Hamburg Model of Knowledge Management

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Abstract
Knowledge management within manufacturing networks allows an efficient integration of distributed business processes in order to realise a common value creation. There are enormous potentials to accelerate the common innovation development or to cut costs through the harmonisation of cross-company value chains. Although the science and industrial community is aware of this, the potentials arising from a collaborative use of knowledge in networks have not been entirely exploited yet. The Hamburg Model offers a general guideline for developing a systematic management of knowledge within value creation networks, which is supplemented by a context-dependent, dynamic qualitative model that takes the relevant impact factors of a specific case of application into account.

Keywords:
Knowledge Management; Distributed Manufacturing; Co-operation Networks

1 INTRODUCTION

The intention of many companies to achieve a stronger concentration on their core competencies results in an increasing outsourcing of business processes. The overall aim is to cut costs as well as to raise the flexibility of the organisation through streamlining. This decentralization of processes disturbs or even breaks the already existing interconnectedness between the actors. Knowledge, which has been developed within the organisation over years or decades, is distributed to autonomous partners [1]. Consequently, knowledge is often not directly accessable and experiential knowledge gets lost.

In order to cope with these circumstances and to integrate the decentralised activities in efficient business processes, a common management of the resource ‘knowledge’ within value creation systems becomes more and more important. However, in comparison to knowledge management (KM) within single enterprises, inter-organisational knowledge management poses an even greater challenge. The different institutional embedding of the actors and its resulting structural barriers as well as mistrust evolving from power asymmetries between the actors of the network are just two examples evolving in the context of KM in value creation networks.

KM can be basically understood as “the identification, generation and transfer of a strategically critical and scarce resource” [2]. ‘Knowledge’ as a phenomenon of interdisciplinary interest has been defined in many different ways often resulting in very widely drawn, blurry conceptions. “If knowledge is everything, than maybe it is nothing” stated SCHREYÖGG/GEIGER [2] meaning that a too broad definition of the term makes it impossible to capture the phenomenon and is therefore not suitable for an efficient KM. But where are the lines to be drawn?

In the context of KM the qualification and selection of knowledge plays an important role [2]. The precondition for qualifying and selecting knowledge is that it needs to appear in a codified, communicable form in order to be validated or negotiated in discourses of specific fields [2]. Consequently, we are excluding concepts such as *tacit* or *embodied knowledge* [3, 4] from the scope of our investigation, because they rather refer to “skills” or individual mental models that are not directly communicable (transferable) and are more subject to the field of cognitive science [5]. However, knowledge can still appear in different forms and the boundaries between these forms are fluent. It can be fixed in an object (i.e. documents) which is not linked to an individual (*informational knowledge*) or it can be manifested in and transferred through narrations. The latter is always linked to an individual and its personal experiences; we therefore refer to it as *experiential knowledge* [6]. The realisation of the knowledge management tasks depends on the form in which knowledge appears and its differing modes of transfer.

2 THE HAMBURG MODEL OF KNOWLEDGE MANAGEMENT

2.1 Overview

The Hamburg Model of knowledge management (HMKM) is an integrative model for the design and implementation of knowledge management systems (KMS) which focuses on the inter-organisational co-operation.

The HMKM has been developed within the framework of the project ‘Development of a Knowledge Management System for the Aeronautical Cluster in Hamburg’ (sponsored by the Federal Ministry of Education and Research (BMBF)). The regional cluster initiative *Hamburg Aviation* (HA) consists of 300 small and medium-sized enterprises (SMEs), the core companies AIRBUS and LUFTHANSA Technik, Hamburg Airport, several federations, as well as research institutes and universities. Due to the heterogeneity and the large number of actors within the cluster as well as the diverse and varying relations among them, the development of a generally applicable and scalable KMS poses a highly complex task. The development of the HMKM has been based on findings from systems theory and cybernetics [7, 8, 9].

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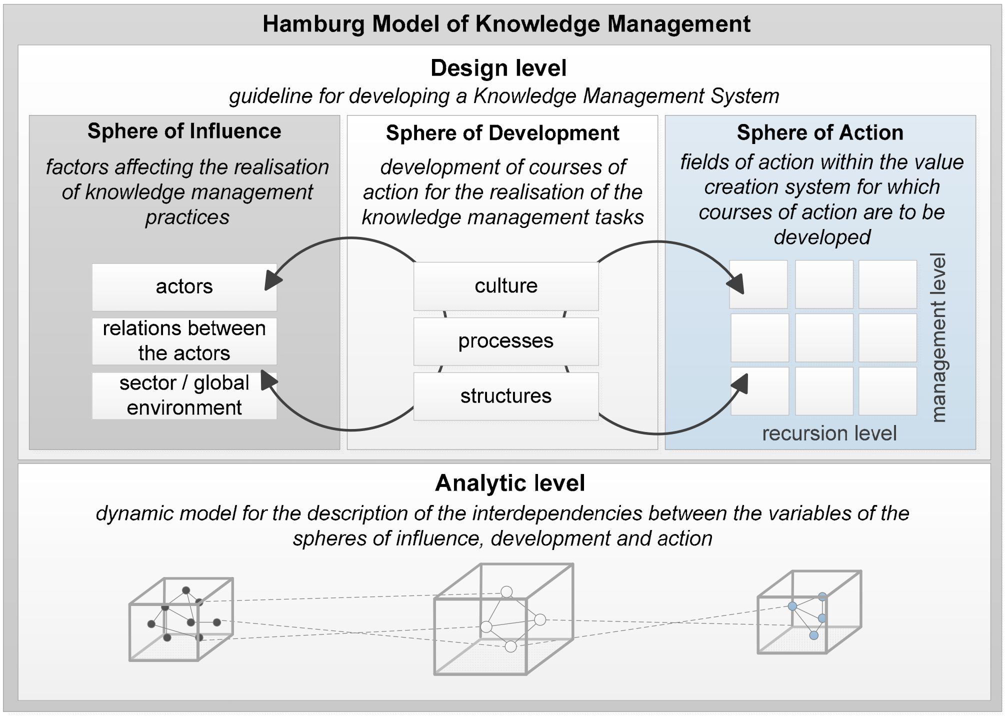

Figure 1: Levels and Spheres of the Hamburg Model of Knowledge Management.

Grasping and mastering the complexity of the various forms of co-operation within a value creation system cannot be achieved through a constructivist approach, which aims at a rather static system with specific instructions and directives [8, 9]. According to Malik, the viability of the inter-organisational co-operation within a cluster evolves rather evolutionary, because it is far too complex than it could have been entirely managed or directed by humans [9, 11].

The HMKM takes this complexity into account and offers a framework for design (design level), which relies on an understanding of the system's internal interdependencies (analytic level). The combination and constant interaction between these two levels serve as a base for the development of courses of action that enable the actors to efficiently fulfill the tasks of knowledge management (see figure 1). In the following, the design and analytic level of the model will be further described.

2.2 The Design Level

The design level corresponds to a general guideline for developing a KMS for specific contexts. The basis for the development is the awareness of the respectively relevant factors affecting the realisation of the KM processes within the system (*sphere of influence*). This awareness allows the design of efficient processes, structures and a 'culture' to perform the knowledge management tasks (*sphere of development*) in the specific fields of action of the value creation system (*sphere of action*).

In an initial stage of the development of the model, qualitative expert interviews with representatives of the clusters' sectors (research institutions, SMEs, original equipment manufacturer (OEM), public authority, cluster management) have been carried out. People were asked about the specific way and characteristics of the inter-organisational co-operation within the cluster and the related opportunities of support through a common KMS [12].

The subsequent process of systematic data preparation and analysis has been conducted according to the methodological principles of the Grounded Theory [13]. The aim of the application of this approach is to create a grounded theory, which is derived inductively from the examination of the phenomenon it represents [13]. "Grounded theories, because they are drawn from data, are likely to offer insights, enhance understanding, and provide a meaningful guide to action" [13]. Within an iterative process, semantically identical or resembling statements of the interviewees have been developed into categories. The further densification and abstraction of the sets of developed categories led (amongst other things) to the key demand of the interviewees: the KMS should provide a systematic support for the actors, in a way that the viability of co-operation networks can be ensured and the aim of the co-operation can be achieved together. This claim implies the demand for an integrative approach, which considers KM not isolated from more general management tasks, but rather integrates KM in the existing management processes.

The abstracted results of the qualitative-hermeneutic analysis have been aligned with already existing models for KM and models for general management. We refer mainly to the Viable System Model [14], the St. Gallen Model [9, 15] and the KM model according to PROBST [16] in order to raise the general validity and applicability of the HMKM's design level. This finally led to three domains, which are crucial to the realisation of KM: the sphere of influence, the sphere of development and the sphere of action.

The **sphere of influence** contains factors, which affect the processes of KM in value creation systems. This general set of factors can be further divided into factors, which result from the actors participating in the cooperation (e.g. structural barriers); factors, which take the relations between the actors into consideration (e.g. the dominance of an actor) and finally factors, which are derived from the industrial sector respectively the global environment the actors are embedded in (e.g. the rate of economic growth in the aviation industry) (see figure 2).

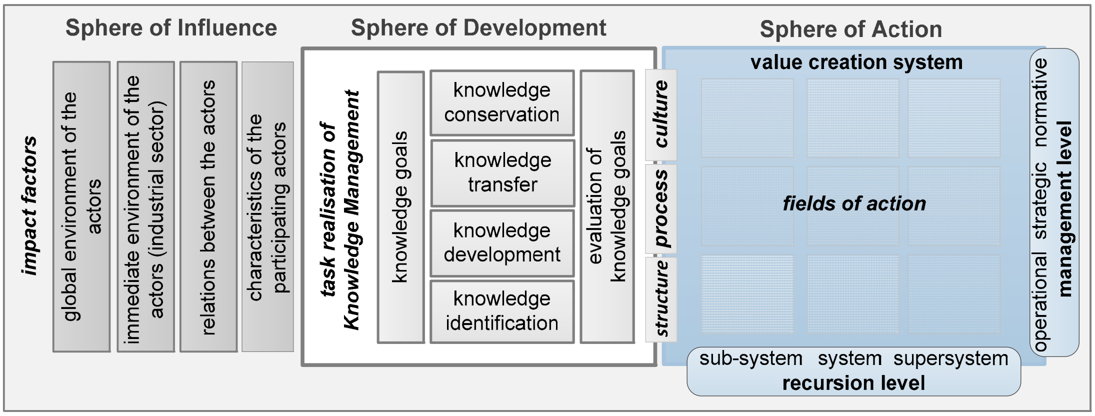

Figure 2: Design Level of the HMKM.

The **sphere of development** aims at the conception of courses of action (structures, processes, culture) for the task realisation of the KM (knowledge management goals, identification of knowledge, knowledge development, distribution and sharing of knowledge, knowledge evaluation, knowledge conservation and the evaluation of the KMS) [16].

The **sphere of action** finally describes the concrete fields of action that are to be supported by the KM and for which the courses of action of the sphere of development are to be developed specifically. The demarcation of the fields of action arises from the consideration along the levels of 'management' and 'recursion' (see figure 2). The distinction inspired by the Viable System Model [14] allows a general description for each field of action.

The *management level* divides the activities within the value creation system into the areas of normative management (a common framework for action), strategic management (external view and future planning) and operational management (harmonisation and optimisation of internal operations) [15].

The *recursion level* refers to the interleaving of the value creation system. This approach enables us to take the interfaces between the different levels of recursion into account and to avoid isolated solutions. The system to be investigated is surrounded by a supersystem and is itself further divided into several sub-systems [7]. Based on the consideration of an inter-organisational research project as a system, the cluster or the network would form the supersystem, whereas single teams of researchers in the project would be defined as sub-systems. These sort of interleaving structures follow explicitly no hierarchical order [10, 14].

2.3 The Analytic Level

The development of a KMS according to the design level of the Hamburg Model requires a deeper understanding of the interdependencies between the sphere of influence, the sphere of development and the sphere of action of the considered system. In order to capture the key factors affecting the fulfillment of knowledge tasks, a cybernetic perspective has been chosen. This perspective takes the high variety and existing dynamics as well as the complexity of the research object into account [9, 14, 17, 18]. The cybernetic research perspective is based on the presupposition that one can only understand a system by analysing its internal patterns or more specifically the relations between the system`s elements and their dynamic (reciprocal) interactions [10, 14].

	impact of variable on variables ↓ →	1	2	3	4	5	6	7	8	9	10	...	51	...	81	...
	impact factors															
1	willingness to share knowledge	**X**	0	0	0	0	0	0	0	0	0	...	**65**	...	0	...
2	ability to share knowledge	0	**X**	0	0	0	0	0	0	0	0	...	**35**	...	0	...
3	interpersonal trust	**35**	0	**X**	0	0	0	0	0	0	0	...	0	...	0	...
4	continuity of collaboration	0	0	**15**	**X**	0	**20**	0	0	0	0	...	0	...	0	...
5	face-to-face communication	0	**40**	**25**	0	**X**	0	0	0	0	0	...	0	...	0	...
6	common identity	0	0	**10**	0	0	**X**	0	0	0	0	...	0	...	0	...
7	power asymmetries between the actors	0	0	**-15**	0	0	0	**X**	0	0	**15**	...	0	...	0	...
8	common innovation development	0	0	0	0	0	0	0	**X**	**25**	0	...	0	...	0	...
9	apparent added value	0	0	0	0	0	0	0	0	**X**	0	...	0	...	0	...
10	mutual dependence between the actors	0	0	**-10**	0	0	0	0	0	0	**X**	...	0	...	0	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	knowledge tasks															
51	transfer of knowledge	0	0	0	0	0	0	0	0	0	0	...	**X**	...	**50**	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	fields of action															
81	common scenario analysis (strat. mgmt)	0	0	0	0	0	0	0	**30**	0	0	...	0	...	**X**	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	sum of impacts	**...**	**...**	**75**	**...**	**...**	**...**	**...**	**...**	**...**	**...**	...	**...**	...	**...**	...

Figure 3: Extract of the Interdependency Matrix.

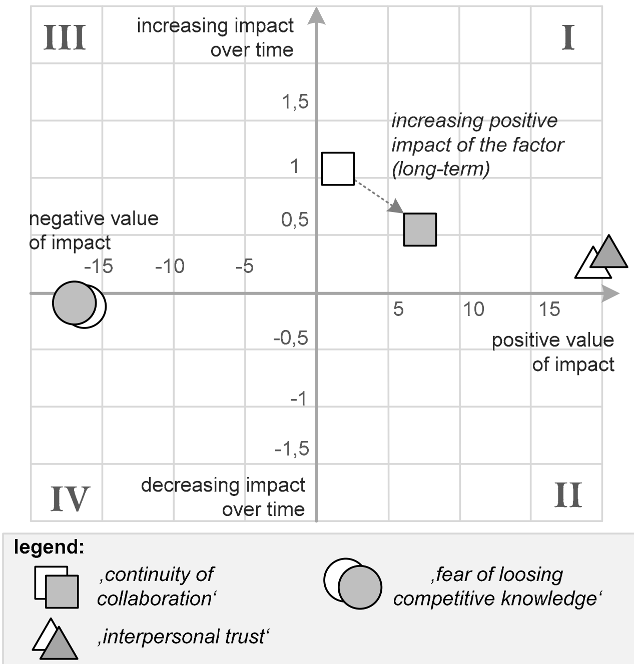

Figure 4: Insight matrix of the variable 'transfer of knowledge' for selected impacts.

On account of permanent changes through feedback loops, complex dynamical systems are hardly tangible. A cybernetic perspective makes the detection of the system patterns feasible and can furthermore be the basis for deriving regulatory mechanisms [8, 10]. In order to detect the complex interactions of the research object and to develop possible mechanisms of regulation (courses of action), the analytic level of the HMKM relies on a qualitative interaction model. This model describes – with regard to a specific case of application – the effect of the impact factors on the realisation of KM tasks within the different fields of action over time. The method of qualitative modeling, also used in the field of scenario management [19] as well as in the field of integrated management systems [9, 15], is based on a procedure developed by NEUMANN/GRIMM [20], which refers to insights of the sensitivity model developed by VESTER [21].

Development of the Analytic Level of the HMKM

The overall aim of qualitative modeling in this context is to recognise the direct and indirect interdependencies between the factors of the three different spheres of the design level [21]. Through the variation of the input parameter of independent factors (impact factors which are not affected by any other factor within the interaction model) the system performance can be simulated [20, 21, 22].

In a first step, impact factors on the co-operation and the realisation of the KM tasks in the cluster were identified on the basis of the results from the qualitative interview study and the concomitant heuristic analysis. These results served as a base for the determination of the direct impacts between the factors with regard to their intensity and their temporal dynamic, which were collected in an interdependency matrix (see figure 3: white = instantaneous effect; grey = medium-term inserted effect; black = long-term unfolding effect) [20, 22].

In order to determine an accurate weighting, those factors affecting an investigated variable directly were identified and weighted in percentages. If the impact factors described in the model fully cover the different impacts of the analysed factor, the sum of the impacts is 100%. If there are impacts, which have not been taken into account in the scope of the model, because they were irrelevant to the investigation, the sum of the impacts is under 100% [22]. The percentage weighting has been also based on the interview study results and the supplementary heuristic analysis.

The further refinement of the model regarding the specific weighting and the temporary impact of the factors has been accomplished in interdisciplinary workshops (with actors of different academic backgrounds) as well as separate individual sessions in order to avoid group thinking [22]. Figure 3 shows a small extract of the interdependency matrix. Column 3 shows the intensity of impacts of the factors 'continuity of collaboration' (15), 'face-to-face communication' (25), 'common identity' (10), 'power asymmetries between the actors' (-15) and 'mutual dependence between the actors' (-10) on the variable 'interpersonal trust'.

In a next step, the intensity of selected factor's effects and their change over time can be determined more precisely based on the interaction between the variables. Figure 4 shows the effect of selected factors on the 'knowledge transfer' within a short as well as a long-term observation. The factors in sector I have a positive impact on 'knowledge transfer' which is reinforcing over time, whereas the factors in sector II have a positive impact, which decreases over time. Sector IV shows factors that have a negative impact that is prospectively reinforcing and the factors of sector III have a negative impact, which decreases in the future.

This example illustrates that 'interpersonal trust' has a strong positive impact on the 'transfer of knowledge' and the value of this impact is almost constant over time. The impact of the factor 'continuity of collaboration' has got a weaker positive impact than 'interpersonal trust', because the effect on the 'transfer of knowledge' is only indirect, however the impact value is increasing over time. The reason for this is a reinforcing retroactive effect of 'continuity of collaboration' (positive feedback loop), which evolves from interdependencies between the factors. Figure 5 shows an example for the reinforcing loop between 'continuity of collaboration' and 'transfer of knowledge'.

The qualitative model (analytic level) thus allows the identification of direct and indirect impacts as well as reinforcing and compensating feedback loops on the realisation of the KM tasks and their implementation in concrete fields of action. The current development and validation of the HMKM takes place in the context of a regional, aeronautical cluster.

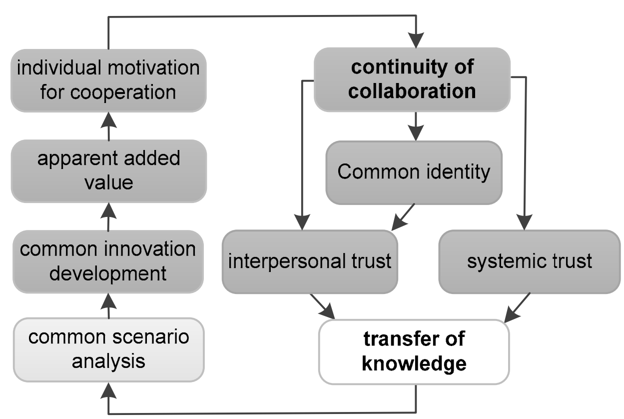

Figure 5: Positive feedback loop of the variable 'continuity of collaboration' within the qualitative interaction model.

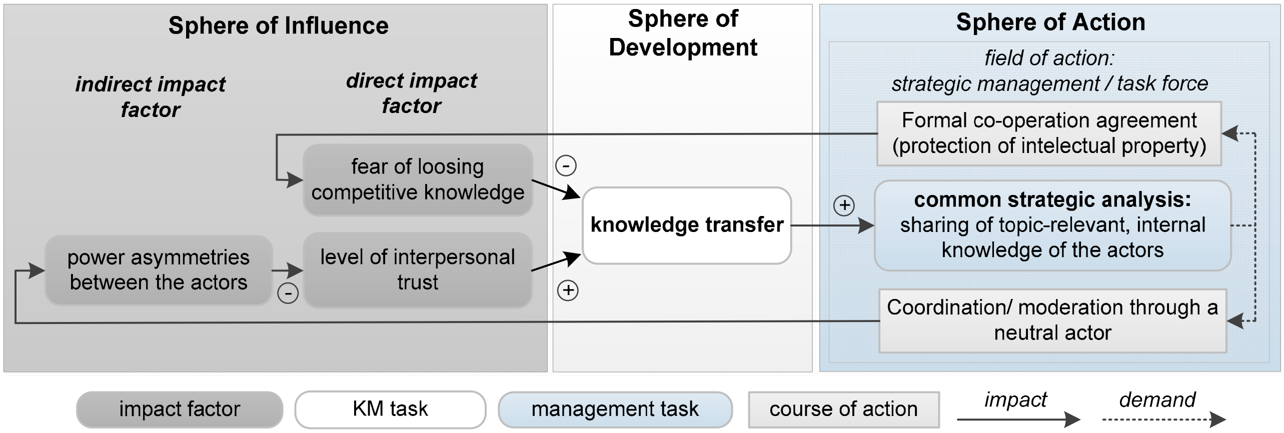

Figure 6: Deriving procedure for the development of courses of action.

A large number of the identified interdependencies between the variables of the three spheres will be also valid in other contexts of application. However, each case of application needs an initial phase of exploration in order to link and weight the relevant factors and to adapt them to the qualitative model of the analytic level. Whereas the design level serves as a context-independent general guideline, the analytical level of the HMKM is considered to be a dynamic, qualitative basis, which can be adapted to different cases of application or to changes that may occur on account of new findings during the research process.

2.4 Case Example: Inter-organisational Innovation Development in the Cluster *Hamburg Aviation*

The consolidation and expansion of the competitive position of an enterprise requires a constant development of innovative and customer-oriented products [23]. The base for an efficient innovation management is a holistic view of the product development process. Due to the increasing decentralisation of value creation processes and the distribution of activities on a high amount of autonomous actors [24], there is first of all a need for establishing an integrated common innovation process. The success of this process depends directly on the prudent management of the common resource ‘knowledge’. The actors of the cluster *Hamburg Aviation* (enterprises, universities, federations) are facing that exact challenge.

In the following section, we are explaining step by step how we applied the HMKM in order to establish and support the development of a common, integrated innovation process.

The application of the HMKM starts with the definition of the fields of action (*sphere of action*) for a respective context (see figure 2). In order to define the relevant and context-specific fields of action, one must take the *level of recursion* and *general management* into account (see figure 2 “sphere of action”). Nine different fields of action arise from this distinction within the sphere of action.

In the given case, we focus on inter-organisational task forces which develop ideas for innovations in a specific thematic framework (e.g. manufacturing in the aviation industry). The inter-organisational task force forms a system on the *recursion level*, which is interleaving with the surrounding supersystem (i.e. the cluster) and several sub-systems (i.e. single teams in the task force). The second dimension of the sphere of action is specified by the *management level* (i.e. operational, strategic, normative). In the course of further application of the HMKM one must now identify the knowledge-intensive business processes for each field of action.

If we consider for instance the following field of action:

- *recursion level:* inter-organisational task force (system)
- *management level:* strategic

‘The execution of a scenario analysis in order to develop a common project portfolio’ represents one knowledge-intensive process in this strategic field of action. It implies the sharing of topic-relevant internal knowledge between the group members and is therefore based on an efficient transfer of knowledge. The analytical level of the HMKM allows the further determination of impact factors that affect the realisation (positive – negative; increasing – decreasing) of the knowledge-intensive processes of the sphere of action. The awareness of the impact of the factors serves as a base for deriving appropriate courses of action to support the processes of the task force.

Figure 6 shows an example of the deriving procedure. ‘Executing a common strategic analysis’ is strongly influenced by an efficient transfer of knowledge. There are several factors that affect these tasks significantly. Power asymmetries between the actors have for instance a direct negative impact on the interpersonal trust among them, which is directly affecting the knowledge transfer (willingness to share) in a positive way. In order to reduce the negative impact of the power asymmetries we suggest for instance to assign a neutral actor for the coordination of the task force.

Through this procedure, we are able to develop context-specific courses of action in terms of processes, structures and culture for each of the nine fields of action. The common qualitative model takes the interdependencies between the three spheres into account (see figure 1 *analytic level*), so we can avoid conflicts between processes of KM in the different fields of action while developing a KM concept for a specific case.

The development and evaluation of a scalable KMS for *Hamburg Aviation* is still ongoing. On the recursion level of the task force, the group “Aerospace Production” has been institutionalised at the Center of Applied Aeronautical Research (ZAL) as a neutral organisation. They are addressing problems and future challenges for manufacturing in the aviation industry. The group consists of heterogeneous representatives of the aviation industry as well as from related scientific research fields. The goal of the support through KM is to align the academic research stronger on the demands of the local and regional industry and to identify and use synergies between the research activities of the local universities and research institutions. Table 1 shows just a little extract of the results of our current work in this task force.

Initial situation (impacts)	Courses of action
task force level	
heterogeneous goals / expectations of the actors	*common strategy development and goal-setting*
lacking common identity	*development of common guiding principles and name*
fear of loosing competitive resources	*formal co-operation agreements (NDAs, etc)*
unilateral domination of the cluster internal cooperation through the OEM	*neutral moderation of the collaboration within the task forces*
structural communication barriers (cultural, functional, hierarchical)	*e.g. direct interconnectedness of the operational level across organisational boundaries*
uncertainty about interfaces and redundancies between the research activities of the actors	*development of an inter-organisational competence matrix / project portfolio mgmt*
insufficient conservation of developed working results	*routines of knowledge work (standardised documentation, common IT platform)*

Table 1: Extract of impact factors of the case example and respective courses of action.

3 SUMMARY AND OUTLOOK

The Hamburg Model of Knowledge Management is based on a design and an analytic level. The design level serves as a context-independent general guideline for the development of courses of action (structures, processes, culture) that enable autonomous actors to efficiently realise the KM tasks within inter-organisational value creation systems. The analytic level of the HMKM corresponds to a context-dependent, dynamic qualitative model that can be expanded and adapted to different cases of application. It is considered to be the base for the development of the specific courses of action, because it illustrates the interdependencies between the different spheres of the design level.

The current implementation and evaluation of the model takes place in the context of inter-organisational innovation development in the aeronautical cluster *Hamburg Aviation* and has shown first positive results. The task now is to explore other contexts of application such as the coordination and harmonisation of value chains or the realisation of an inter-organisational quality management. Further empirical research needs to be carried out in order to test and validate the model in different contexts and to proof and refine the efficiency and applicability of the design level as well as the validity of the analytic level so that it can be adapted to different cases. However, we are just starting to take advantage of the enormous potential lying in inter-organisational knowledge management.

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