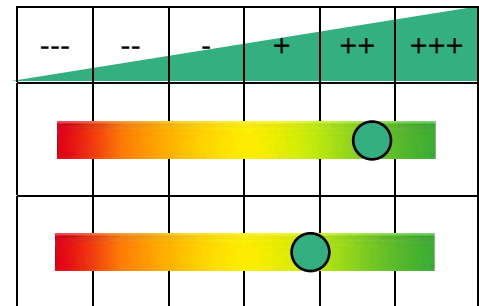


(„---“ = nein, nie; „--“ = häufig nicht; „-“ = manchmal nicht; „+“ = manchmal ja; „++“ = häufig ja; „+++“ = ja, immer)

Organisation

Wissen Sie wer im Unternehmen für welche Aufgaben zuständig ist?

Sind die allgemeinen Abläufe im Unternehmen transparent?



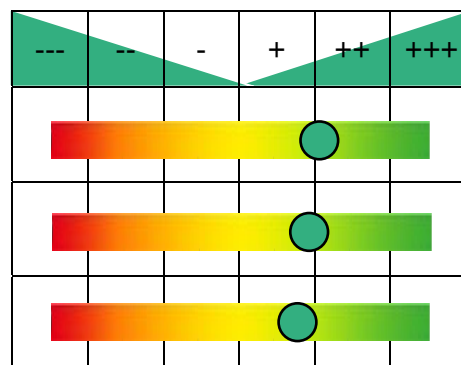
(„---“ = nein, nie; „--“ = häufig nicht; „-“ = manchmal nicht; „+“ = manchmal ja; „++“ = häufig ja; „+++“ = ja, immer)

Wie definieren Sie die Unternehmenskultur?

geschlossen

Schuld zuweisend

starr



offen

fehlerverzeihend

flexibel

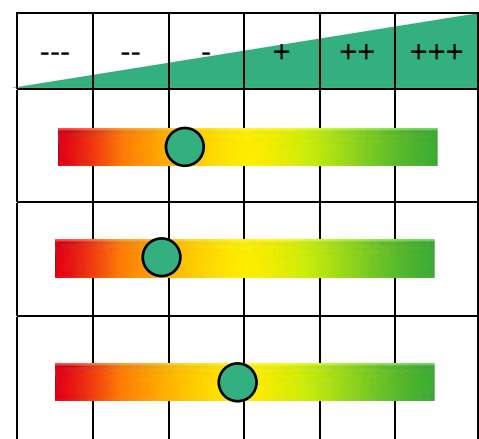
Umgang mit Wissen

Wissen erzeugen

Erfolgt bereichsintern ein strukturierter Erfahrungsaustausch zum Projektabschluss?

Erfolgt bereichsübergreifend ein strukturierter Erfahrungsaustausch zum Projektabschluss?

Wird der Mitarbeiter gezielt in die Erzeugung neuen Wissens und Lösungen einbezogen?



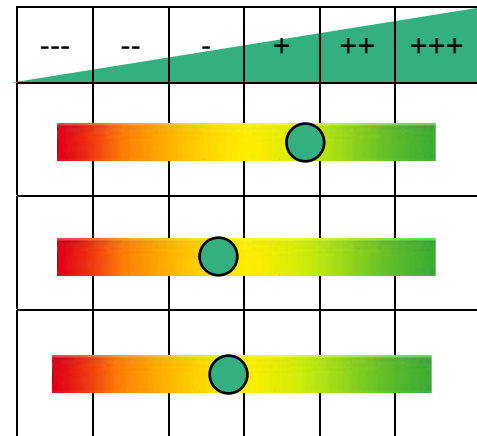
(„---“ = nein, nie; „--“ = häufig nicht; „-“ = manchmal nicht; „+“ = manchmal ja; „++“ = häufig ja; „+++“ = ja, immer)

Wissen verteilen

Herrscht im Unternehmen eine hohe Bereitschaft Wissen weiterzugeben bzw. zu teilen?

Findet ein bereichsübergreifender Erfahrungsaustausch statt?

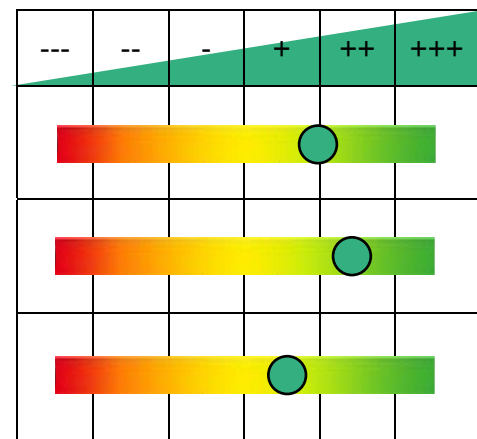
Werden die formellen Methoden zum Wissensaustausch (z.B. regelmäßige Besprechungen, Berichte) effizient eingesetzt?

**Wissen anwenden**

Ist es für Sie transparent, wer im Unternehmen über welches Wissen verfügt?

Setzen Sie bei der Lösung von Aufgaben vorhandenes Wissen zielgerichtet ein?

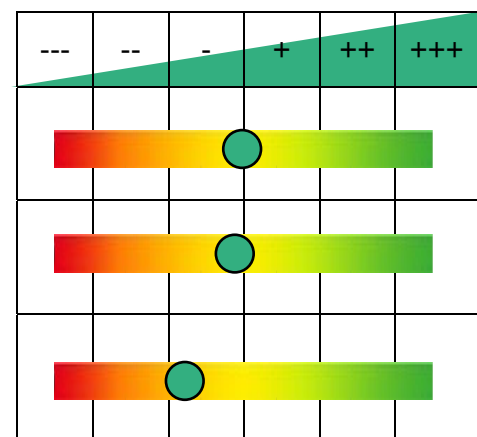
Werden Erfahrungen aus vergangenen Projekten in neuen Projekten systematisch genutzt?

**Wissen speichern**

Sind die Möglichkeiten des schnellen Auffindens von gespeichertem Wissen zufriedenstellend?

Ist Ihnen bekannt, wo Wissen abzulegen ist, um es anderen Mitarbeitern zugänglich zu machen?

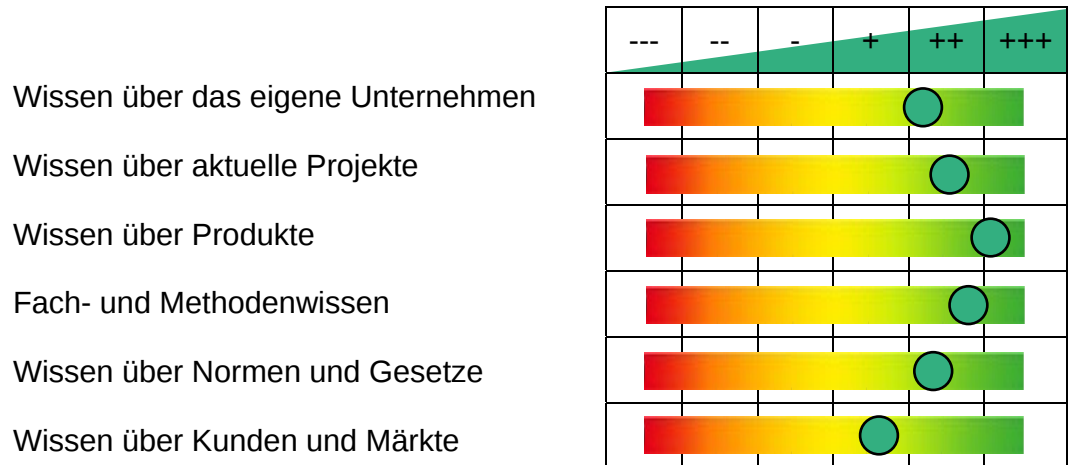
Werden Erfahrungen nach Projektabschluss dokumentiert und zentral abgelegt?



(„---“ = nein, nie, „--“ = häufig nicht, „-“ = manchmal nicht, „+“ = manchmal ja, „++“ = häufig ja, „+++“ = ja, immer)

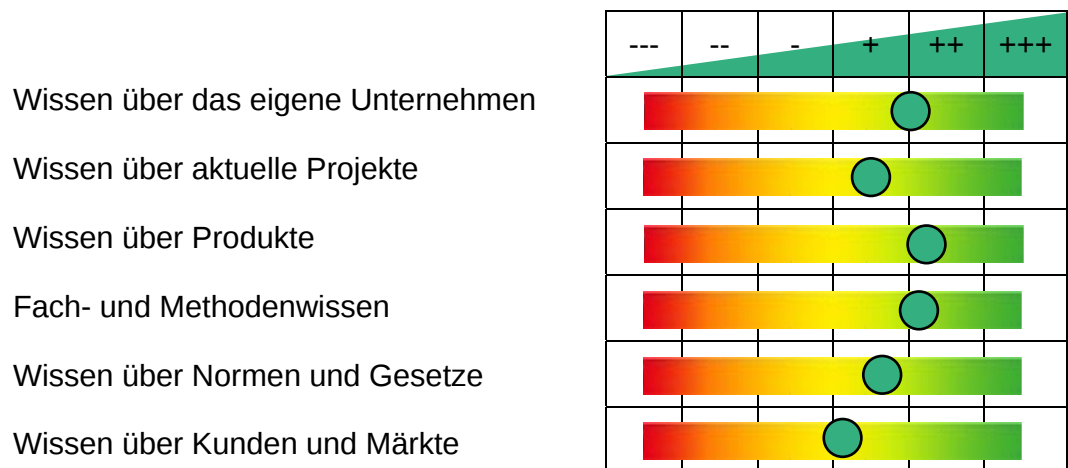
Wissensgebiete

Wie bewerten Sie den Bedarf der folgenden Wissensgebiete für die Erledigung Ihrer zentralen Aufgaben?



(„---“ = absolut nicht wichtig; „--“ = nicht wichtig; „-“ = eher nicht wichtig;
„+“ = eher wichtig; „++“ = wichtig; „+++“ = absolut wichtig)

Wie bewerten Sie die Verfügbarkeit der folgenden Wissensgebiete für die Erledigung Ihrer zentralen Aufgaben?



(„---“ = nie verfügbar; „--“ = häufig nicht verfügbar; „-“ = manchmal nicht verfügbar;
„+“ = manchmal verfügbar; „++“ = häufig verfügbar; „+++“ = immer verfügbar)

Appendix 2: Knowledge Management Focus Group Interview

Name	Function
Behrend, Jan	Project Manager
Dittmann, Martin	Project Engineer Sales
Goepel, Guido	Project Engineer Sales
von der Kampen, Ferdinand	Project Engineer Sales
Mrowka, Piotr	Design Engineer
Peer, Rudi	Project Manager
Schwarzer, Gunnar	Senior Engineer
Schäfers, Bernd	Project Manager
von der Weiden-Embers, Ralf	Project Manager

Table 11: Overview Participants of Group Focus Interview³²⁷

³²⁷ Source: created by the author

Name	Statement
1: von der Weiden-Embers, Ralf	findings are no surprise
2: Goepel, Guido	findings do confirm own observations
3: Schäfers, Bernd	information always has to be fetched
4: Behrend, Jan	pressure of cost & time have negative impact on information flow
5: Author	counter example of current project wherein - due to lack of time - high degree of communication is applied
6: Behrend, Jan	communication causes high need for personal resources
7: von der Kampen, Ferdinand	management decision influences communication intensity
8: Schwarzer, Gunnar	management until today focus on effectiveness, no budget for communication
9: Schwarzer, Gunnar	current project management focus on operational progress and communication, final project review required
10: Schäfers, Bernd	minutes of meeting present, but too great extent; prioritization required
11: Schwarzer, Gunnar	structured, regular meetings for departments & interfaces required
12: Author	project meeting on responsibility of project manager
13: Peer, Rudi	no department meetings of project management as yet
14: von der Weiden-Embers, Ralf	more transparency within bookings of hours enables learning effect
15: von der Weiden-Embers, Ralf	face-to-face conversation is favored due to promptness and possibility of discussion, short distances within NPS
16: Author	danger since it is only individual & none stored
17: Schäfers, Bernd	short-term and long-term knowledge has to be differentiated and treated differently
18: Schäfers, Bernd	long-term knowledge (e.g. project review) has to be stored

Table 12: Minutes of Meeting of Group Focus Interview³²⁸

³²⁸ Source: created by the author

Process-oriented Knowledge Management Concept

An application for NEM Power-Systems



Focus Group Interview
Recklinghausen
17/07/2012

Agenda



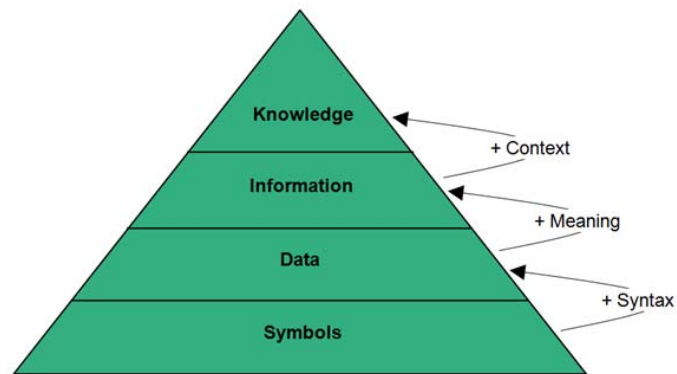
- 1 Introduction
- 2 Description of Concept
- 3 Current Knowledge Situation
- 4 Application of Concept
- 5 Findings
- 6 Discussion

1

Introduction

FOM

■ What is Knowledge?



17/07/2012

Knowledge Management

2

1

Introduction

FOM

■ Types of Knowledge?

	individual knowledge	collective knowledge
explicit knowledge	facts about customer and products	manuals, guidelines, documentations
implicit knowledge	individual attitude to colleagues, experience knowledge	corporate culture and value, manners, processes

17/07/2012

Knowledge Management

3

1

Introduction

FOM

■ Aim of Knowledge Management?

- ☐ “transfer knowledge from implicit to explicit and individual to collective”
- ☐ “the right knowledge at the right place at the right time”

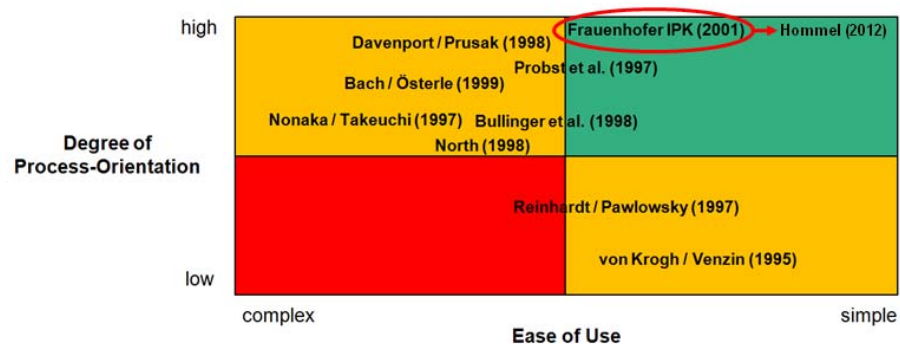


2

Description of Concept

FOM

■ Which Concept is suitable for NEM Power-Systems?



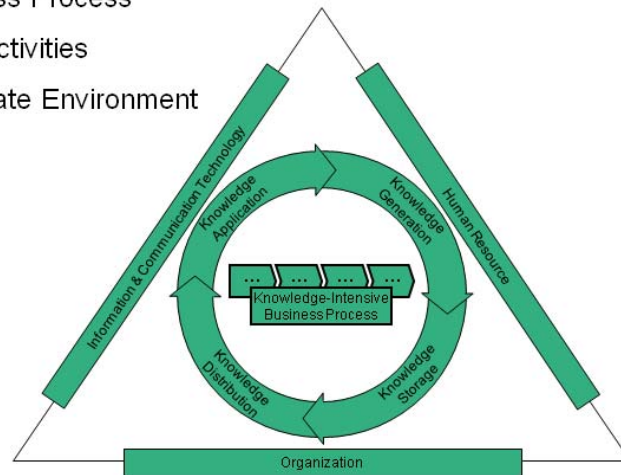
2

Description of Concept

FOM

■ Business Process-Oriented Knowledge Management

- ☐ 1. Layer: Business Process
- ☐ 2. Layer: Core Activities
- ☐ 3. Layer: Corporate Environment



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Knowledge Management

6

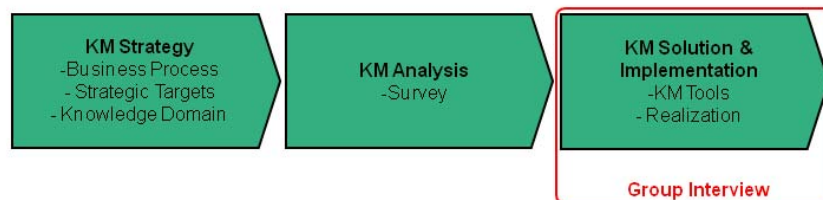
2

Description of Concept

FOM

■ Knowledge Management Implementation Procedure

- ☐ Phase 1: Strategy
- ☐ Phase 2: Analysis
- ☐ Phase 3: Solution & Implementation



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Knowledge Management

7

3

Current Knowledge Situation

FOM

■ Instruments for Knowledge Management

☐ Knowledge Generation

Instrument	Evaluation
External Trainings	
External IT Service Provider	
Cooperation with External Experts	
Attendance of Fairs	
Offer of Bachelor Thesis	
Inter-departmental Cooperation	

3

Current Knowledge Situation

FOM

■ Instruments for Knowledge Management

☐ Knowledge Generation☐ Knowledge Storage

Instrument	Evaluation
Document Management	
Project Documentation	
Hand Over	

3

Current Knowledge Situation

FOM

■ Instruments for Knowledge Management

- ☐ Knowledge Generation
- ☐ Knowledge Storage
- ☐ Knowledge Distribution & Application

Instrument	Evaluation
Intranet	
Wiki	
Team Meetings	
Minutes of Meeting	
Lesson Learned	
Newsletter	
Produkt Data Base	
RAK	

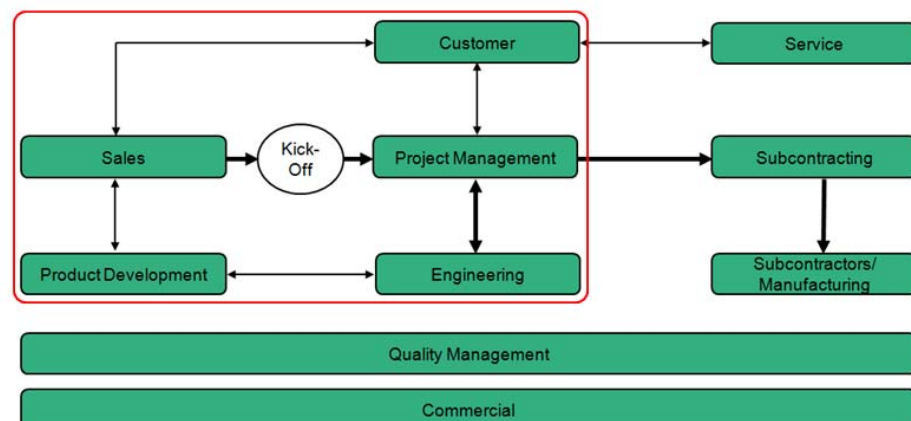
4

Application of Concept

FOM

■ Strategy: Business Process

- ☐ Quality Manual defines Project Cycle



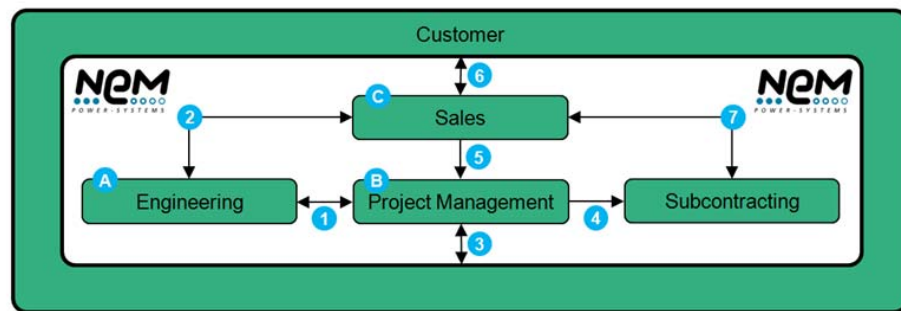
4

Application of Concept

FOM

■ Strategy: Business Process

- Engineering Process with 3 Departments and 7 Interfaces



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Knowledge Management

12

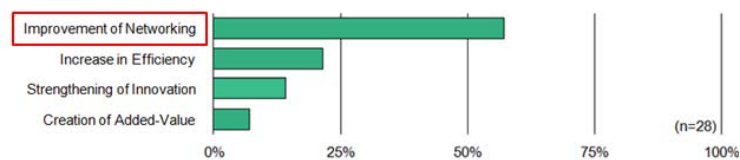
4

Application of Concept

FOM

■ Strategy: Knowledge Management Targets

- Strategic Goals



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Knowledge Management

13

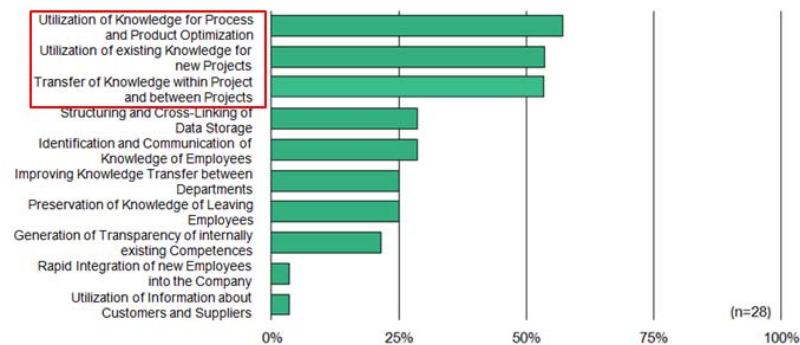
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Application of Concept

FOM

■ Strategy: Knowledge Management Targets

□ Operational Goals



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Knowledge Management

14

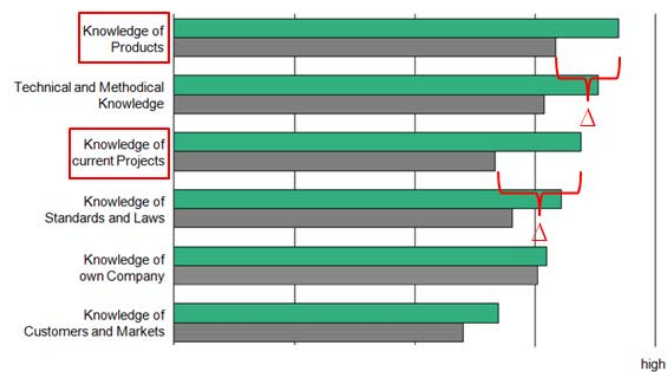
4

Application of Concept

FOM

■ Strategy: Knowledge Domains

□ Definition of 6 Categories



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Knowledge Management

15

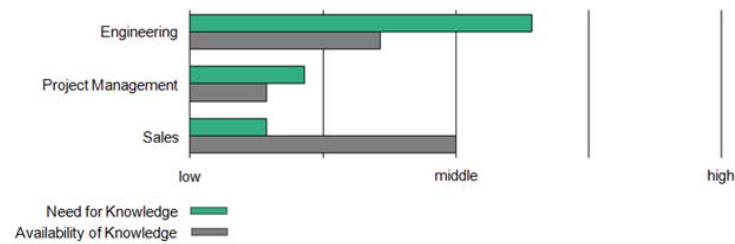
4

Application of Concept

FOM

■ Analysis: Business Process

□ Departments



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Knowledge Management

16

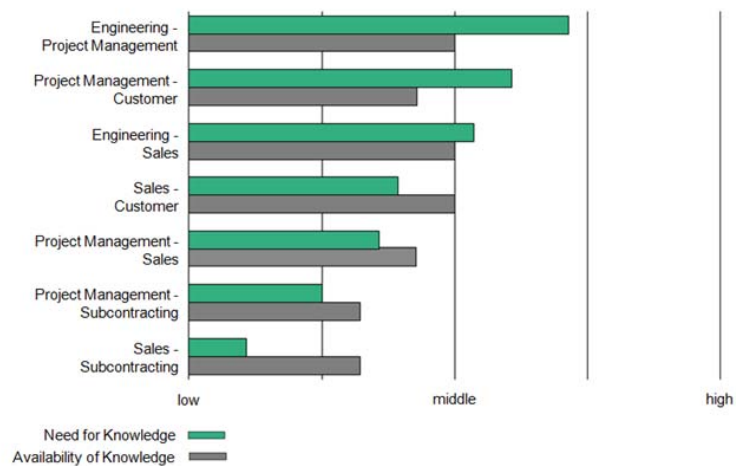
4

Application of Concept

FOM

■ Analysis: Business Process

□ Interfaces



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Knowledge Management

17

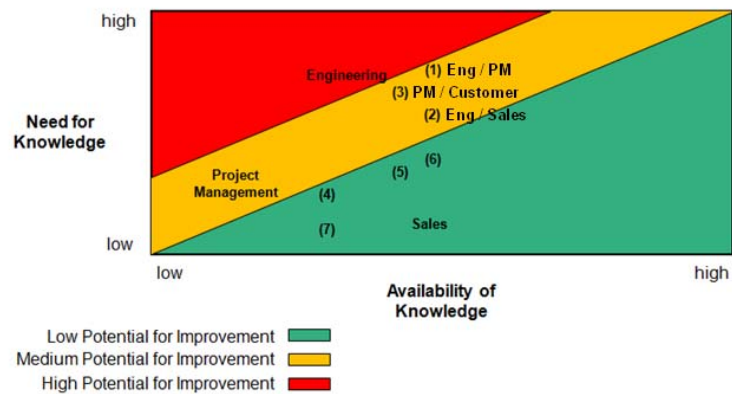
4

Application of Concept

FOM

■ Analysis: Business Process

□ Evaluation Matrix



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Knowledge Management

18

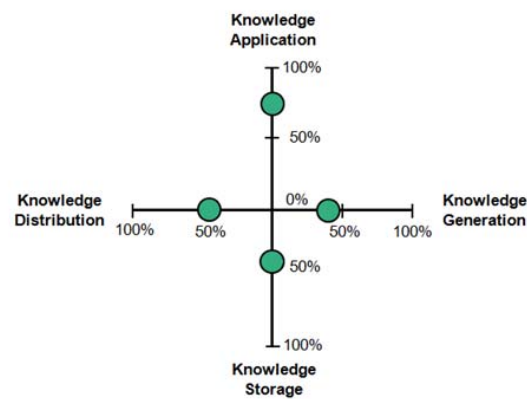
4

Application of Concept

FOM

■ Analysis: Core Activities

□ Global Evaluation



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Knowledge Management

19

4

Application of Concept

FOM

■ Analysis: Core Activities

□ Global Evaluation

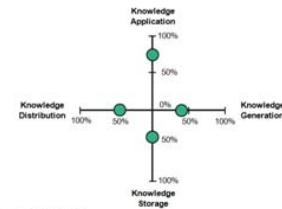
□ Local Evaluation

□ negativ:

- exchange of experience at project end (29%)
- documentation & storage of knowledge at project end (34%)

□ positiv:

- existing willingness to share knowledge (66%)
- target-oriented application of knowledge (79%)



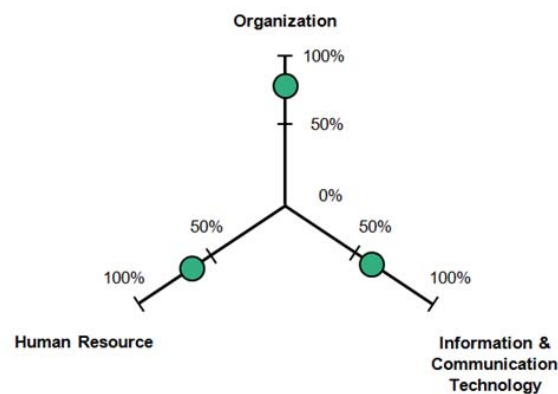
4

Application of Concept

FOM

■ Analysis: Corporate Environment

□ Global Evaluation



4

Application of Concept

FOM

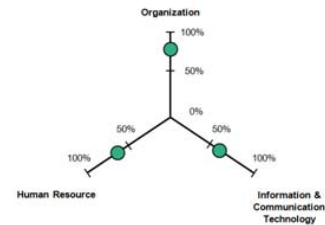
■ Analysis: Corporate Environment

☐ Global Evaluation☐ Local Evaluation☐ negativ:

- introduction into ICT systems (48%)
- structure of document folders (54%)

☐ positiv:

- motivation of employees to share knowledge (72%)
- transparent task responsibility (83%)

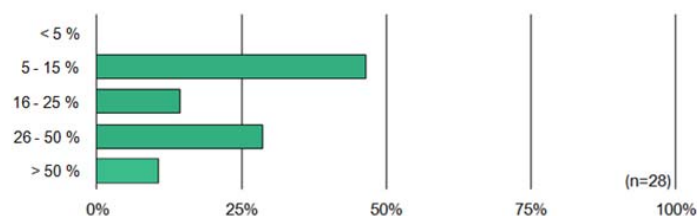


4

Application of Concept

FOM

■ Analysis: General Aspects

☐ Part of Business Working Time

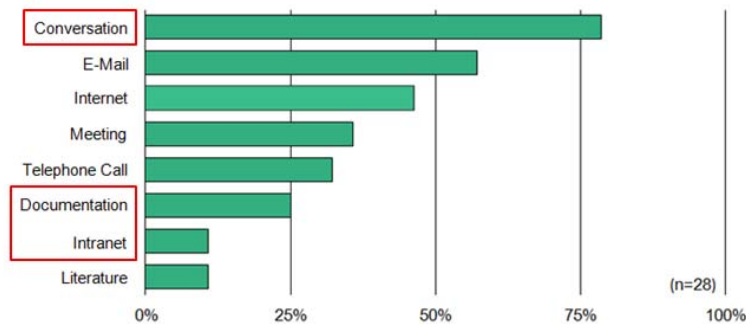
4

Application of Concept

FOM

■ Analysis: General Aspects

- ☐ Part of Business Working Time
- ☐ Applied Media for Knowledge Transfer



5

Findings

FOM

■ Summary

- ☐ high improvement potential for Eng, PM & Eng-PM, Eng-Sales
- ☐ project & product knowledge of employees improvable
- ☐ underdeveloped treatment of project knowledge
- ☐ underdeveloped usage of KM instruments
- ☐ suboptimal structuring and handling of documentation
- ☐ corporate culture / management attention strongly influences KM situation

6

Discussion

FOM

- Do these findings reflect your individual observations?
- Recommendations for NEM-PS?

Knowledge Management Targets	Improvement of Networking		
	Optimization of Process & Product	Application of existing Knowledge for new Projects	Transfer of Knowledge within Project & between Projects
Corporate Environment	 ICT  Human Resource  Organization		→ poor document handling → poor ICT introduction
Core Activity	 Generation  Storage  Distribution  Application		→ poor project review → poor project documentation
Business Process Elements	 Engineering  Project Management  Sales	 Eng / PM  Eng / Sales  PM / Customer	
Knowledge Domain	 Knowledge of current Projects  Knowledge of Products		

6

Discussion

FOM

- Recommendations
 - ☐ structured application of existing tools
(DMS, lesson learned, regular meetings, etc.)
 - ☐ optimization of meetings & communication
 - ☐ storage of project experience
 - ☐ improvement of inter-departmental cooperation
 - ☐ consideration of communication time within budget

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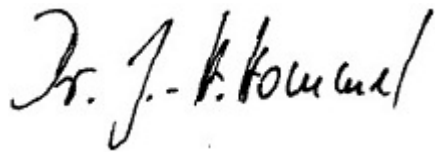
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I hereby declare that I produced the submitted paper with no assistance from any other party and without the use of any unauthorized aids and, in particular, that I have marked as quotations all passages, which are reproduced verbatim or nearby-verbatim from publications. Also, I declare that the submitted print version of this thesis is identical with its digital version. Further, I declare that this assignment has never been submitted before to any other examination board in either its present form or in any other similar version. I herewith disagree that this thesis may be published. I herewith consent that this thesis may be uploaded to the server of external contractors for the purpose of submitting it to the contractor's plagiarism detection systems. Uploading this thesis for the purpose of submitting it to plagiarism detection systems is not a form of publication.

Essen, 25th July 2012

A handwritten signature in black ink, appearing to read 'Dr. J.-H. Hommel', written in a cursive style.

Dr. Jan-Hendrik Hommel