

Model for the Network-Specific Design of the Type-Based Governance of Focal-Organized, Self-Financed Research Networks: Conceptual Research Design

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Abstract—Companies face increasing challenges in research due to higher costs and risks as well as the need of unique interdisciplinarity know-how. On the other hand, research institutes meet intense challenges to achieve suitable financing and to obtain high research reputation. To realize faster and better research, companies and research institutes collaborate progressively in organized research networks, which are managed by a focal administrative organization. For an effective and efficient collaboration of independent network partners, the governance organization needs to be designed with regard to the specific network requirements. Goal of this paper is to illustrate a conceptual research methodology to design to the governance organization of focal-organized, self-financed research networks.

Keywords— *Interorganizational Collaboration, Design Of Governance Organization, Research Network*

I. INTRODUCTION

Companies and research institutes are increasingly collaborating in university-close centers, e.g. the INC Invention Center and the ACAM Aachen Center of Additive Manufacturing on the RWTH Aachen Campus [1] [2]. These centers are dedicated to specific scientific questions (e.g. INC for technology and innovation management, ACAM for 3D printing) and are assigned to specific research clusters of the campus, e.g. INC to Cluster Production Engineering and ACAM to Cluster Photonics [2], see Figure 1. The research of the given scientific problem takes place with the aid of the center specific network, which consists of matriculated companies and involved research institutes. Therefore, the centers act as main contact point for companies to conducted dedicated scientific research topics with several entities of the university. The network partners are able to influence the scientific orientation of the center e.g. regarding conducted research projects. These projects are mainly industry funded by the network partners within the center. The research network is managed by a focal entity which provides an infrastructure for network activities, but the research activities are conducted by the companies and research institutes of the center. These focal-organized, self-financed research networks consisting of companies, research

institutes and the focal entity constitute the university-close center. Within the focal entity, research institutes are presented, which allows them to significantly influence the management of the center. Companies are partners of the center, but do not own any operational functions. Due to the self-financing character of this kind of research network, the participating companies have a strong interest in applicable research results. Since network partners pursue different interests, the center management needs a suitable organization to enable an efficient and effective research collaboration. Therefore, focus of this paper is to illustrate the research approach to design the governance framework with its organizational elements to operate such focal-organized, self-financed research network in order to achieve high collaboration profits for all center partners.

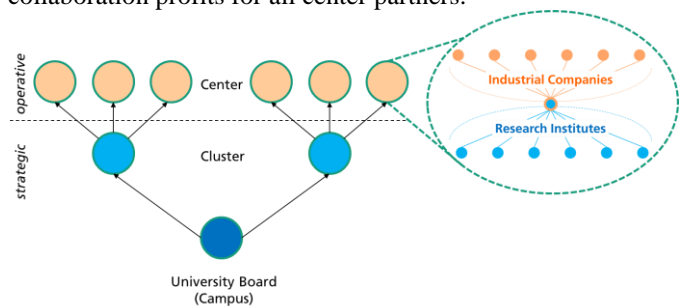


Figure 1: Relation of centers and clusters on the RWTH Aachen Campus [2]

II. DEMAND FOR COLLABORATION IN RESEARCH NETWORKS

Due to growing competition, companies are confronted with increasing challenges [3, 4]. A continuous technological progress is indispensable in this environment [5]. New competitors from emerging countries in Asia and Latin America are entering the markets [6, 7]. To maintain their competitiveness western companies need to innovate [8]. Rising customer demands and the request for individualized products lead to increased product adaptations [9, 10]. To meet this demand more complex system technologies are necessary. These systems require enhanced interdisciplinary and unique know-how [11, 12]. However, for such highly

interdisciplinary technology development tasks companies are not able to provide all needed human and technological resources by their own [13]. Moreover, the adoption of new abilities outside the core competences cannot be efficient for companies [14]. Therefore, the access to external knowledge via collaboration is essential for the technological innovation process inside the company [15, 16].

On the other hand, research institutes face increasing challenges as well. Obtaining in the competition for high research reputation and safe financing is essential [17]. Thus, a specialization of competences is necessary to reach top-level research. At the same time interdisciplinary research topics need a variety of different competences. Additionally, a long-term cooperation with industrial partners is desirable for research networks to perform application orientated research and achieve financial assurance through industry funds [17]. Due to these factors, collaborations with industrial companies and further research institutes are necessary for institutes to remain successful in competition.

Research networks offer a wide spectrum of required competences compared to bilateral cooperations, which support complex technology developments and a better knowledge transfer. Bundling competences between industry and research enables the allocation of holistic and continuous solutions [18–21]. Therefore, joint research and development activities in networks contribute a big part to the companies value-addition process and mean an important strategic instrument for maintaining the companies competitiveness [22, 23]. Europe-wide benchmark studies performed by the Fraunhofer Institute for Production Technology IPT show that successful companies are mainly focusing on cooperations with research institutes, customers and suppliers. Some of them even implement open innovation cooperations [24]. But the results show also that 37 % of the companies do not practice a systematic network management. [25], see Figure 2.

III. CHALLENGES OF NETWORK MANAGEMENT

Due to the demand for a close collaboration in research networks, the number of newly initiated research networks has raised in the last years [26, 16]. However, the failure quote of such networks is high [24, 26]. On a long-term base, a cooperation is even more likely to fail than to succeed [27, 23]. The failure rate rises with the number of collaboration members due to the simultaneous burden of developing complex technologies and managing the network. These challenges potentially lead to an unsecure research quality and increased transaction costs for the network operation, which is often times followed by high unplanned expenses [28, 21, 29, 30]. Delayed research results lead to longer development times, which result in later product launches. That might lead to a loss of competitive advantage and decreases the companies' profit [31, 32, 28]. For these reasons, an efficient network management has a decisive influence on the network-participation of companies [33, 23, 34].

Obviously, in practice there is a need for the network management to be performed by an administrative organization. Therefore, organized networks are recommended, in which a management unit is responsible for administrative tasks [33, 23, 35]. Organized networks aim at long-term collaboration profits and remain after archiving single goals. Based on that, organized networks clearly differ from short-time project networks. Further characteristics of organized networks are a particular network identity as well as steering elements on network level. By that, process flows within the organized networks can be standardize, which allows to use the given time and resources efficiently and innovation supporting. To obtain these benefits, a steering, focal (central) instance need to perform the administrative tasks [33, 23]. Regarding research networks, a focal entity, usually university-close, manages the network administration.

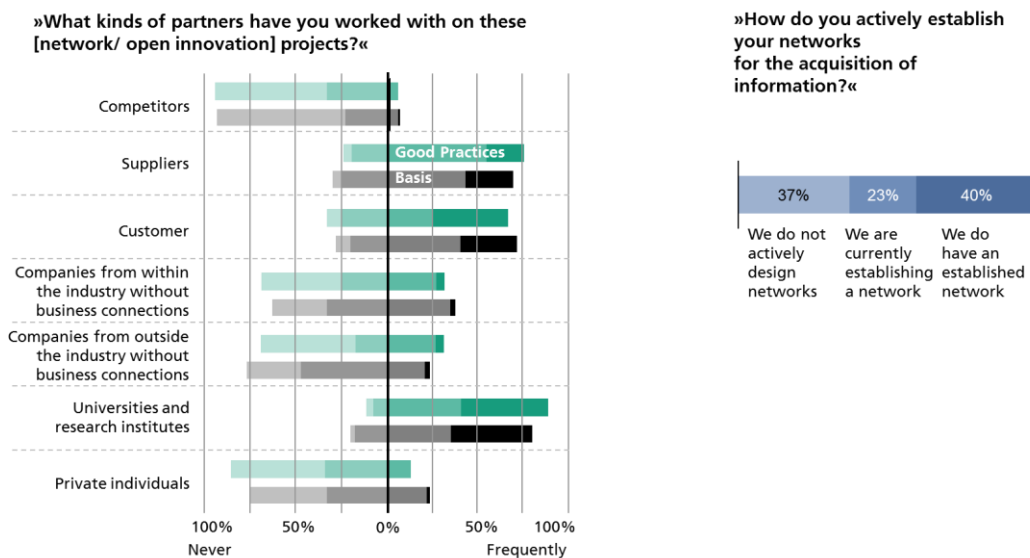


Figure 2: Usage of cooperations in practice [25, 24]

Incentives for a successful research network can be implemented by rewarding the focal entity with a bonus for the network management. The bonus for the focal entity is justified by the gained profits of all network partners due to coordinated network activities [20].

The high attractiveness of the performed research activities is essential for the commitment and continuation of the network partners and is therefore crucial for the long-term survival and success of the research network. However, network members have different aims regarding strategy and cooperation. [33, 23, 35]. The network success can be significantly influenced by the misconduct of individual partners like opportunistic behavior by conscious deduction of foreign knowledge [36, 29, 28]. Additionally, secrecy and distrust may lead to an information asymmetry between partners, which results in inefficacy and inefficiency in network activities [37]. A striking attribute of research networks is that the members are legally and economically independent and that they want to keep their entrepreneurial freedom [23, 35]. Since members see themselves as independent and equivalent, the control of multilateral research networks through third parties – such as a university-close focal entity – cannot be taken for granted. The management control through third parties is one of the main differences compared to so-called strategic networks. These represent value networks which allow the steering through a focal company due to economical connections e.g. the supply chain [35, 23].

Hence, the governance organization of research networks operates in a field of tension between leadership and flexibility, see Figure 3. Leadership is necessary to obtain efficiency in a network while efficacy is achieved through flexibility [20]. In addition, there exists a second field of tension between joint network interests and individual company interests. Besides focusing on the own company's interests, collaboration results can also be evaluated differently by an individual company and the joint network regarding the outcome-value [23, 38]. These factors are able to influence the success of a research network significantly.

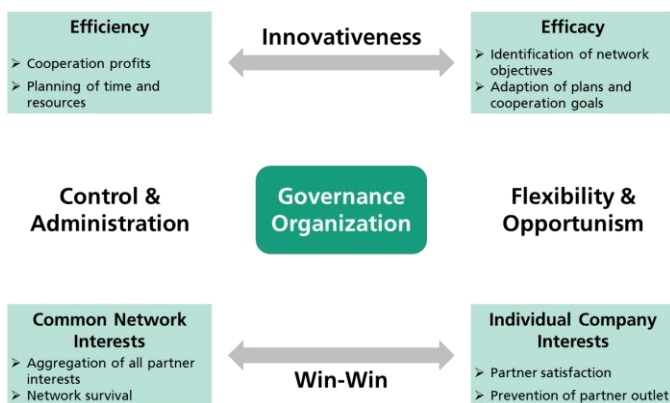


Figure 3: Governance challenges of research networks

To assure network success, an effective and efficient network management has to shape, steer and develop the research collaboration systematically as a sociological-technical system. Therefore, collaboration of the members, initiation of collaboration projects, segmenting of the tasks and roles as well as control and evaluation of the cooperation-structure must be organized. Central steering and coordination of the network are of particular importance for the collaboration [22]. Also, upcoming management costs are supposed to be kept as low as possible to prevent a reduction of collaboration profits, which makes the network governance even more difficult [23, 27]. That is why competitiveness and success of the research network are correlating strongly with the management performance of the focal entity [26].

IV. RESEARCH DEMAND

The resulting practical deficit consists in the unsystematic coordination of the collaboration, which prevents the network from reaching top-level research. There is no systematic approach for network officials to choose and combine organizational elements for steering such focal-organized, self-financed research networks [35, 23, 33]. Further, the requirements for governing such organized networks are uncertain due to the center type and the specific network characteristic. Besides, there is no overview which contains all potential organizational elements for the governance management.

The theoretical deficit results from the literature's focus on building networks and motivating network members. Leading and steering of networks has been observed barely so far [23, 33, 35]. In existing literature organizational elements for the operation of networks have been named only partly. A comprehensive governance framework for aligning the organization elements regarding their requirements has been investigated only punctually in literature [33, 17]. Thus, a systematic approach to describe the requirements for the operation of a focal-organized, self-financed research network regarding the center type and network characteristic is missing. For far, potential organization elements for the operation of research networks are not defined systematically. It lacks on knowledge regarding possible center-typical and network-specific characteristics. Furthermore, the understanding is missing to how combine management elements in order to form a consistent network organization since the cause-effect relationships between elements and requirements cannot be justified systematically. Efficacy and efficiency losses in the collaboration performance due to an unsystematically configuration of the operation of focal-organized, self-financed research networks are the consequences.

These deficits, existing in corporate practice as well as in scientific theory, motivate to develop a design framework for the governance organization of focal-organized, self-financed research networks, see Figure 4.

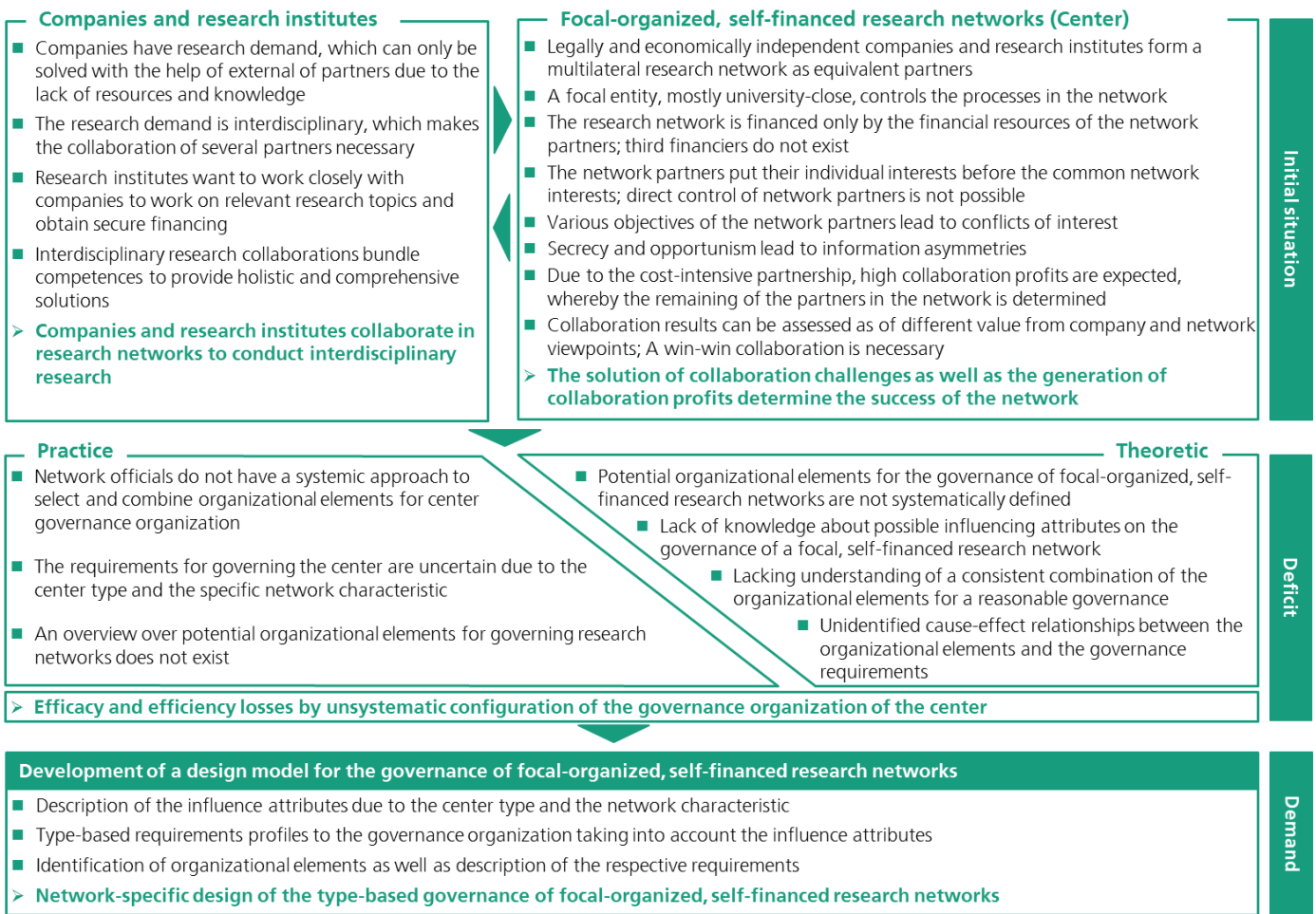


Figure 4: Derivation of the research demand

V. LITERATURE REVIEW

For this kind of cross-sectional research, literature is in particular relevant that addresses the topic cooperations in research and development as well as industry-university research cooperations. Especially, the analysis of organizational instruments such as processes, roles, tools and rules are of particular interest. Therefore, relevant research approaches regarding »cooperation management in research and development« and »network management« have been analyzed. Following, relevant works are listed to show the state-of-the-art in literature, see TABLE I.

TABLE I

SUBJECT FIELDS OF INTEREST AND RELEVANT LITERATURE

Cooperation management in research and development	Hakansson (2009), Ortiz (2013), Dhanaraj and Pharkhe (2006), Zentes (2005)
Network steering and management rules	Provan and Kenis (2007), Glueckler et al. (2012), Sydow (2006), Schuh and Millar (1998), Nollau (2014), Wohlgemut (2002), Noteboom (2004),

A. Cooperation management in research and development

DHANARAJ AND PHARKHE illustrate that governance, or as they call it "orchestration" of innovation networks, consists of the three processes: managing knowledge mobility, managing innovation appropriability and managing network stability [38]. Thereby, social interactions for achieving trust,

information sharing, and joint problem solving are discussed. The network stability is being secured by an administrative hub firm, the orchestrator, which meets network typical threats such as isolation, migration, cliques, and attrition. Managing these challenges increases the dynamic stability of the network and raises the reputation, the future perspective and the diversity. According to DHANARAJ AND PHARKHE [38], the hub firm can increase stability by developing its own strength through its reputation and leadership in the market. Because members seek the legitimacy given by links to the market leader. This motivates the members to remain in the network with the prospect of future gains because the connection between current moves and future consequences is illustrated. By conducting joint projects with network members, the hub firm increases the multiplicity and the scope of relationships. Such actions are coordinated by the administrative hub firm, which results in greater dependency and loyalty towards the hub firm. Thereby, isolation in the network can be prevented. This network stability prevents unstable linkages between network partners and encourages the company to cooperate [38]. However, besides a set of rules for cooperations DHANARAJ AND PHARKHE do not further detail how the processes and roles of the hub firm organization should look like in order to operate the network.

ORTIZ analyses the structural features, which characterize the cooperation between universities and companies in regional innovation systems [17]. The research bases on four cooperation management instruments: selection, allocation, regulation and evaluation [39, 35, 17]. These instruments are further classified by ORTIZ in management mechanisms regarding the regional innovation system between universities and companies. Each mechanism is analyzed regarding the influence for companies, universities and regional innovation systems such as networks [17]. Regarding the regulation of an innovation system between industry and university, ORTIZ identifies that the spatial proximity allows a more effective and efficient management process due to the direct alignment between decision-makers, especially in terms of readjustments of cooperation projects. Thereby, possible conflicts can be avoided. In addition, a central organization for coordination tasks is proposed. Thereby, a harmonization of the cooperation relationships in the network can be achieved [17]. However, besides a set of rules for the regulation of regional innovation systems ORTIZ does not detail further how the management in terms of processes and roles should look like.

In the anthology "Cooperations, Alliances and Networks" published by ZENTES [29] OESTERLE presents an overview over "Cooperations in Research and Development" in which cooperations and their advantages are characterized. Therefore, R&D-cooperations are typecasted and several management challenges are discussed. In the same anthology, GERYBADZE gives an outline of "Technology Alliances and Cooperations". Content of the outline is the organization and steering of medium-term to long-term orientated, cross-company alliances with the goal to gain joint technology profits and innovation. Main aspects of the organizational design and the regulation of the cooperation on the implementation level are portrayed but not detailed [30].

HAKANSSON deals with industrial interaction regarding R&D-cooperations and networks [40, 41]. On the basis of empirical studies HAKANSSON analyses the behavior of companies within research and development networks and demonstrates the significant meaning for the corporate success. Especially networks consisting of customers and suppliers are within the research focus. Summed up, HAKANSSON points out the impact of networks on technological innovations without detailing the organizational design [40].

B. Network steering and management rules

PROVAN AND KENIS analyze the governance of organized networks and its influence on network effectiveness [33]. Thereby, it is distinguished whether the network is self-organized or organized by an administrative organization, the broker. Further, the brokered networks are distinguished in participant governed or external governed networks. Because self-organized governance can result in inefficiency, a single network participant most commonly acts as a lead organization, e.g. in vertical value chain relationships. For the external governed networks, a separate network administrative organization (NAO) is specifically created to

coordinate the network and its activities. The NAO "may be either voluntarily established by network members or mandated as part of the network formation process" [33]. Due to the unique administrative structure of the NAO, a larger number of diverse participants can be handled in the network. The NAO is preferred when working together is difficult because competitive pressure makes network partners reluctant to cooperate and share information. NAO are more committed to network goals and more involved in the future of the network. PROVAN AND KENIS formulate propositions to examine the conditions for the effectiveness of each form. Therefore, the tensions in each form and the role of the management addressing these tensions are discussed. PROVAN AND KENIS conclude that organized networks generally archive more stability while self-organized networks allow more flexibility. Self-organized networks realize more partner inclusion whereas member-organized networks allow a better efficiency. However, NAO-governed networks accomplish a balance between integration and efficiency. Furthermore, it is illustrated that self-organized networks might lead to inefficacy which is why they evolve to a brokered form during their lifetime [33]. The analyses made by PROVAN AND KENIS are relevant because they show the importance and benefits of a network steering. Additionally, they indicate which organizational forms are most suitable for cooperation projects in the research network.

GLUECKLER ET AL. analyze horizontal organized networks that contain competing companies of the same value chain level. Therefore, network architectures, network structures and participating parties are analyzed [23]. Regarding the discussed context, the controlling systems are mainly relevant. GLUECKLER ET AL. examine the link between the type of coordination and the innovation success. For this purpose, the coordination instruments "self-alignment", "centralization", and "process standardization" are evaluated in an empirical study. The analysis shows that the process standardization followed by the centralization has a strong influence on the innovation success of networks. Self-alignment, however, has only little influence, especially in more established networks. If communication only bases on self-alignment, from the perspective of an independent company no incentive to contribute to the common network objective exists [23]. The joint innovation work in the network can be regulated by rules to prevent fraud, opportunism and knowledge drain [38]. Furthermore, the existence of formal and binding processes acts positively on the successful work and the achievement of network objectives. Standardization can therefore lead to high innovativeness if formally processes ensure a smooth operation between the members to enable knowledge exchange and innovations [42, 23]. GLUECKLER ET AL. conclude that the central aspect of network governance is to standardize processes, responsibilities, and communication structures. Due to process standardization, time and resources can be used more efficient to promote innovation. Furthermore, GLUECKLER ET AL. conduct an analysis of the most used controlling instruments and show the relationships

regarding specific network objectives. Based on that, the controlling instruments are categorized. In addition, GLUECKLER ET AL. develop a method to analyze the legitimacy of network governance structures, cf. [33]. Based on an empirical analysis GLUECKLER ET AL. [23] show that a deviation between planned and lived governance structure due to the distribution of legitimacy exists. Thus, formalized governance structures such as steering committees should include informal but legitimate and accepted partners in the decision finding processes of the network as well. Neglect may even raise conflicts. However, the work of GLUECKLER ET AL. represents an important literature basis although it does not discuss details regarding necessary roles and processes for the network governance.

SYDOW has been concentrating on the management and governance of networks in many of his works [39, 43, 35]. Especially in the anthology "Management of Network Organizations" SYDOW illustrates the latest developments in research regarding cooperate networks and their management. Thereby supplier networks are focused. Knowledge-intensive networks are investigated as well but must be classified to the software and financing industry. The articles focus on the management, the evaluation and the optimization of cooperations. In addition, sociological aspects such as trust in networks and the chances and risks of cooperations in networks are discussed. As a whole the work does not aim to constitute a standardized systematic for the development and management of a corporate network [35]. In the volume "Steering of networks" SYDOW and WINDELER develop steering elements for the network regulation [43]. These steering elements influence the design of the business processes and include six levels: selection, allocation, evaluation, system integration, position configuration and border constitution [43]. Thereby, a differentiated distinction of the important steering elements is made for the first time. This distinction defines the central elements of the network organization such as the selection of the network members, the differentiation of the network to its environment, the process management, the allocation of network resources and revenues or the goalsetting and valuation of the target achievement. Hence, the steering of networks consists of strategic and operational objects which have to be used efficient to ensure the cooperation profits of the network members. The network regulation is performed by network coordinators that own the legitimacy to operate representative for the network [43]. The work of SYDOW et al. represents a valuable part for the roles and tasks in the organization of research networks.

DAVIDOW AND MALONE illustrated in the 1990ies the virtual corporation [44]. Based on that, SCHUH AND MILLARG introduce the Virtual Factory, which is a guided enterprise network in the form of a virtual enterprise in order to coordinate production [45, 46]. The intention of a Virtual Factory lies in the production of ordered products. The structural concept of the Virtual Factory consists of two levels: stable platform, which contains all network partners, and virtual factories, which are dynamic order-related,

temporary value network. The entire Virtual Factory is coordinated by self-organizing forces. A focal network company that coordinates is not intended. The stable platform enables transactions regarding business or social nature between the participating independent companies. Based on the existing potential for cooperation enabled by the stable platform, the companies combine themselves depending on their competences in new dynamic order-related virtual factories. After the order processing, the virtual factories dissolve and the involved partners return to the stable platform. Therefore, the existence of the virtual factory is only temporary. The stable platform undergoes a continuous change, due to further development of individual companies, the optimization of links in the network and the integration of new companies as well as exclusion of existing partners. SCHUH AND MILLARG also describe the needed roles within self-organization for the Virtual Factory. Main role is the broker that acquires new orders for the network. The competence-based configuration of the virtual factories is conducted by a performance manager. In-/outsourcing managers are responsible for communicating their companies' competences and capacities for use in the order-related virtual factories. The required stability during order processing of the activated network is ensured by the central role of the contract manager. The network relationships are managed by a network coach. An auditor examines the conducted work and watches the compliance of network rules. Besides these network roles, a process for the inclusion of new partners as well as a set of guidelines describing the quality of the order are illustrated. Further organizational details for operating the stable platform as well as the dynamic virtual factories are not described in detail.

However, in newer research SCHUH recommends a focal management instance, which coordinates the Virtual Factory to enable more efficient work especially in terms of initiating cooperation projects [47].

Based on the Virtual Factory, NOLLAU presents in [28] a concept of the virtual technology development enterprise, which combines order-related a specific pool of partners to conduct an interdisciplinary technology development for a customer [19]. The order confirmation as well as the configuration of the project partner pool is coordinated by a focal entity of the network, the central coordinator (broker). The central coordinator also has the central decision-making authority as well as the responsibility for the success of individual projects. Therefore, the central coordinator also assesses the companies for becoming partners in the network. The network partners also have codetermination in terms of a pool committee and project steering groups, but are mostly responsible for conducting the actual technology development. NOLLAU further describes how based on competence profiles the suitable partners are selected for the specific technology project. In addition, NOLLAU describes the development process within the cooperation project.

However, the operating organization like processes for strategy alignment or controlling as well as necessary tools of the focal entity are not further described by NOLLAU as well

as *SCHUH*.

By performing a detailed analyze of research contributions *WOHLGEMUT* develops a reference framework for the management of corporate networks [48]. Furthermore, he takes a look at three practical case studies to examine the management of network-like virtual cooperations. Without focusing the network purpose necessary tasks are classified and typical performance structures are discussed. Based on the findings, *WOHLGEMUTH* develops a model for the comprehensive coordination of the network partners. The model includes the development of a network constitution, the evaluation of the network success, the coordination of collective strategies, the selection of partners, the promotion of a joint network culture and the steering of conflicts [48]. These elements of the network management represent an important basis of the research intention.

In his works *NOOTEBOOM* examines cross company cooperations [14, 49]. He develops an integrated theory of cross company cooperations, which includes the network structure, the management of networks and the formation process of a network. Regarding the contents of this paper his conclusive and comprehensive approaches have a big relevance [14].

In total, the literature insight shows that some aspects of the investigated topic can be realized with existing literature, considering especially the rules of the network management and some management elements. However, there is no holistic solution approach for the operation of focal-organized, self-financed research networks which allows a systematical derivation of management elements with regards to the aims of the network and its characteristic.

VI. CONCEPTUAL RESEARCH METHODOLOGY

To face the discussed challenges for network governance, a solution approach is proposed in the following. It consists of five submodels which are connected among each other. The connections exist in terms of effect mechanisms and correlations. Every submodel includes a completed and describable partial aspect for the design of the network governance framework. In Figure 5 this conceptual research methodology is illustrated.

At first, different *center types* need to be characterized regarding their performance mandate (economic objectives etc.) by using different attributes and specifications. Therefore, existing focal-organized, self-financed research networks need to be analyzed, including expert interviews. In a next step, the *network characteristic* of the belonging research network with its partners is identified using literature research and discussions with network officials. The network characteristic is described by its attributes and specifications regarding the influence on the governance of the center. After describing the center type and the network characteristic, the created contents are used to develop a model which describes the *requirements* to operate a focal-organized, self-financed research network. To do so, the impact of the network characteristic on the performance mandate of the center type is investigated. Based on the determined center type, generic requirement profiles for the governance of focal-organized, self-financed research networks are derived with regards to necessity and qualitative requirements of a certain organizational task.

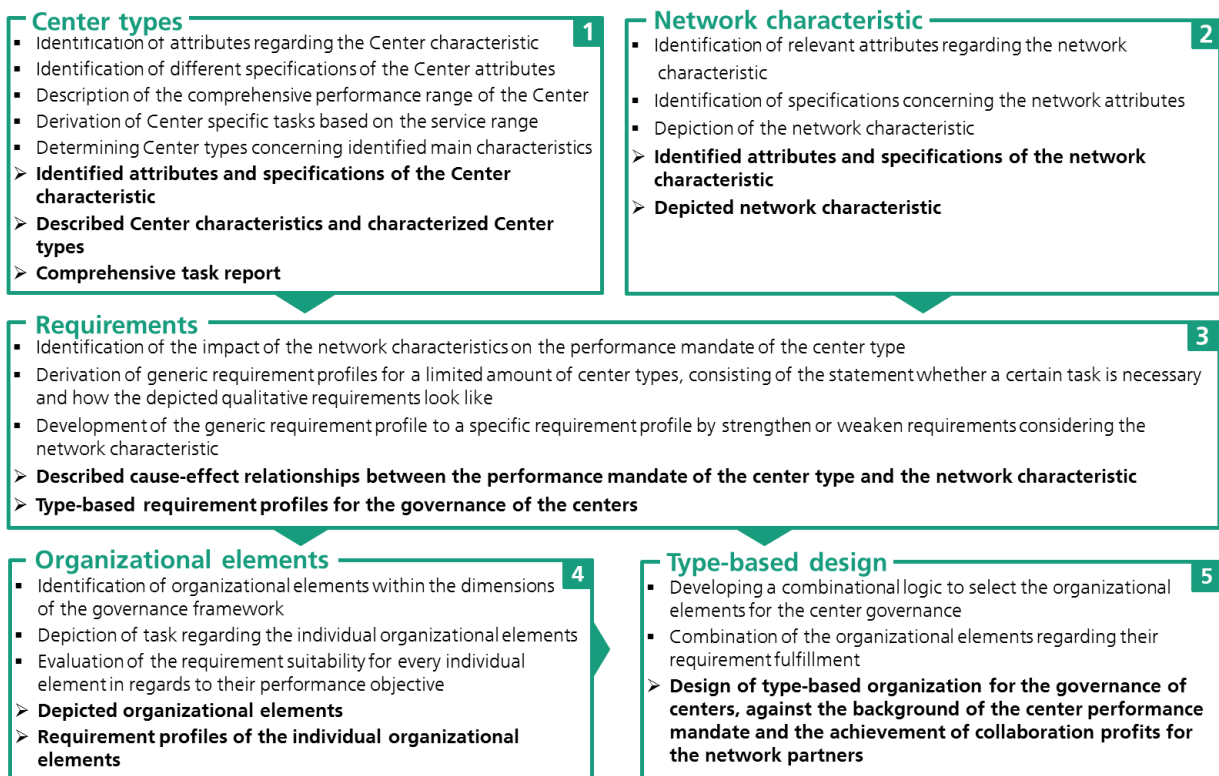


Figure 5: Conceptual research methodology

Subsequently, the generic requirement profile is evolved to a specific requirement profile by strengthening or weakening requirements, depending on the specific network characteristic. The results of this submodel represent requirement profiles for the identified center types that contain qualitative requirements for the network governance. Then, with the help of literature analysis and interviews with network managers, relevant *organizational elements* are identified and structured within a framework. These elements represent design elements of the governance organization of the focal-organized self-financed research network and fulfill single or multiple tasks. Besides the identification and description, the design elements are evaluated in terms of requirement suitability for specific organizational tasks. Finally, in the submodel *type-based design*, a combinational logic need to be developed to combine individual design elements concerning their suitability per requirement profile to build the governance organization. Result of this research methodology is to provide a governance organization for a focal-organized, self-financed research network, depending on the specific center type and network characteristic.

Following, the necessary submodels are discussed in more detail. Therefore, the objective, the planned approach to reach the objective and the final result of every submodel are described.

Submodel 1: Center types

In submodel 1 the different types of focal-organized, self-financed research networks shall be described. Based on the attributes and their specifications a limited number of center types is identified. By describing the performance mandate of a center type, requirements for the governance organization can then be derived in submodel 3.

To identify governance related attributes of the center type a comprehensive analysis of existing centers and research networks in practice and literature is performed. Thereby, it is distinguished in “type-building” and “detailing” attributes. In a next step, specifications of the attributes are determined. Based on practical experience relevant center types are identified out of the numerous possible combinations. Next, the resulting organizational tasks regarding the attributes and specifications are described in order to deviate the type-based governance requirements in submodel 3.

Result of submodel 1 is to hand over the governance relevant attributes and specifications to submodel 3, e.g. in form of a morphologic box. Attributes in submodel 1 might be center typical aspects of the performance degree and the performance spectrum. Also relevant center types (ideally 2-3) are identified, see Figure 6.

Submodel 2: Network characteristic

Within submodel 2, relevant impacts of network characteristics on the center governance are analyzed. A detailed explanation of attributes and specifications of the network characteristics enable the determination of network specific requirements in submodel 3.

To identify possible influencing attributes of research networks a literature analysis and expert interviews with network officials in research and practice are performed. Subsequently, the influence of attributes and their

specifications on the governance are analyzed. To do so, the requirement categories from submodel 3 are respected.

Result of submodel 2 is a depicted network characteristic which has influence on the governance design, see Figure 7. Network specific attributes that influence the network management might be for instance the numbers of partners, the spatial proximity or the intensity of competition.

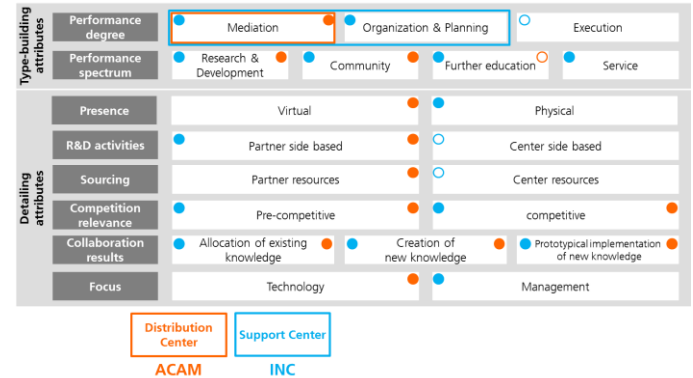


Figure 6: Center characteristics with examples for possible center types (extract)

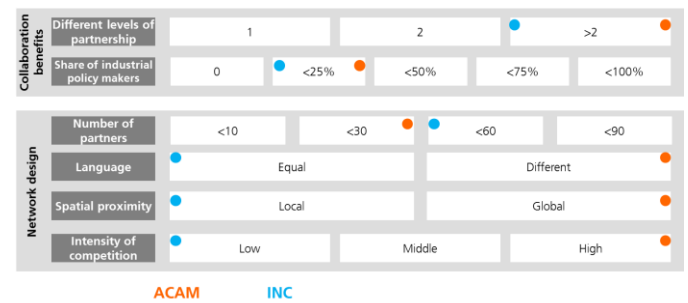


Figure 7: Network characteristic with examples (extract)

Submodel 3: Requirements

In submodel 3 requirement profiles are built to enable the type-based design of the governance organization in submodel 5. Therefore, the influencing attributes from the previous submodels are transferred in governance requirements.

For this, the cause-effect relationships between network characteristics (specific influencing attributes) and the performance mandate of the center type (generic influencing attributes) are analyzed. Based on the number of identified center types in submodel 1, generic requirement profiles are created with regards to the organizational tasks. These generic requirement profiles include the statement whether a certain organizational task is necessary and what the qualitative requirements regarding the task are (e.g. regarding the requirement categories: information transfer, information density, coordination effort). For instance, some tasks might not have any importance for certain center types (e.g. “develop further education programs” may not need to be fulfilled for a research-only center). Subsequently, the generic requirement profile is developed to a specific requirement profile by using the network characteristics to strengthen or weaken generic requirements (e.g. requirements for the

governance of an international, big center differ from requirements for a national, small network).

Result of submodel 3 are type-based requirement profiles that take the center type and the network characteristic into account. The requirement profile contains qualitative requirements for the organizational tasks of a specific center type, see Figure 8.

Legend: +++ High requirements
 ++ Middle requirements
 + Low requirements
 0 No requirements

Tasks	Requirement categories				
	Information transfer	Information density	Coordination effort	Collaboration	...
Alignment of the Center strategy	++	++	+++	+	
Mediation of partners	+	+	++	0	
Identification of project topics	+++	+++	+++	++	
Project planning	++	++	+	0	
Project choosing	+++	+++	+++	++	
Project conduction	++	++	+++	+++	

Figure 8: Requirements for the governance of a center type (extract)

Submodel 4: Organizational elements

Aim of submodel 4 is to describe necessary organizational elements for operating the center. Thereby, the organizational elements are structured within a framework and assessed with regard to their requirement suitability.

To identify organizational elements present literature is utilized. Additionally, interviews with experts and officials that deal with the governance of research networks in industry and in research landscape are conducted (e.g. within workshops and consortial benchmarks). These identified organizational elements are systematized regarding their relevance for network governance. The selected organizational elements are then structured within a framework consisting of fields: processes, roles, tools, rules etc. The evaluation of the requirement suitability can take place quantitatively or qualitatively, e.g. by a four-staged ordinal scale (high, middle, low or no requirement fulfillment). Following, a requirement suitability profile is created for every organizational element.

Result of submodel 4 are systemized organizational elements that can be used to design the governance organization of research networks, see Figure 9. In addition, the organizational elements are assessed regarding their requirement suitability to obtain requirement suitability profiles, see Figure 10.

Processes	Alignment	Online	Bilateral at partner side	Joint workshop	
	
Roles	Focal Entity	Center Manager	Network Coach	Resource Manager	Auditor
	Partner	Decision-maker	Expert	Auditor	
Tools	Sharing	Knowledge base	Communication platform	...	
	Planning	Radar	Roadmap	...	
	Laboratory	Test bench	Theme park	...	
	
Rules	Discussion	Free	Moderated	Mixed	
	

Figure 9: Organizational elements of the governance organization (extract)

Organizational element Tool: Radar

Legend: +++ high suitability
 ++ middle suitability
 + low suitability
 0 no suitability

Tasks	Suitability level				
	Information transfer	Information density	Coordination effort	Collaboration	...
Coordination of the Center strategy	++	+	++	0	
...
Project planning	+	+	+	0	
...

Figure 10: Example for a requirement suitability profile of an organizational element

Submodel 5: Type-based design

Objective of the type-based design is to combine organizational elements according to the requirements in order to build a consistent governance organization of focal-organized, self-financed research networks. Main task of the submodel is to develop a combination logic for selecting the fitting organizational elements for the governance organization.

The development of a combination logic helps to generate reasonable combinations out of the different organizational elements. Thus, submodel 5 connects type-based requirement profiles from submodel 3 with organizational elements from submodel 4, since the models contain requirements on the one hand and elements for the requirement fulfillment on the other hand. The combination of the organizational elements is conducted with regard to the requirement suitability. That way, the particular organizational tasks due to the center type and the network characteristics are aligned to the fitting organizational elements.

Result of submodel 5 is a concrete design of the governance organization for a certain center type depending on the specific network characteristic. In other words, the user obtains a design model which shapes network-specifically the governance organization of center types. At first, the user chooses a center type and characterizes the research network. Appropriate attributes are transferred in the model for the type-based design, which combines organizational elements by comparing them with requirements for a coherent governance organization of the focal-organized, self-financed research networks, see Figure 11.

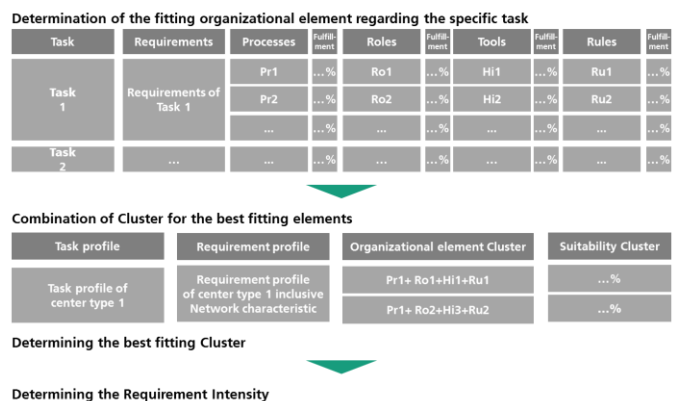


Figure 11: Type-based design of the operation

VII. SUMMARY AND DISCUSSION

Increasing costs and risks in research and the need of unique interdisciplinary know-how results in collaborations of companies and research institutes in focal-organized, self-financed research networks. Thereby, a focal entity provides the governance framework with the objective to conduct administrative tasks and to organize processes within the network in order to prevent network failure. Network failure is possible, because network activities can be affected by various conflicts due to independent network partners with different goals and own interests. Therefore, a governance organization plays a crucial role in order to gain collaboration profits for all network partners. Within this paper, a literature review of relevant research regarding the fields: "cooperation management in research and development" as well as "network steering and management rules" has been presented. In literature, different types of governance and organization structures as well as sets of rules are discussed well. However, specific design elements in terms of processes and roles for a governance organization are rarely named. A superior framework for the governance organization to align the management elements in terms of the specific requirements regarding center type and network characteristic has not been focused in research yet. Based on the identified deficits in literature and practice, a conceptual research methodology for designing the governance organization of focal-organized, self-financed research networks has been illustrated. The approach consists out of five submodels that relate to each other. Submodel 1 and 2 depict the individual center type and network characteristic to determine in submodel 3 the requirements of the governance organization. Within submodel 4, organizational elements are described respectively to their specific requirement suitability. Finally, in submodel 5 a type-based design of the governance organization is conducted by combining organizational elements with regard to their requirement fulfillments. In future research, the submodels need to be detailed further. Furthermore, the framework needs to be transferred into a user orientated application to ensure usability for the network governance.

VIII. REFERENCES

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