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Governance Framework for the Operation of Focal-Organized, Self-Financed Research Networks

Prof. Dr.-Ing. Dipl.-Wirt. Ing. G. Schuh is Chair of Production Systems at RWTH Aachen and co-director of the Laboratory for Machine Tools and Production Engineering (WZL) and the Fraunhofer Institute for Production Technology IPT, 52074 Aachen, Germany

Dipl.-Ing. S. Woelk, M.Sc. and M. Faulhaber, B.Sc. are with the Department of Technology Management at Fraunhofer Institute for Production Technology IPT, 52074 Aachen, Germany

***Abstract*— Companies face increasing challenges in research due to a constant changing international competitive environment as well as a high innovation pressure. To be competitive companies need to cooperate and innovate together in research networks. However, these networks can fail. This observation can be reduced on insecurities concerning management tasks, missing competence management, increasing number of members and thereby increasing organizational complexity. Consequentially, an organizational framework is needed as a guideline addressing processes, roles, tools and rules within research networks. Goal of this paper is therefore to describe and structure the elements of a governance framework for research networks.**

Keywords*— *Interorganizational Cooperation, Design Of Network Governance, Research Network

I. INTRODUCTION

Companies face increasing challenges in research due to a constant changing international competitive environment, shortened product life cycles, increasing individualization of demand-related behavior, as well as a high innovation pressure [1] [2] [3] [4] [5] [6] [7]. To be competitive under these conditions, companies need to innovate concerning product-, process-, and material-technologies [8] [9] [10] [11] [12]. The increasing complexity of technologies impede the attempt of being competitive since high investments come along with high risks [1]. Germany as a high-wage country depends on innovative products as its' competitive advantage [5] [13]. An extension of competencies outside of the core competencies is often not reasonable [14] [15]. Consequential, especially German companies focus on their main competencies and collaborate in networks [1] [16] [17] [18]. To manage the complexity and interdisciplinary nature of technologies, companies enter research cooperations [13] [19] [11]. Additionally, reasons like sharing risks, achieving synergy effects, accelerating the innovation process as well as creation of new business units drive companies into cooperations [13] [7]. Meanwhile research institutes aim to develop external funds and new fields of research [20].

However studies show many of these research cooperations and networks fail during their execution period and before achieving their set goals [10] [19] [21]. Failing is even more likely than succeeding [22] [23]. This observation can be reduced on interorganizational rivalries, insecurities concerning management tasks, missing competence management, increasing number of members and thereby increasing organizational complexity [10] [24] [11] [14] [25]. Another problem is opportunistic behavior, which means that partners take advantages of the network without contributing or sharing resources themselves [14] [26] [27] [28] [29]. Consequentially, an organizational framework is needed as a guideline for managers to help overcome these problems of research networks [30].

II. CHARACTERIZATION OF RESEARCH COOPERATION

The wide variety of cooperation forms and their frequent treatment in literature illustrate the relevance of the addressed topic. In practice one can rarely differentiate between cooperation forms [31].

For research cooperation the main focus lays on research and development [1] [32] [18]. This form of cooperation takes place in an early stage of value creation [32]. Due to this self-financing the network is independent on choosing projects and setting priorities. Interorganizational cooperation between companies and research institutes are called diagonal because the cooperation is no direct part of the company´s value chain [33] [32]. The number of partners has a great impact on the organizational and administrative effort. The interorganizational research cooperation is supposed to have 10 to 100 partners. Due to the international background of network partners face-to-face contact is not economical and communication needs to be supported by media tools [34] [35]. Furthermore, the partners are bounded to the network by contracts [25] [1]. The research cooperation is designed for long-term collaboration as 35% of all networks are [1]. With the pool of potential partners for dynamic cooperations the network is able to work efficient and effective on selected projects [14] [36] [1] [37] [33] [32]. An efficient network organization is of great importance and one of the main requirements for companies to participate in a cooperation [38]. Furthermore, a focal entity is recommended for coordinating processes in the research cooperations similar to the virtual company [14] [10] [39].

Complexity, uncertainty and high dynamics describe the environment in which companies are interacting today which is why they are required to focus on flexibility, efficiency and effectiveness [27]. Only a dynamic and adoptable organizational structure is able to form a framework in which

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defined objectives can be achieved [7]. On the one hand the organization needs to ensure rapid action and on the other hand limit the action and decision area of network partners [37]. Meanwhile focus is not only on innovations concerning products, production techniques and materials but also on organizational innovation. Those can increase the speed of action, raise the adaptability and slow the decrease of the indirect investments [37]. The field of tension between the target figures efficiency on the one hand and flexibility on the other hand is called organizational ambidexterity [40] [41]. Especially research cooperations require a constant renewal of the organizational structure [10] [42] [43] [44].

As mentioned initially, the special character of interorganizational research cooperations requires a certain form and freedom of organization. Due to this fact and the growing number of cooperations and networks, a framework needs to be developed to enable managers to provide guidance.

III. LITERATURE REVIEW

The failing of cooperations can be reduced on uncertainties in the organization of networks [10] [19] [21] [25]. In practice the long term orientation of resources concerning the network goals is missing. There is no holistic model in literature which helps officials to identify required processes, roles, tools and rules to achieve the network goals. Therefore, single approaches need to be identified and combined to form this needed model. The interdisciplinary nature of this task leads to different literature resources. Literature dealing with organizational structures of networks is relevant as well as literature concerning management of companies and cooperations, dealing with network constitutions or used tools for operating networks. In the following different literature shall be analyzed to build the foundation for the holistic model.

The existing literature concentrates on the establishment of cooperations and not on their operation. Therefore, guidelines on how to operate research cooperations are missing. By identifying required elements in the four fields – processes, roles, tools and rules – the foundation of governance framework for interorganizational research cooperations shall be constituted. For an effective and efficient operation one need to allocate required processes to their responsible roles as well as identify needed tools and rules.

The above mentioned four fields can be derived from different approaches in literature. One approach is the virtual company by SCHUH, MILLARG and WEGEHAUPT. The introduced principles obtain the definition of roles, processes, rules for cooperation as well as supporting infrastructure [14] [36] [36]. Another approach can be found in literature of business administration. Tasks, authorities, tools and information are called the four organization elements [45]. SYDOW identifies the selection of partners, the allocation of tasks, resources and responsibilities, the regulation of cooperation as well as the evaluation of the network as four central functions of interorganizational network management [11].

Figure 1 provides an overview of the different approaches in existing literature.

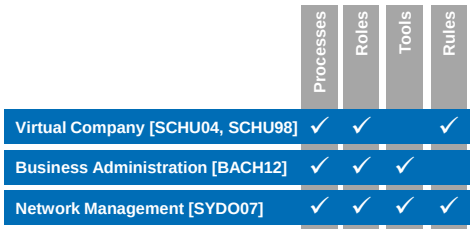

Figure 1: Derivation and validation of the four fields of the organizational framework

SYDOW has been concentrating on the management and governance of networks in many of his works [11] [46] [28] [47]. In an anthology SYDOW introduces four central management tasks of interorganizational networks. Nominal these are the selection of network members, the allocation of tasks, resources and responsibilities within the network, the regulation of the cooperation as well as the evaluation of the joint activities, single relationships between members and of the network as a hole [11]. As illustrated before these four tasks correspond to the elements which are building the governance framework of interorganizational research cooperations. The allocation of tasks, resources and responsibilities, as well as the regulation of the cooperation are of special interest for the governance framework. Although SYDOW identified the four central tasks, he is missing a detailed approach upon these. His declared objectives are new management, evaluation and optimization approaches instead of the effective and efficient operation of the corporate network itself.

ORTIZ refers to the four central aspects – selection, allocation, regulation and evaluation – while examining the special cooperation relationship between corporates and universities. His focus is on local associations and the positive effects of geographical proximity of network members for production- and innovation-orientated cooperations [20]. While ORTIZ speaks of positive effects throughout the whole network, concentrating on the interorganizational research cooperations there are positive effects concerning a centralized management. By centralizing the management an intensification and personalization of the coordination between responsible managers is achieved which leads to a more dynamic leadership [20]. These insights are used to build the organizational structure of the research cooperations.

In an anthology published by ZENTES, OESTERLE is concerned about the management of cooperations and divides it into different phases. Of special interest for the governance framework is the phase "Management of ongoing cooperations" where he stresses the importance of trust within a successful cooperation [31]. However, despite the awareness of the importance of trust, OESTERLE does not work out many more important factors for the ongoing management of cooperations.

SCHEER ET AL. meanwhile deal with the development of the business environment and its influence on networks and cooperations. They concentrate thereby on the influence of new information and communication technology. The authors see big potentials in the increase of speed and flexibility, as

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well as the reduction of transaction costs [31]. They are closing up with a summary of relevant skills for cooperation success under the term "network capabilities". These skills not only consider the usage of modern information systems for connectivity and transparency, but furthermore a flexible organizational structure of the corporates and a modular process build up [31]. The insights created by SCHEER ET AL. concerning the usage of new ICT are used to define needed tools to operate research cooperations successfully. Furthermore, a flexible organizational structure emphasizes their importance for an effective and efficient cooperation. Nonetheless both aspects need a more detailed view to be implemented in the actual process of cooperation governance.

The virtual company approach by SCHUH and MILLARG is a modern organizational form in which small- and medium-sized enterprises build horizontal value networks [36]. The concept is a role model for the organization of research cooperations and characterized by its pool of partners which participate in dynamic founded project networks. One of the main differences between those two networks is the appearance on the market. While the virtual company strives a joint market appearance to place their products and services, the research cooperation doesn't place their products and services on the market at all. The market appearance of the research cooperations serves only the purpose of partnership acquisition. In their joint publication SCHUH and WEGEHAUPT analyze the results of established virtual companies and acknowledge the importance of a focal authority [36] [19]. SCHUH supports this opinion as well in the anthology published by STANOEVSKA, in which the tasks of the focal authority are explained in more detail [39].

In his work NOLLAU adapts the organizational structure characteristics of the virtual company [10]. On the basis of existing literature and six case studies he develops a method for order development of technologies, which is based on a virtual form of organization. Its goals are increasing the efficiency without restricting the creativity. His work concerning the development of a process and allocation of tasks towards pool members can be used in further proceedings of creating a governance of interorganizational research cooperations. Furthermore, his insights on tools for control and managing an organization are of value for this work.

A merger of more than 20 scientists and practitioners for over four years resulted in the publication of the anthology by GLÜCKLER ET AL. In the course of the research study the authors concentrated on the structure and governance of cooperations between small- and medium-sized companies concerning an efficient innovation process. By analyzing more than 200 corporate networks standardization was identified as one of the key factors concerning the success of innovations. Formalized rules and defined processes help using existing resources more efficiently [25]. Furthermore, the study shows that centralization has neither good nor bad influence on the innovative capability [25]. However it is shown that centralization of decision making processes in one focal authority or "hub-corporate" leads to a more stable network [25]. The authors see the tasks of this focal entity, besides others, in providing the network framework, containing the set of rules and control of their compliance, as well as the steering of information [25]. Although GLÜCKLER ET AL. deal with the management of roles inside the network on micro-level (player focused perspective) and the macro-level (network perspective), an explicit definition of roles and their allocation to tasks is missing. Instead GLÜCKLER ET AL. concentrate on tactics and methods to manage single players or groups [25]. To counteract on the disadvantages resulting of the missing face-to-face interaction, the authors propose the visibility strategy. By this strategy decision-makers are obliged to show a strong presence within the network to be recognized and acknowledged in their roles as decision-makers [25]. This prevents the members of networks of not knowing each other or the other ones role in the network [25].

WOHLGEMUTH focuses on the coordination of interorganizational cooperations and their management tools. In his sight the above mentioned high failure rate of cooperations and the fall short on expectations, are results of missing coordination and management tools. He divides the structure management into four fields – creation of a network constitution, evaluation of the network success, coordination of collective strategies and selection of network partners [48].

Meanwhile SCHULTE-GEHRMANN focuses in her elaborations on roles in the technology management and the requirements placed upon them [49] [50] [51]. Her work on roles, tasks and processes are used to build the governance framework for interorganizational research cooperations. Since she focuses especially on technology management the insights can't be used without changes concerning the requirements of the present problem.

BAUMANN works out a business model for innovation cluster. From his point of view the definition of roles, determination of their competencies, rights and duties are essential for the success of the network [13]. However, he is also missing a detailed draft on the explicit components. His classification of roles into intern and extern players as well as the necessity of a network conductor are not detailed enough to provide a governance for the research cooperations.

Figure 2 shows the obtained insights and deficits from analyzing the existing literature.

The high amount of literature concerning networks, cooperations as well as the range of studies concerning organizational structures underlines the importance of the addressed issue. This chapter introduced isolated approaches on the identified four fields. While some approaches are detailed and can be transferred on research cooperations, others need to be more specified and adapted. For example, NOLLAU's work on a set of rules and network constitution are detailed while identified roles need to be worked on. Furthermore, a needed linkage between the four fields is missing, which will be approached in this paper. For an efficient and effective management of research cooperations a holistic and systematic framework needs to be defined.

Insights	Deficits
• Highly relevant issue • Isolated approaches to breakdown the organizational structure of cooperations • Isolated approaches concerning required roles • Set of rules for networks and cooperations	• No detailed and generally accepted design elements to organize the efficient operation of roles and processes in networks • Missing connection between roles and processes • No holistic and systematic regulatory framework

Figure 2: Identified insights and deficits in analyzed literature

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IV. THE ORGANIZATIONAL FRAMEWORK FOR OPERATING RESEARCH NETWORKS

The framework consists of the four fields: processes, roles, rules and tools, see Figure 3.

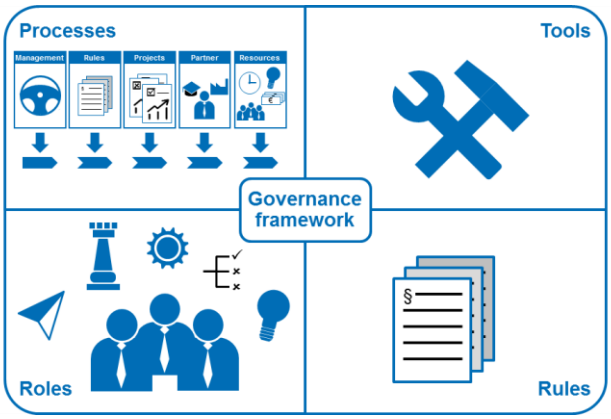

Figure 3: Governance framework of research networks

The definition and further detailing will be done isolated before the elements are linked to each other.

A. Processes

The required processes are derived from existing approaches in literature as well as the identified characteristics of the interorganizational research cooperations concerning their organizational- and process-structure. In the following the processes will be analyzed in-depth and structured subsequently under an object-orientated point of view. The processes will be grouped into management-, business- and supporting-processes as they have been in many works [45] [11] [14] [36]. Within this rough structure the processes will be differentiated more precisely comparable to the St. Gallen Management Model used by RUEEGG-STURM [52], see Figure 4.

A process can be interpreted differently depending on the context. In the following a process shall be understand as an aggregation of self-contained activities in a certain chronology, which transform input into output [45] [2] [3] [52] [53] [4]. The defined objects under which the process will be looked at are the management, rules, projects, partners, resources, see Figure 5.

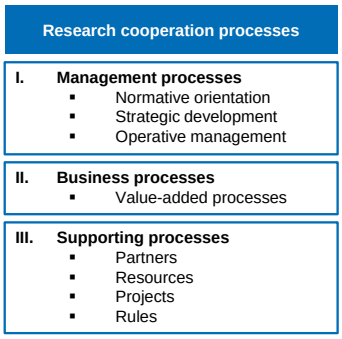

Figure 4: Processes of research cooperations [52]

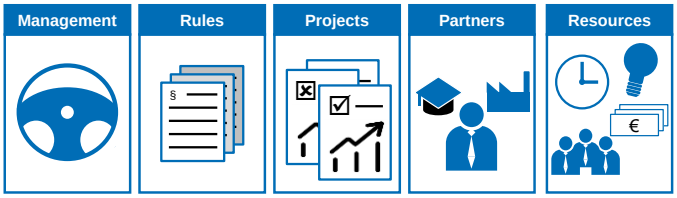

Figure 5: Objects for process identification

Two of the main success factors are similar to the virtual company the network partners and resources [36]. Consequently, they are of special interest for identifying required processes. One of the characteristics of research cooperations are the dynamic founded project-networks. This particularly organizational- and process-structure requires certain processes to work efficiently, which need to be defined [54]. Furthermore, important objects for identifying processes are management and rules which need to be looked at.

Management processes

As networks in a knowledge-intensive segment, research cooperations need leadership as well as management processes [55] [10]. Similar to BACH, who orientates himself at the works of BLEICHER [56], BEER [57] and ULRICH [58], the management processes are divided into normative, strategic and operative processes. The normative management forms the foundation for strategic development- and operative management-processes by defining goals, visions and principles for the entire network [45].

Based on this, foundation strategies are developed and organizational structures are built. The right structures and network strategies are of great importance for the success of the research cooperations [45] [25] [59]. Within strategies the network chooses a direction to work in and weights the distribution of resources [45] [52] [59]. The operative management meanwhile acts within the given framework of strategies and distributes available resources to where they are needed to achieve the defined goals [45]. The main tasks of operative management are personnel and process management, as well as finance and quality processes [52]. While the strategic management is responsible for long-term strategies the operative management is working on short-term strategies.

Regulation process

The empirical study of GLUECKLER ET AL. shows an increase of efficiency for networks if they operate on basis of a set of rules [25]. SCHUH and MILLARG, BAUMANN and NOLLAU also believe that a set of rules is required to handle the business processes [10] [13] [36]. This network constitution forms the framework on which every network member can refer to enforce rights and duties. The regulation process contains the development and the enforcement of formal and informal network rules. These rules regulate amongst others conflict management, intellectual property rights, rights and duties of network members, conditions of admission, quality standards and a code of conduct [25] [36] [48] [11].

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Project processes

Arising processes concerning the projects are the acquisition, execution and completion of projects. First the cooperation has to identify potential fields of interests, define projects and evaluate them. For this the interorganizational research cooperation can fall back on the combined knowledge of prestigious universities, research institutes and experienced companies. Furthermore, the cooperation needs to assess if they have the required resources [13]. For the project execution partner need to be chosen from the pool to supply needed knowledge, resources and manpower [10] [36]. Milestones are defined, tasks are distributed, and the proceeding is documented. Within the process of project completion the defined goals are compared to the achievements and further proceedings are determined.

Partner processes

Many authors see the selection and acquisition of the right network members as the foundation of a successful network [26] [43] [48]. The partner acquisition is a steady process within the network which enables the cooperation to adapt to a changing environment by expanding its own competencies. This acquisition process takes place under defined criteria and requirements which have been dealt with in wide range of literature [10] [60] [26] [1] [19] [36] [27]. A detailed draft on these criteria can be found in MICHEL'S work [1]. The acquisition process of the research cooperation is orientated towards the process in the virtual company [36]. More partner focused processes concern the development of members and conflict management. Against the background of a constantly changing environment and competition the development of the partner skills become one of the main success factors for cooperations [2] [27] [36]. Continuing training objectives can aim at the technical knowledge as well as the organizational or social skills [59]. To be efficient coordinators need to know about the individual competencies and capacities of each partner concerning their technical knowledge and their organizational skills [10] [59] [19] [43]. Therefore it is recommended to develop partner profiles [10] [19]. These profiles are used to identify the best combination of partners to form a dynamic project network and achieve the defined goals [19] [36] [43]. Furthermore, coordinators need to be able to prevent and resolve conflicts. Often conflicts lead to opportunistic behavior, deterioration of the flow of information and communication relations [59]. To solve conflicts those responsible can fall back on tools and methods which are defined in the network constitution [26] [10].

Resource processes

In their empirical study GLUECKLER ET AL. show that 79% of companies and research institutes participate in cooperations and networks to use joint knowledge, competencies and capacities [25]. Those joint resources need an acquisition, development and allocation process. Within the acquisition the network identifies required resources to achieve defined goals and follow network strategy. To gain new resources there are two possible ways either the mentioned development of existing partners (internal resources) or the integration of new partners (external resources). New resources, no matter how they are generated, need to be integrated into the network by inclusion into the partner profiles [60] [11] [11]. The information is used to select projects as well as new partners [10] [25] [36]. The allocation process contains maintenance, provision and protection of network resources. IT- and communication infrastructure, machines, buildings, and research facilities need to be build up and maintained [45] [36]. The protection of network knowledge and skills needs to be effective against free riders internally and other external parties [1] [36]. Free riders are network partner who don't contribute to the network knowledge but try to retrieve resources from the network. An overview of methods and procedures to protect resources are listed in the "Technology management" by SCHUH [8].

B. Roles

The term "role" is often put on the same level as a job or position but needs to be separated from those understandings. In the following "a role is a bundle of normative, formal and informal behavioral expectations of reference roles at the role holder, who finds himself in a certain position with defined tasks and functions which he interprets in his own manner" [61]. A role thereby can be hold and fulfilled by one or more persons or institutions the same way one person can hold more than one role. The number of persons fulfilling a role depend on the amount of work and need to be adjusted occasionally [49] [50] [51].

For this approach of a network framework roles are differentiated into formal and informal roles. Formal roles are agreed and defined by contract and fulfill a certain service in the network while informal roles are socio-technical roles. This distinction can be clarified with an example, see Figure 6.

While the network manager contributes to the network steering he carries out the informal role of the coordinator and his tasks. Working on the strategy selection the network manager participates in the role of the decider, since he is selecting the strategy proposed by the strategist and the expert. In the following the informal as well as the formal roles of the research cooperation are introduced.

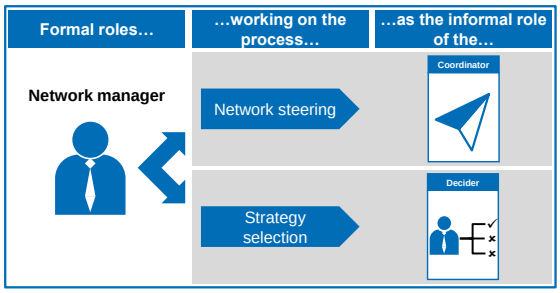

Figure 6: Distinction between formal and informal network roles

1) Informal roles

For the efficient operation of the research cooperations certain socio-technical roles need to be carried out. These informal roles are derived from different works in literature, see Figure 7.

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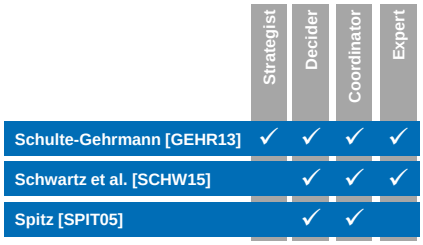

Figure 7: Approaches for informal roles in literature

By analyzing existing approaches for defining roles in networks and cooperations four informal roles could be derived for the interorganizational research cooperations. These are the strategist, the decider, the coordinator and the expert, see Figure 8.

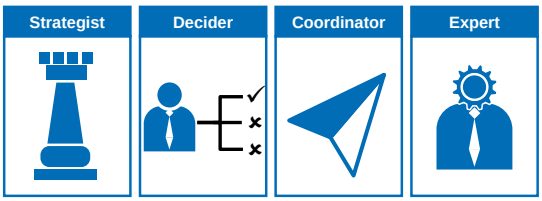

Figure 8: Identified informal roles for research cooperations

The requirements of formal roles are derived from the defined informal roles, as they have to be able to plan their proceeding actions, make decisions, select from opportunities and coordinate their action. The foundations of planning and decision processes are built by the expert knowledge.

The strategist as well as the decider participate in the normative management and the strategy development process. Additionally, for the strategy development process an expert is consulted to contribute his technical knowledge. The operative management is meanwhile handled by deciders and coordinators.

All four informal roles contribute to the regulation process. Experts are consulting concerning intellectual property rights, deciders and strategists determine final regulation and coordinators ensure a smooth operation and the enforcement of the rules.

For project acquisition as well as the project completion strategists, deciders and experts are needed, while the execution calls for the additional skillset of a coordinator.

On the one hand the partner related processes need a strategist who is responsible for the acquisition of new members and the planning of their individual development in the network. On the other hand, the final decision, who to include in the network and who not to, requires deciders. Experts are needed to evaluate potential new members and coordinators are participating in the process of conflict management.

Since research cooperations are designed to be long-term networks, strategists are called in together with deciders and experts to acquire resources. Coordinators contribute meanwhile in the distribution of resources.

The single involvement of informal roles in the above identified processes is shown in Figure 9.

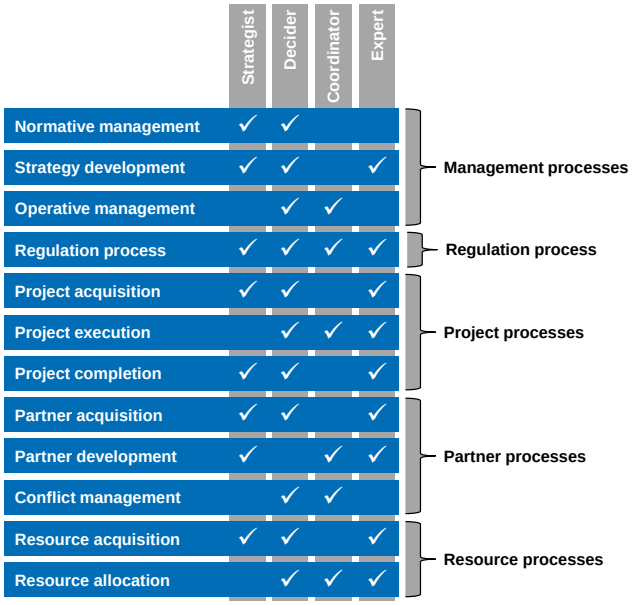

Figure 9: Linkage between informal roles and processes

2) Formal roles

Formal roles of the research cooperation fulfilling a certain service in network are derived from defined roles of the virtual company under consideration of the four identified objects and further literature [62] [35]. By that, six roles have been identified for the operation of research cooperations.

Network manager

The network manager is central coordinator and responsible within the network. He is project manager of the entire network and subsequently his tasks are associated with the ones of a project manager [42]. The necessity of a focal coordinator is accepted in literature and proven by NOLLAU in his case studies [10] [19] [42] [14] [39]. GLUECKLER ET AL. identify three main tasks for the network manager which are the mobility of knowledge, design of the network constitution and the securing of network stability [25].

Project manager

Tasks of the project manager are the execution planning of projects, arrange of tasks, competencies, resources and responsible partners [63] [64] [59] [65] [36] [66]. He coordinates and controls internal activities, is a leading figure, and is the responsible contact person for project members [43]. His required skills obtain among others empathy, intuition, and he needs to be able to take a position and convince others. Furthermore, he should be acting in an integrating way and not be polarizing [2]. Additionally, he is equipped with the needed decision-making power to solve conflicts and determine further proceedings [59]. In the planning process he defines milestones, required performances as well as resources. Besides the above mentioned part in conflict management his activities in the project execution processes include risk analysis as well [59] [36]. He aligns the individual interests along with the defined project and cooperation goals using means of incentive and sanctions

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mechanisms [29]. He also can obtain technical knowledge but the main focus of his skillset is set on organizational skills. Last but not least he is in charge of the time-, personal- and cost-structure of the project [43].

Auditor

Similar to the virtual company the auditor is in charge of the control over the compliance of network constitution [36]. Moreover, in the research cooperation he is responsible for the constant renewal of the constitution as not all regulations can be made ex ante [60] [13] [27]. Additionally, the auditor is responsible for documentation and analysis of project results [36].

Partner manager

To his tasks belong, among others, the acquisition of new members, the creation of partner profiles and the integration of different company cultures into the network culture [10] [20] [36]. He as well aligns the individual interests along the network goals using the incentive and sanctions mechanisms. Moreover he deals with trust building and staff motivation [36] [29].

Resource manager

The task portfolio of the resource manager obtains the development, maintenance and provision of network resources and infrastructure [48] [67] [48]. Because of missing personal contact amongst the network partner due to geographical distances, modern communication and information technology is of great importance. The resource manager provides importance service to the network by integrating and maintaining the medial infrastructure [1] [52] [61]. Through his contribution he enables the network to work international.

In-/Outsourcing manager

The role of in-/outsourcing manager is derived of the virtual company by SCHUH and MILLARG as well as the "boundary spanners" by WOHLGEMUTH [36] [48]. Each company, institute or university needs to declare an official contact person for network intern communication who knows about its competencies and capacities. He is representative for and mediator between network partners and his own colleagues. By this role the participation of each network partner shall be guaranteed [55].

Figure 10 shows the involvement of the above identified and described formal roles in the identified processes.

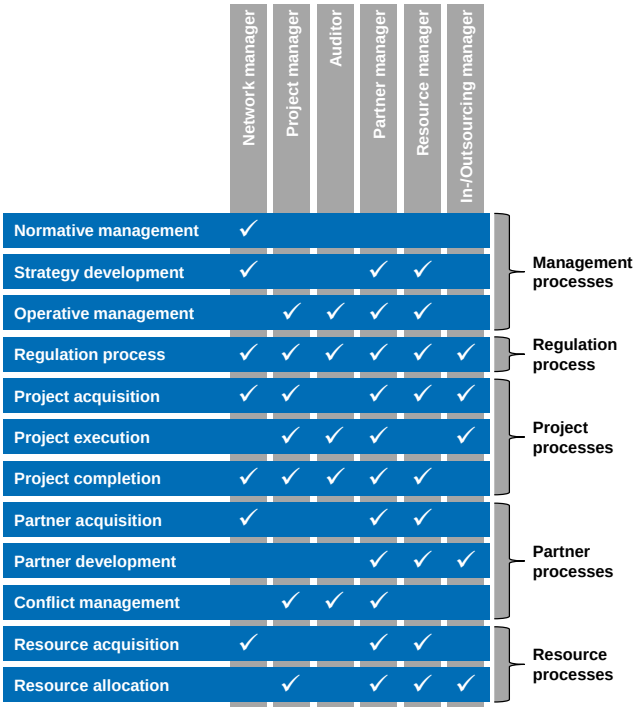

Figure 10: Linkage between formal roles and processes

C. Rules

The third field of the governance framework for interorganizational research cooperations comprises the management structure, elaborations and procedures for joint targeting, network contracts, code of conduct and regulations concerning the network culture. Rights, duties and standardized processes are manifested which is why it is the central instrument for the cooperation [60]. It provides the players within the network with the needed stability and security for interacting without distrust or fear [1] [1] [25] [68]. The set of rules serve anchoring the organizational- and process-structure of the network [10]. Figure 11 gives an overview over the content of the third field of the framework. The network constitution consists of elaborations concerning the management structure and the joint targeting (organ constitution) as well as a general code of conduct and rules for dynamic projects (cooperation constitution). Furthermore, the field contains standardized network contracts as well as specifications of the network culture.

Management structure

Within the rules the management structure is determined. It comprises the roles to be staffed as well as the linkage to their tasks and responsibilities, as shown in Figure 9 and Figure 10 [10]. Thus, all network members are informed about their own and the roles of others within the network.

Joint targeting

The joint targeting of the network is of great importance for the network being successful. It is formed by the network manager in the normative management process and applied by project and partner manager in the strategy development and operative management. NOLLAU proposes to manifest a certain process design for the joint targeting field [10]. This

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process is simplified by a joint network culture, which is outlined below. Since the project results can be evaluated differently depending on the point of perspective – from a research network, from companies participating on the project or non-participating companies – conflicts are expected and individual interests need to be managed [69] [70].

Rules of conduct

Standards and criteria for admission process of new members are specified as well as voluntary nature of the network. Furthermore, regulations for avoidance of internal competition and a confidentiality statement are defined in writing. While the network contracts deal with regulations concerning terms, quality, usage as well as distribution of knowledge and rights and duties of partners, the code of conduct treats social behavior and standards. The code of conduct of the research cooperations is derived from the guidelines for social interaction from the virtual company [36], the "German corporate governance code" [71] and the "Network governance codex" [72]. Points contained are transparency of goals, knowledge and costs, social standards as for example no swearing and let each other speak out, avoiding conflict of interests and right of co-determination.

Network contracts

Against the background of joint research and an highly competitive industry, network contracts are needed [25] [1]. Contracts regulate the rights and duties of network members concerning resources and services [29]. Since the contracts are important to the flexibility and stability of the network they should be standardized as ORTIZ recommends [42] [20]. They should contain among other points contract terms, individual services or resources of partners to be contributed, type of cooperation, quality of work and intellectual property rights [20] [36]. The detailed draft of network contracts confronts a lot of cooperations with difficulties. For a role model a more detailed presentation is given in the work of NOLLAU, SCHUH and MILLARG [10] [36].

Network culture

The network culture or corporate identity is a system of joint goals, values, moral concepts as well as a way of thinking and acting which is accepted and learned by partner or employees [64] [55] [59] [52] [33] [33]. Decisions are made on the basis of a "we-consciousness" and a joint corporate- or network-image [64] [33] [14]. An own network culture makes it easier for the network and project managers to align the individual interests of partners with the set goals of the network [10]. The network culture cannot be set up ex ante and is developing while cooperating [33]. When specified and updated on a regular basis it supports the joint targeting of the interorganizational research cooperation.

Figure 12 shows the linkage between formal roles and rules of the interorganizational research cooperations. It shows the participation of the formal role in rule-elements. For instance, the partner manager works on network culture and contracts as well as he participates in the §2 joint targeting element. He is responsible for the integration of company cultures into the network culture and works on the draft of the standardized network contracts. With his knowledge and skills by designing the network culture, he qualifies himself for the employee alignment in §2.

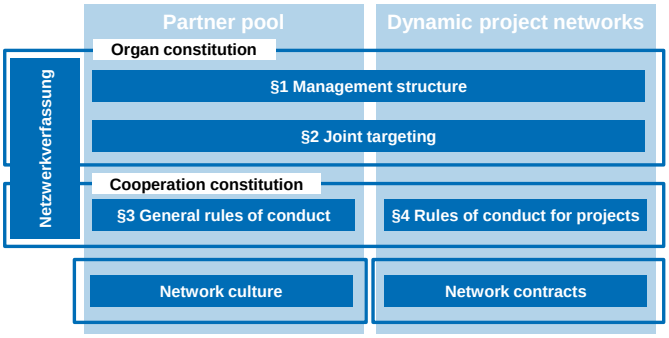

Figure 11: Structure of rules for partner pool and dynamic networks [10]

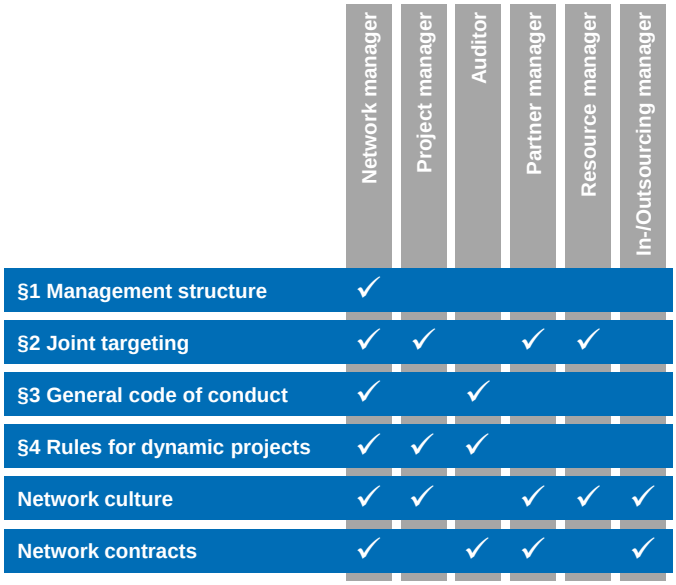

Figure 12: Linkage between formal roles and rules

D. Tools

The fourth field of the framework is tools. As tools all kinds of resources used to operate the network are considered. The resource elaborations by MUELLER-STEWENS who differentiates between material and immaterial resources on a first level are shown in Figure 13.

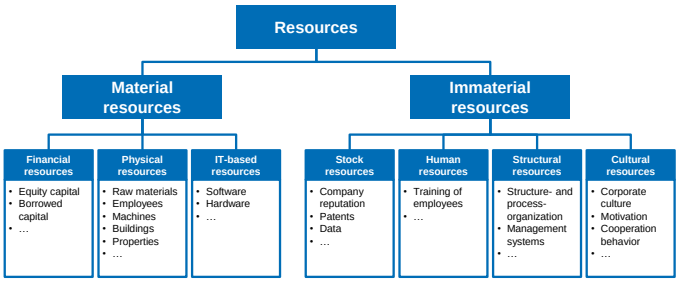

Figure 13: Material and immaterial resources of companies [73]

In mind of research cooperation, the IT-based, physical, financial resources are of special interest as well as the used methods and procedures. DHILLON offers ,besides others, an overview of tools and methods for technology management which are used in cooperations as well [34].

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IT-based resources

The most important tool and heart of the network is a web based cooperation platform to visualize partner profiles, organize a joint schedule management, basis for working asynchronous, as well as access distribution of network knowledge and information [25]. It contains chats and discussion board for exchange among network partners, for surveys, coordination and requests. Hereby, it enables the network to work with international partners on the same project [25]. Together with a knowledge database it offers comprehensive possibilities, but also demands new skills of coordinators who are depending on the tools to fulfill their roles.

Physical resources

Depending on the project, networks need different physical resources to achieve their goals. Those can be man-power, machines, raw materials, offices and buildings, test benches as well as creative spaces [74] [75]. Creative spaces are used for generation of ideas and research.

Financial resources

The interorganizational research cooperations are financed internally, which means that they do not receive public funds. Therefore, they are independent concerning their selection of projects. The required financial resources for projects are acquired by membership fees, knowledge sales or directly in form of for example a consortium benchmarking study. Financing can be either monetary or through in-kind donations by members.

Methods

Additionally, research cooperations can fall back on a big pool of methods as tools. Those can be for example early recognition methods for technologies like a monitoring radar or a roadmap as a planning tool [8]. Other examples are scenario technique, trend analysis, benefit analysis or portfolio approaches.

II. SUMMARY AND DISCUSSION

Changes in the competitive environment are pushing companies as well as research institutes into interorganizational cooperations. However, a big number of these cooperations fail during their operation. This can be reduced to the high complexity of international, diagonal research cooperations. Subsequently to these two observations the need of an organizational framework for cooperations is high. Against this background, this paper builds a first approach to get hold of the organizational complexity and reduce it to a reasonable and functional size. Therefore, elements of the four fields – processes, roles, tools and rules – were identified, accumulated and connected.

Six formal roles could be identified who are working on twelve defined processes. Those processes were described by their tasks and subsequently clustered into management-, regulation-, project-, partner-, and resource-processes. The defined formal roles are the network-, project-, partner-, resource-, in-/outsourcing-manager and auditor. Depending on the exact process they work on these six formal roles take up four informal, socio-technical roles, which are the strategist, the decider, the coordinator and the expert. These roles act within the network constitution and use tools to achieve defined goals. Figure 14 gives an overview over the identified elements of the four fields.

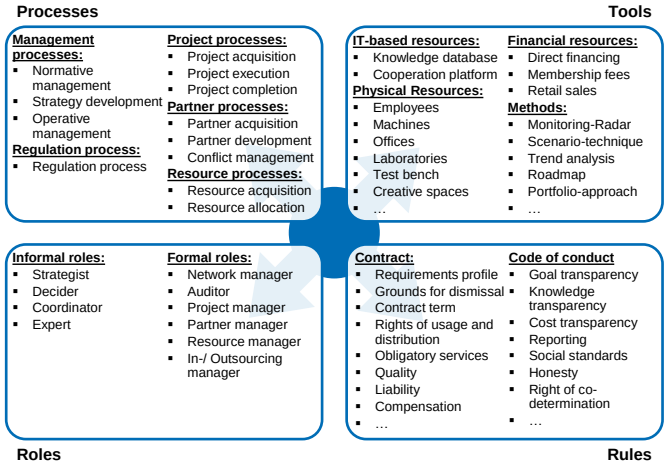

Figure 14: Overview of the elements in the four fields of the governance framework

In future research, the linkages between the elements should be analyzed in more detail. This should be followed by an analysis of the cause effect relationships between the elements in the four fields. Furthermore, the identified elements should be verified by empirical case studies. Also, further research needs to design a combinational logic to select required organizational elements regarding the specific research network. Thereby, officials shall be supported to operate their individual research cooperation.

REFERENCES

[1] L. M. Michel, Management von Kooperationen im Bereich Forschung und Entwicklung. Eine empirische Studie. Konstanz. Hochschule Konstanz, 2009.

[2] J. Becker, Ed., Prozessmanagement. Ein Leitfaden zur prozessorientierten Organisationsgestaltung. Berlin. Springer Gabler, 2012.

[3] J. Becker, "Information Models for Process Management – New Approaches to Old Challenges," in Emerging Themes in Information Systems and Organization Studies. A. Carugati, C. Rossignoli, Eds. Heidelberg: Springer-Verlag Berlin Heidelberg, 2011, pp. 145–154.

[4] H. Österle, Business Engineering Prozeß- und Systementwicklung. Band 1: Entwurfstechniken. Berlin, Heidelberg, s.l. Springer Berlin Heidelberg, 1995.

[5] G. Schuh and C. Schmidt, Produktionsmanagement. Handbuch Produktion und Management 5. Berlin. Springer Vieweg, 2014.

[6] G. Schuh, M. Graw, and N. Schön, "Exploitation-oriented Manufacturing Technology Development," Procedia CIRP, vol. 17, pp. 680–685, 2014.

[7] A. Picot, R. Reichwald, and R. T. Wigand, Die grenzenlose Unternehmung. Information, Organisation und Management. Wiesbaden, s.l. Gabler Verlag, 2001.

[8] G. Schuh, Ed., Technologiemanagement. Handbuch Produktion und Management 2. Berlin, Heidelberg. Springer-Verlag Berlin Heidelberg, 2011.

[9] G. Schuh, J. Arnoscht, A. Bohl, and C. Nussbaum, "Integrative assessment and configuration of production systems," CIRP Annals - Manufacturing Technology, vol. 60, pp. 457–460, 2011.

[10] S. Nollau, Die virtuelle Technologieentwicklungsunternehmung. Aachen. Apprimus-Verl., 2014.

[11] J. Sydow, Management von Netzwerkorganisationen. Wiesbaden. Springer Fachmedien, 2007.

[12] M. E. Porter, "The Competitve Advantage of Nations," Harvard Business Review, pp. 71–91, 1990.

[13] B. Baumann, Konzeption hochschulnaher Innovationscluster. Aachen. Apprimus-Verl., 2011.
[14] G. Schuh and P. Wegehaupt, “Lessons Learned zehn Jahre danach,” in Unternehmensnetzwerke. Fragen der Forschung und Erfahrungen der Praxis ; [Kongress 2003], vol. 1. B. Kaddatz, Ed. Bielefeld: Kleine Verl., 2004, pp. 117–127.
[15] B. Nooteboom, Inter-firm collaboration, networks and strategy. An integrated approach. New York, N.Y. Routledge, 2004.
[16] A. Weißenbach, W.-M. Scheid, N. Vojdani, and T. Schmidt, Verbundinstandhaltung bei Kleinstunternehmen, kleinen und mittleren Unternehmen (KMU). Ein Konzept für neue Organisationsformen der Instandhaltung. Ilmenau, Ilmenau. Univ.-Verl. Ilmenau; Univ.-Bibliothek, 2012.
[17] D. Morschett, “Formen von Kooperationen, Allianzen und Netzwerken,” in Kooperationen, Allianzen und Netzwerke. Grundlagen - Ansätze - Perspektiven. 2nd ed. J. Zentes, B. Swoboda, D. Morschett, Eds. Wiesbaden: Gabler, 2005, pp. 378–403.
[18] E. M. Grochowski and P. Ohlhausen, “Cooperation Models as Success Factor for Interdisciplinary, Inter-Organizational Research and Development in the Automotive Industry,” in 2015 Proceedings of PICMET '15: Management of the Technology Age. Portland State University, Ed., 2015, pp. 270–279.
[19] G. Schuh, M. Wellensiek, and S. Nollau, “Management of a virtual technology development enterprise,” in Towards new challenges for innovative management practices. J. Legardeur, K. North, Eds., 2010, pp. 161–168.
[20] A. Ortiz, Kooperation zwischen Unternehmen und Universitäten. Eine Managementperspektive zu regionalen Innovationssystemen. Wiesbaden. Springer, 2013.
[21] R. Ermisch, Management Strategischer Kooperationen im Bereich Forschung und Entwicklung. Wiesbaden. Springer Fachmedien, 2009.
[22] Ö. Sölvell, G. Lindqvist, and C. Ketels, The cluster initiative greenbook. Stockholm. Ivory Tower, 2003.
[23] S. H. Park and G. R. Ungson, “Interfirm Rivalry and Managerial Complexity. A Conceptual Framework of Alliance Failure,” Organization Science, vol. 12, pp. 37–53, 2001.
[24] G. Schuh, M. Wellensiek, and S. Nollau, “Resolving Challenges in CooperativeResearch and Development,” Proceedings of the XXI ISPIM Conference, vol. 1, 2010.
[25] J. Glückler, W. Dehning, M. Janneck, and T. Armbrüster, Unternehmensnetzwerke. Architekturen, Strukturen und Strategien. Berlin, Heidelberg. Springer, 2012.
[26] J. Fest, Controlling zwischenbetrieblicher Forschungs- und Entwicklungskooperationen. Eine lebenszyklusorientierte Konzeption. Aachen. Shaker, 2006.
[27] M. A. Bienert, Organisation und Netzwerk. Organisationsgestaltung durch Annäherung an Charakteristika der idealtypischen Organisationsform Netzwerke. Wiesbaden, Deutscher Universitätsverlag, 2002.
[28] J. Sydow, Ed., Steuerung von Netzwerken. Konzepte und Praktiken. Opladen. Westdt. Verl., 2001.
[29] J. Rühl, Vertragliche Gestaltung von Innovationskooperationen. Optimierung bei Informationsasymmetrie. Wiesbaden, Deutscher Universitätsverlag, 2001.
[30] G. Schuh and S. Woelk, “Governance of Inter-Organizational Research Cooperation,” World Academy of Science, Engineering and Technology, International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering, vol. 9, pp. 4103–4110, 2015.
[31] J. Zentes, B. Swoboda, and D. Morschett, Eds., Kooperationen, Allianzen und Netzwerke. Grundlagen - Ansätze - Perspektiven. Wiesbaden, Gabler Verlag, 2003.
[32] G. Schuh and A. Kampker, Strategie und Management produzierender Unternehmen. Handbuch Produktion und Management 1. Berlin, Heidelberg. Springer-Verlag Berlin Heidelberg, 2011.
[33] T. Hadeler and U. Arentzen, Eds., Gabler Wirtschafts Lexikon. Wiesbaden, s.l. Gabler Verlag, 2000.
[34] B. S. Dhillon, Engineering and technology management tools and applications. Boston. Artech House, 2002.
[35] R. K. Jain and H. C. Triandis, Management of research and development organizations. Managing the unmanageable. New York. Wiley, 1990.
[36] G. Schuh, K. Millarg, and Å. Göransson, Virtuelle Fabrik. Neue Marktchancen durch dynamische Netzwerke. München. Hanser, 1998.
[37] H.-J. Bullinger, D. Spath, H.-J. Warnecke, and E. Westkämper, Handbuch Unternehmensorganisation. Strategien, Planung, Umsetzung. Springer-Verlag, 2009.
[38] K. G. Provan and P. Kenis, “Modes of Network Governance. Structure, Management, and Effectiveness,” Journal of Public Administration Research and Theory, vol. 18, pp. 229–252, 2007.
[39] K. Stanoevska-Slabeva, The Digital Economy - Anspruch und Wirklichkeit. Festschrift für Beat F. Schmid. Berlin, Heidelberg. Springer, 2004.
[40] W. H. Blarr, Organizational ambidexterity. Implications for the strategy-performance linkage. Wiesbaden. Gabler Verlag, 2012.
[41] S. Raisch and J. Birkinshaw, “Organizational Ambidexterity. Antecedents, Outcomes, and Moderators,” Journal of Management, vol. 34, pp. 375–409, 2008.
[42] G. Schuh, W. Boos, and U. Gartzen, “Concept of an Organizational and Process Design for a Rule-Based Network,” in Advanced manufacturing engineering quality and production systems. Proceedings of the 2nd International Conference on Manufacturing Engineering, Quality and Production Systems (MEQAPS '10) : Constantza Maritime University, Constantza, Romania, September 3-5, 2010. C. Panait, E. Barsan, A. Bulucea, N. Mastorakis, C. Long, Eds. Romania: WSEAS Press, 2010, pp. 190–193.
[43] T. Spitz, M. Blümle, and H. Wiedel, Netzarchitektur - Kompass für die Realisierung. Unternehmensnetzwerke erfolgreich gestalten und erhalten. Wiesbaden. Vieweg+Teubner Verlag, 2005.
[44] T. Hermann, I. Jahnke, and K.-U. Loser, “The Role Concept as a Basis for Designing Community Systems,” in Cooperative systems design. Scenario-based design of collaborative systems. F. Darses, Ed. Amsterdam: IOS Press, 2004, pp. 163–178.
[45] N. Bach, C. Brehm, W. Buchholz, and T. Petry, Wertschöpfungsorientierte Organisation. Architekturen - Prozesse - Strukturen. Wiesbaden. Imprint Gabler Verlag, 2012.
[46] J. Sydow, S. Duschek, G. Möllering, and M. Rometsch, Kompetenzentwicklung in Netzwerken. Eine typologische Studie. Wiesbaden. VS Verlag für Sozialwissenschaften, 2003.
[47] J. Sydow, Strategische Netzwerke. Evolution und Organisation. Wiesbaden. Gabler Verlag, 1992.
[48] O. Wohlgemuth, Management netzwerkartiger Kooperationen. Instrumente für die unternehmensübergreifende Steuerung. Wiesbaden. Dt. Univ.-Verl., 2002.
[49] A.-L. Schulte-Gehrmann, Gestaltung des strategischen Technologiemanagements für mittelständische Unternehmen. Aachen. Apprimus-Verl., 2013.
[50] A.-L. Schulte-Gehrmann, M. Wellensiek, and G. Schuh, “Development of a Technology Management Concept for SMEs,” in Towards new challenges for innovative management practices. J. Legardeur, K. North, Eds., 2010, pp. 202–209.
[51] A.-L. Schulte-Gehrmann, M. Wellensiek, J. Schubert, and G. Schuh, “Designing technology Management in SMEs,” Proceedings of 21st International Conference on Management of Technology, pp. 18–22, 2012.
[52] J. Rüegg-Stürm, Das neue St. Galler Management-Modell. Grundkategorien einer modernen Managementlehre - der HSG-Ansatz. Bern. Haupt, 2002.
[53] J. Becker, M. Rosemann, and C. von Uthmann, “Guidelines of Business Process Modeling,” in Business Process Management. Models, Techniques, and Empirical Studies. W. Aalst, J. Desel, A. Oberweis, Eds. Berlin, Heidelberg: Springer, 2000, pp. 30–49.
[54] G. Schuh, H. Zimmermann, Å. Göransson, and U. Willi, “Enterprise Engineering and Integration - Future Challenges,” in Enterprise Engineering and Integration. Building International Consensus Proceedings of ICEIMT ’97, International Conference on Enterprise Integration and Modeling Technology, Torino, Italy, October 28-30, 1997. K. Kosanke, J. G. Nell, Eds. Berlin, Heidelberg: Springer, 1997, pp. 317–326.
[55] M. Schwartz, L. Kramer, F. Gebauer, and J. Brell, TiCo - Technologiemanagement in Communities. Entwicklung eines Leitfadens zum Einsatz von Experten-Communities für kleine und mittlere Unternehmen im Technologiemanagement, 2015.
[56] K. Bleicher, Das Konzept Integriertes Management. Frankfurt am Main. Campus Verlag, 2004.
[57] S. Beer, Brain of the firm. The managerial cybernetics of organization ; companion volume to "The heart of enterprise". Chichester u.a. Wiley, 1981.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 12, December-2016

[58] H. Ulrich, Die Unternehmung als produktives soziales System. Grundlagen der allgemeinen Unternehmungslehre. Bern. Haupt, 1968.
[59] H. Hungenberg and T. Wulf, Grundlagen der Unternehmensführung. Einführung für Bachelorstudierende. Berlin, Heidelberg. Springer-Verlag Berlin Heidelberg, 2011.
[60] P. Kalkowski and O. Mickler, "Zwischen Autonomie und Kooperation. Koordination und Strukturierung zwischenbetrieblicher F+E Projekte," in SOFI - Forschungskolloquim. SOFI - Soziologisches Forschungsinstitut der Georg-August-Universität Göttingen, Ed., 2015.
[61] I. Jahnke, S. Metz-Göckel, and T. Herrmann, Dynamik sozialer Rollen beim Wissensmanagement. DUV Deutscher Universitäts-Verlag, 2006.
[62] C. C. Snow, R. E. Miles, and H. J. Coleman, Jr., "Managing 21st Century Network Organizations," Organizational Dynamics, pp. 5–20, 1992.
[63] J. Kuster, E. Huber, R. Lippmann, A. Schmid, and E. Schneider, Project management handbook. Heidelberg .u.a. Springer, 2015.
[64] A guide to the Project Management Body of Knowledge (PMBOK guide). Newtown Square, Pa. Project Management Institute, 2013.
[65] G. M. Hill, The complete project management office handbook. Boca Raton. Auerbach, 2008.
[66] D. I. Cleland and W. R. King, Eds., Project Management Handbook. New York. Wiley, 1988.
[67] C. L. Pritchard, The project management communications toolkit. Norwood, MA. Artech House, 2004.
[68] A. H. Gausdal and E. R. Nilsen, "Orchestrating Innovative SME Networks. The Case of "HealthInnovation"," J Knowl Econ, vol. 2, pp. 586–600, 2011.
[69] G. Hendrikse, Ed., Strategy and governance of networks. Cooperatives, franchising, and strategic alliances. Heidelberg. Physica-Verl., 2008.
[70] C. Dhanarag and A. Parkhe, "Orchestrating Innovation Networks," Academy of Management Review, vol. 31, pp. 659–669, 2006.
[71] Regierungskommission, Deutscher Corporate Governance Kodex (english), 2015.
[72] D. Ahlert, M. Ahlert, B. Bolsenkötter, and K. Gehrmann, Verantwortungsvolle Führung in kooperativen Unternehmensnetzwerken, 2011.
[73] G. Müller-Stewens and C. Lechner, Strategisches Management. Wie strategische Initiativen zum Wandel führen ; der St. Galler General Management Navigator. Stuttgart. Schäffer-Poeschel, 2003.
[74] T. Moll, ICTM International Center for Turbomachinery Manufacturing, http://www.ictm-aachen.com/, 2016.
[75] T. Drescher, Invention Center, http://invention-center.de/, 2016.