

Managing to Facilitate Cross-Sectoral Inter-Organizational Collaborations: Findings From the Experience in Germany

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ABSTRACT

The promotion of new and competitive industries through cross-sectoral inter-organizational collaborations are tackled in many regions globally. This study explores the management of facilitating collaboration with consideration of the planned approach to change based on change management theory. The “initial conditions,” “field,” and “emerging interaction toward the collaborations” are clarified as key elements for management through intervention. It is considered how these interventions are implemented on these elements. A conceptual model for considering comprehensive management of the self-organization process toward collaboration is proposed. In the case study, experiences of the medical technology industry of three German states are examined. The activities of cluster organizations of these states, which provide services to facilitate cross-sectoral collaborations, are scrutinized. The results of the case study are comparatively analyzed, and the modified conceptual framework is depicted by reflecting the findings of the study. The implications are then discussed.

KEYWORDS

Complexity, Emergent Interaction, Field, Initial Conditions, Inter-Organizational Collaborations, Intervention, Planned Approach to Change, Self-Organization

INTRODUCTION

The promotion of new and competitive industries through cross-sectoral inter-organizational collaborations is tackled in many regions of the world. This is done by utilizing the advantages of network organizations to adapt, compete, and survive in industrial districts where economic and industrial environments are increasingly becoming dynamic, complex, and interconnected. Here, the key is facilitating the self-organization process of a number of diversified actors.

First, this study discusses that inter-organizational collaborations, a type of network organization, is formed through a self-organization process, which is characterized by complexity; therefore, it requires intervention. Second, considering the planned approach to change based on change management theory, it is clarified that the initial conditions, field, and emerging interaction toward the collaborations are the key elements to be targeted in management through intervention. Third, the method of intervention in the key elements for facilitating the self-organization process is considered, and a conceptual model is proposed. In the case study, focusing on the medical technology industry, the experience of three areas in Germany (North Rhine-Westphalia, Bavaria, and Baden-Wuerttemberg) are studied by focusing on the facilitators of cross-sectoral collaborations. Finally, the results of the study are comparatively analyzed, and the validity of the conceptual model is scrutinized. Management implications are then considered.

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REVIEW OF RELATED LITERATURE

Formation of Inter-Organizational Collaboration Through a Self-Organization Lens

Network organizations are characterized by the strength of flexibility and innovativeness. Here, inter-organizational collaboration is a type of them. This type of organization can learn/adapt from the environment, perform flexible transformations, and create new organizational structures through self-organization (Baker, 1992; Miles & Snow, 1995; Knoke, 2001; Imada, 2008). Joham et al. (2014) explain that self-organization is “the ability of a non-centralized system to create a strategic response to a change in its environment” (p.2376). It is argued that self-organization is characterized by pattern formation, autonomy, resilience, robustness, adaptability, and dynamics (Wolf & Holvoet, 2005; Gilbert et al., 2015). Pyka and Windrum (2003) show that, in the self-organization process, small-scale interaction produces a “field” at the macro level; in turn, it influences and modifies activity at the small-scale phenomenon. On the other hand, it is also argued that the self-organization process is characterized by complexity because historical development is relatively open (Fuchs, 2003; Heylighen, 2013; Plowman et al., 2007). To increase the possibility of certain paths to be taken and others to be avoided, Fuchs (2003) explains that subjective factors are needed and presents a human intervention as an example. This implies “intervention” is required to increase the possibility of inter-organizational collaboration toward a certain direction, and “field” also influences and modifies the activities of individuals.

The approach to facilitate the self-organization process can be further scrutinized. Imada (2008) introduces the concept of goal-directionality and proposes that the process can be facilitated intentionally through intentional intervention. The intervention is implemented by a control center (hereafter, the “management layer”), which performs the role of supporting to facilitate the bottom-up movements of structural change of social systems, which appear to be equivalent to field. He shows that bottom-up movement is activated by changes in the environment and changes in the needs and values of members of the social system. In this context, the role of the management layer is “to read new values and desires in fluctuations, distinguish order parameters” (p.30). Moreover, the layer is required to determine the direction to employ and accelerate the synergy of the members by influencing the social system. This helps create an environment for facilitating spontaneous order formation by accelerating the interactions of people.

For further development of the argument, the view of change management theory appears to provide insight into a more systematic approach for directing the self-organization process.

Planned Approach to Change Toward Self-Organization

Based on the study of Kurt Lewin’s work, Burnes (2004) stresses the concept of “felt-need” and explains “change can only successfully be achieved by helping individuals reflect on and gain new insights into the totality of their situation” (p.984). He describes Lewin’s view that change is a complex, unpredictable, and iterative learning process, and stability is quasi-stationary and fluid. Therefore, outcomes cannot be predicted because of non-linearity but emerge on a trial-and-error basis. In response to it, he shows “field theory,” “group dynamics,” “action research,” and “the stage model (3-step model)” with a unified view and proposes that all four elements are “necessary to understand and bring about planned change, whether it be at the level of the individual, group, organization or even society” (p.981).

The unified view by Burnes (2004) provides a robust approach for management to change under complexity, where the self-organization of diversified actors is deployed. In facilitating the self-organizing process of inter-organizational collaboration, the management is considered, and there are some implications from this argument. First, group behavior, involvement, and empowerment through learning is important, as this enables individuals to understand and restructure their perceptions of the world around them and share felt-need. Second, the field, which is accompanied by group dynamics, brings a variety of people together and accelerates emergent interaction to change self-organizationally

toward the collaboration to achieve a certain goal. Lastly, a process/method, for example, action research based on the stage model, is required to facilitate the change more systematically. This corresponds to the “intervention” proposed by Imada (2008) and Fuchs (2003).

Targets of the Intervention

Considering the argument thus far, the management, to facilitate a self-organization process toward inter-organizational collaboration, is required to consider the following key elements as the target through “intervention.”

- (1) A felt-need must be fostered. For that, it is necessary to recognize the “initial conditions” to help people reflect on and gain new insights into the totality of their situation (Burnes, 2004).
- (2) “Field,” which is set up based on the felt-need.
- (3) Under the field being set up, facilitating “emerging interaction” is required for inter-organizational collaborations.

In the following section, the targets of management through intervention are examined.

Initial Conditions

Several studies have shown the factors “preconditions,” “antecedent conditions,” and “initial conditions,” which positively and negatively affect the process of establishing and promoting inter-organizational collaborations (Whetten, 1981; Chen, 2008; Bryson et al., 2006; Gray, 2008; Bryson et al., 2015). Moreover, considering the effect of embeddedness, social networks are also argued to be positive as well as negative contributors (Granovetter, 1985; Gulati, 1998; Gulati & Gariulo, 1999; Lazzarini et al., 2008). These factors can be summarized as:

1. Macro-environmental factors of institutional and sector level (summarized in Table 1).
2. Micro-environmental factors of business strategy and organizational level (summarized in Table 2)
3. Social networks which also contribute positively and negatively, are considered intermediate because they can be considered in both macro- and micro-environmental factors.

Field

The field was introduced in social science by K. Lewin’s work in the 20th century, and the theory was developed as the foundation of planned change by affecting the behavior of individuals and groups (Burnes & Cooke, 2013). The field is the environment and works as a device to facilitate interaction, which enables people to attain mutual understanding and self-organization toward a new order (Itami, 1999). Itami also proposes that the field can be established and refined by combining the approaches of emergent and setting-up. This implies that there is a cyclical process in which the established field gives directions of behavior to individuals/groups; then, the behavior reconfigures the meaning of the field concerning environmental factors. This process enables the field to sustain the continuous state of adaptation (Burnes, 2004).

Table 1. Initial conditions: macro-environmental factors

Positive factors	Negative factors
<ul style="list-style-type: none"> • Mandate by law and regulation • Incentive by the government or other interested parties • Common opportunities arising from changes in institutional environments • Existence of support to promote the collaboration • Social compound factor • Unstable environment in competition and institutions • In the case that efforts within single sector cannot achieve their objectives 	<ul style="list-style-type: none"> • Conflict and mutual distrust • Impediments by the economy and the government • Difference in power between partners • Cultural and commercial practices

Table 2. Initial conditions: micro-environmental factors

Positive factors	Negative factors
<ul style="list-style-type: none"> • Commonality of the domain to be solved and a common understanding of the problem • Need for complementary management resources of partners, including supply capabilities, specific expertise and technologies, geographic scope, access to local knowledge and people, and cultural/linguistic capabilities. • Pursuing efficiency and scale economies • Awareness of the need for active coordination for building relationships • Interdependency • Ensuring legitimacy by partnering with reputable partners or to meet the requirements of financing institutions • History of active communication, sharing of information, knowledge, demonstrated ability and goodwill, and trust through past collaboration • Realizing that continued rivalry is more damaging than bringing it together • Organizational capabilities of individual organization, such as personnel and flexibility etc., for maintaining the relationships 	<ul style="list-style-type: none"> • The poor vision of the domain • Perceiving the loss of dominance (by each of the entities) • Awareness of the loss of support of constituents • Internal conflict between partners

Emergent Interaction Toward Inter-Organizational Collaboration

Related to the self-organization process toward inter-organizational collaboration, Follett (1927) describes the process of cooperation between organizations and focuses on personal interactions and relationships. Moreover, Koschmann et al. (2012) explain that communication in the interaction is developed, and the process is composed of text-conversation dialectic. This process can be scrutinized

more concretely by referring to several studies that show the recursive process of self-organization toward inter-organizational collaborations (Schacter, 1951; Turner, 1962; Hartman & Johnson, 1990; Nicotera, 2013). Here, first, the emergent interaction between individuals brings coherence of attitude and action. Second, a social group is generated; then, the group sets the common goal and starts interaction to achieve it. Lastly, the entity is established to be accompanied by a defined role, established project, and the form disseminated to the broader public and audiences.

Management Through Intervention

Lastly, the management to facilitate the self-organization process toward inter-organizational collaboration is considered by focusing on the intervention on the targets above.

First, regarding the purpose of intervention, Gray (2008) explains the intervention is “to improve the quality and the likelihood of alliance success” (p.665) by exerting an influence on the interactions among alliance partners through “reducing restraining factors or increasing driving factors” (p.668).

Second, the view proposed by the argument of leadership under complexity, which is featured by enabling emergence (Plowman et al., 2007), organic (Baker et al., 2011), and integrative change leadership (Crosby & Bryson, 2010), appears to be effective for considering the intervention implemented in a complex self-organization process. To perform leadership under complexity, action research-based intervention appears to be a suitable approach to facilitate the self-organization process toward inter-organizational collaboration. This aims to involve and foster group, organizational, and societal change (Dickens & Watkins, 1999). It also increases adaptive capacity, ability to innovate, and competence in the self-design of systems (Elden & Chisholm, 1993).

Based on the review, the interventions on the targets above are discussed as follows.

Interventions on the Initial Conditions

The aim of the intervention on the initial conditions is to facilitate participatory learning of the situation (including the change in the environment) and share the felt-need for inter-organizational collaborations. This seems to be enabled by learning the initial conditions through “helping individuals to reflect on and gain new insights into the totality of their situation” (Burnes, 2004, p.984). The process can be facilitated by the intervener (the management layer) with an action research method characterized by working collaboratively to observe, understand and reach felt-need, which enables people to clarify the new direction and take action (Dickens & Watkins, 1999) to promote inter-organizational collaborations.

Interventions on Field

The setting up of a field is based on the felt-need to create an environment that works as a device to facilitate emergent interactions toward inter-organizational collaborations.

First, regarding how to intervene in the establishment of the field, some requisites are shown by Itami (1999): 1. Selecting members, 2. Setting basic elements of the field (agenda, code for interpretation, information career, desire for solidarity), 3. Working on members to share the elements; and 4. Designing a micro-macro loop, such as who should communicate with whom. He shows convention as an example of the establishment of the field. Related to this, Gray (1989) explains the functions of the convener: 1. The power to convene stakeholders, 2. Maintaining legitimacy, authority and fairness, 3. Clarifying the purpose of collaboration to understand the potential value of collaboration as well as to organize the area of collaboration, 4. Having the skill for carrying out a cooperative process and forming the details, 5. Specifying appropriate stakeholders.

Second, concerning the refinement of the field, Imada's (2008) argument about the role of the self-organization layer, which facilitates the bottom-up process of self-organization through influencing the social system, provides us with useful insight. The process can be facilitated, first, by receiving information on the changes, identifying the development vector, and creating future images and new goals. Then, it is necessary to facilitate the establishment of new roles, rules for resources,

and structures that include changes in the boundary and members of the field. It is also confirmed that, through the support or inducement by the management layer, the refinement is cycled through feedback from members of the field and changes in the environment.

Interventions on Emerging Interaction

Regarding the formation of inter-organizational collaborations, interveners who facilitate inter-organizational collaborations, called public managers, sponsors, and champions, are discussed in several studies (Thompson & Perry, 2006; Crosby & Bryson, 2005; Bryson et al., 2006). Moreover, it is argued that the role of interveners covers a broad range (Gray, 2008; Kaats & Opheji, 2014; Koschmann et al., 2012; Hogg et al., 2012). The roles are summarized as follows:

- Visioning and shared ambition
- Convening, meaningful participation, and creating intergroup relational identity
- Organizing professionally
- Problem structuring
- Institutional entrepreneurship (shared rule and agreement)
- Reflective intervening
- Doing justice to the interest of each of the partners and managing centripetal and centrifugal forces
- Process design, constructive group dynamics, and sense-making process
- Internal brokering
- Conflict handling

These interventions are implemented by the management layer under the direction of established and refined fields. Moreover, it is proposed that, in the implementation of the intervention, the management layer is required not to impose its intention but take supportive ways to enhance self-reliance efforts (Imada, 2008).

Based on these arguments, the conceptual model for the management to facilitate the self-organization process of inter-organizational collaborations is depicted in Figure 1.

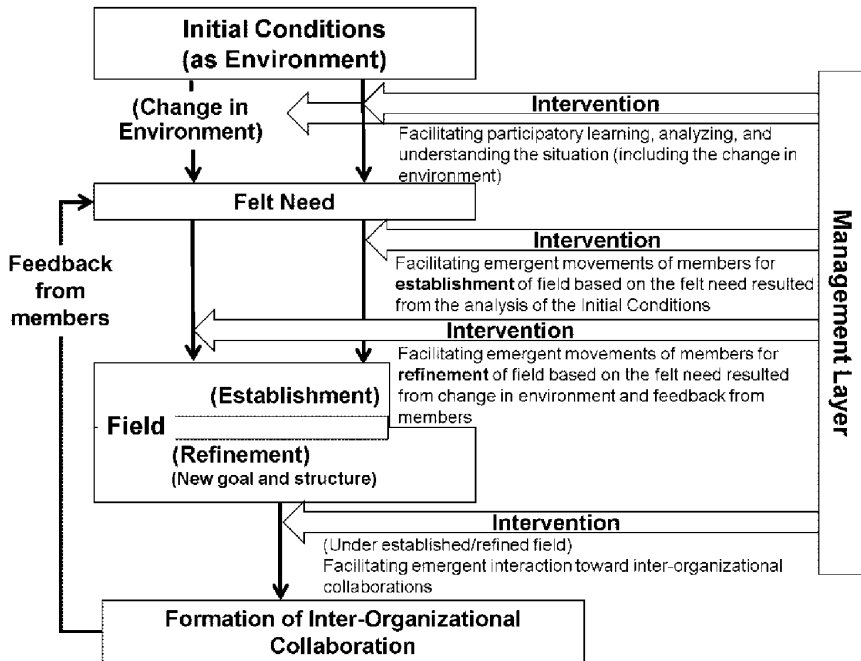
The conceptual model shows a comprehensive approach for the management of targets implemented by the management layer to facilitate the self-organization process toward inter-organizational collaborations.

As depicted in Figure 1, the self-organization process is to learn the initial conditions and share felt-need, to establish the field, and to interact toward inter-organizational collaboration. The process is cycled based on the felt-need by the change in the environment and feedback from members. The intervention is implemented to facilitate the process. This comprehensive management approach to the cycle of the self-organization process, as the stage model proposes, enables members to unfreeze the assumption of actions, to move toward the refinement of the field, and to refreeze for emerging the interaction toward the formation of inter-organizational collaborations in a new direction. The cycling process displays adaptability and robustness in a dynamic environment.

RESEARCH DESIGN

The case study focuses on the movements of the following three states in Germany: North Rhine-Westphalia, Bavaria, and Baden-Wuerttemberg. Cross-sectoral inter-organizational collaborations are facilitated by cluster organizations with the support of the state governments. In this study, the term “cluster organization” refers to an association or a company that provides services (i.e., matching service) to industry and academia to promote a certain industry through cross-sectoral collaborations. Here, the way inter-organizational collaborations between different sectors are facilitated is explored by focusing on movements in the medical technology field in the three states. Since the experiences

Figure 1. Conceptual model: management to facilitate self-organization process of inter-organizational collaborations



are cases where emerging interactions between people from different sectors (for example, industry, universities, and hospitals) toward inter-organizational collaborations are facilitated by the cluster organizations, the cases are appropriate for this study to consider management of the self-organizational process toward the collaborations.

Since this study explores how inter-organizational collaborations are facilitated, following Yin (2003), it is appropriate to clarify the process by conducting a case study that evaluates the interactions between the entities considered an analysis unit.

Data Gathering and Analysis Method

The data used for this case study was collected from secondary sources as well as from interviews with concerned parties. Secondary sources include magazine columns, information on the internet and materials received from the interviewees. Interviews were conducted with the following persons:

1. North Rhine-Westphalia: a staff of Innovative Medizin NRW (interview conducted in November 2017, November 2018, and November 2019), a staff member of the Health Region Cologne/Bonn (interview conducted in November 2017), and a staff member of MedEcon Ruhr (interview conducted in November 2017). Innovative Medizin NRW is a statewide cluster organization in the field of medical technology, and the latter two are the local cluster organizations that deploy in a certain area of the state (like the Ruhr area) in the same field. Since the system was restructured in the field of medical technology and a new system was launched in January 2019, the case study describes the movement before the period.

2. Bavaria: An official of the state government (Bavarian Ministry of Economic Affairs, Energy and Technology) responsible for cluster policy (interview conducted in November 2018). A CEO and a member of the Executive Board of Bayern Innovative, which is an affiliated organization of the state government. The institution supports the activities of cluster organizations (interviews conducted in December 2018). A CEO of Forum MedTech Pharma, which is a cluster organization in the medical technology field (Interview conducted in December 2018).
3. Baden-Wuerttemberg: A staff member of the Cluster Agency BW. The institution supports the activities of cluster organizations in the state as an affiliated organization of the state government of Baden-Wuerttemberg (interview conducted in January 2019). A staff member of Baden-Wuerttemberg International. This is also an affiliated organization of the state government for promoting the internationalization of industries in the state and collaborating with the Cluster Agency BW. A staff member of the Cluster Medical Technology Mannheim, which belongs to the city government of Mannheim as one of the units and operates as a cluster organization in the field of medical technology (Interview conducted in March 2019; Additional interview by email in January 2020).

Regarding the analysis method, this study performs a qualitative analysis of the three cases to elucidate the management approach of facilitating the self-organization process toward inter-organizational collaborations. Thus, in each case, the events are chronologically tracked to explore cause-and-effect relationships. Here, the study ranges from the period when the parties began to interact to facilitate collaborations to the present day. Then, the three cases were compared and analyzed.

CASE STUDY

Background and Scope of the Case Study

The stagnation in the 1990s was the driver for the state governments in Germany to tackle policy making and implementation aimed at strengthening innovation capability and increasing the competitiveness of industries by promoting cross-sectoral collaborations. The policy was called a “cluster program” in which the state governments (and the affiliated institutions) support the activities of industrial networks managed by cluster organizations. The cluster organizations provide services to facilitate the formation of cross-sectoral collaborations for promoting regional industries. Medical technology, where the trend is one of the increasing market size (30.6 billion euro, 4.8% increase in 2017) and which displays a high export ratio (64%, 2.5% increase in 2017), was one of the fields to be targeted for the promotion (Germany Trade and Invest, 2019) (Figure 2).

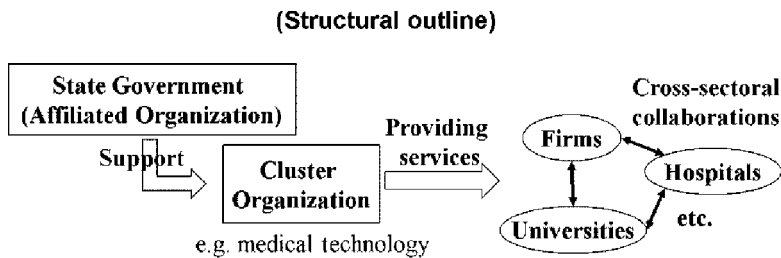
The case study focuses on the experiences of the following three states in Germany: North Rhine-Westphalia (hereafter “NRW”), Bavaria, and Baden-Wuerttemberg (hereafter “BW”). First, the socio-economic environment, the regional systems that promote the cluster program, and cluster organizations of the medical technology field in the three states are analyzed. Then, the initial conditions that the cluster organizations faced are clarified, and how they learn and react are examined. Moreover, the measures of the cluster organization for facilitating cross-sectoral collaborations are described by focusing on the establishment/refinement of the field and the emerging interaction.

Based on the conceptual model above, in the next part, the case study is analyzed and interpreted to consider how the cluster organizations manage to facilitate cross-sectoral inter-organizational collaborations.

Overview

In the following section, the socio-economic environment, the regional systems that promote the cluster program, and cluster organizations of medical technology in the three states are summarized. The details are described in Tables 3–5.

Figure 2. Structural outline of the regional system to facilitate cross-sectoral collaborations (e.g., medical technology industry)



Socio-Economic Environment

The scales of the three states are relatively large in Germany in terms of population and economy. They also benefit from locational advantage with the large market in surrounding areas and economic integration in the European Union (EU). On the other hand, they also face competition with other developed economies as well as emerging countries, especially East Europe, which is close to them and gaining competitiveness due to low cost and qualified labor (Iwamoto, 2015). Among them, NRW faced the most apparent problem of declining leading industries (mining, metal, and steel), which was accompanied by serious job losses (Ache, 2002). This factor still negatively affects the economy (lower GDP per capita and higher unemployment rates compared with those of the other two states). In any case, all the states faced a decline in traditional industries and were met with the necessity to develop industries in new areas.

Regional System

The regional systems of the three states aim to promote the policy (cluster program) of increasing innovation capability and promoting competitive industries. They support the activities of the cluster organizations that facilitate cross-sectoral collaborations (Kawabata, 2019). First, the present NRW system was launched based on the agreement of several ministries in 2007. Each of these ministries supervises some of the cluster organizations. Second, the system in Bavaria was established in 2006. The Ministry of Economic Affairs, Energy, and Technology supervises the cluster program. Bayern Innovative GmbH, which is the affiliated organization of the ministry, provides support to cluster organizations. Lastly, the system in BW was launched in 2006 and is supervised by the Ministry of Economic Affairs, Labor, and Housing. Cluster Agency BW, which is the affiliated organization of the ministry, provides a program for strengthening the management capability of cluster organizations.

The cluster organizations in the medical technology field are operated under the regional system. In NRW, with the support of the state government, Innovative Medizin NRW was founded in 2011 as a statewide cluster organization by the three local cluster organizations of the medical technology field operating in their own region (like the Ruhr area in the state). In Bavaria, as a statewide project organization, Cluster Medizin Technik was launched in 2006. However, in reality, this is cooperatively operated by two independent cluster organizations (Forum MedTech Pharma and The Medical Valley EMN). The former focuses on state, national, and international level activities, while the latter focuses on local activities. In BW, six cluster organizations of the medical technology field are officially recognized as cluster organizations of the state. These are enrolled in the Cluster Portal operated by the state government.

Table 3. Overview: socio-economic environment

	NRW	Bavaria	BW
Socio-economic environment of the state	<ul style="list-style-type: none"> • Capital: Düsseldorf • Surface area: 34,085 km² (4th in Germany) • Population 17.9 m. (Largest (one-fifth) in Germany) • GDP (2017) 693 bn . Euro (Largest in Germany) • GDP per capita: €35,600 (2017, in PPS; Purchasing Power Standards), slightly below the national level • Unemployment rate (2018): 3.8 % • Numerous Patent registrations: 10,4% of German patent applications • Strength in basic industry (for example metal, mechanical engineering, chemical) : many SMEs (hidden champions) 	<ul style="list-style-type: none"> • Capital: Munich • Surface area: 70,552 km² (2nd largest in Germany) • Population 12.99 m. (2nd largest in Germany) • GDP (2017) 597 bn . Euro (2nd largest in Germany) • GDP per capita: €42,400 (2017, in PPS) • GDP development (2008-2017): average 3.5% • Unemployment rate (2018): 2.2 % • Numerous Patent registrations: 25,3% of German patent applications • Strength in manufacturing: many large enterprises, SMEs (hidden champions) 	<ul style="list-style-type: none"> • Capital: Stuttgart • Surface area: 35,752 km² • Population 11 m. (3rd largest in Germany) • GDP (2017) 496 bn . Euro (3rd largest in Germany) • GDP per capita: €41,500 (2017, in PPS) • GDP development (2008-2017): average 2.97% • Unemployment rate (2018) : 2.5% • Numerous Patent registrations: 31.3% of German patent applications, Highest amount for R&D: 4.92% of its GDP (2015) • Strength in Manufacturing (Automobile), high tech engineering, light industries SMEs (hidden champions)

Source: European Commission Home Page, Table 1 in Kawabata (2019)

The Medical Technology Cluster Organizations in Three States

With support from regional systems, cluster organizations in the medical technology field operate in each state. The case study focuses on the following cluster organizations in the three states. The details of the structure and activities are described in Table 5.

In NRW, Innovative Medizin NRW was founded in 2011. The cluster organization receives financial support for the operating cost from the state government and follows its mandate on its scope of activities (4 fields of innovations in biotechnology, digitalization, human-technology-interaction, and personalization). The main purpose of Innovative Medizin NRW is to comprehensively support collaborative R&D projects composed of industry and academia, to facilitate participation from the region, country, and overseas.

In Bavaria, Forum MedTech Pharma was founded in 1998 with the support of Bayern Innovative GmbH. The cluster organizations receive financial support from the state government for operating costs. The aim of the cluster organization is to stimulate new ideas, projects, and partnerships in the field of medical technology by getting people from various sectors together.

Lastly, in BW, the Cluster Medical Technology Mannheim was founded as one of the units of the city government of Mannheim in 2011. This is based on the economic strategy of the city. The cluster organization does not receive financial support from the state government for operating costs but is entitled to apply for a competitive fund and accreditation program provided by the state government. The main goal of the cluster organization is the efficient integration of research, clinical,

Table 4. Overview: regional system

	NRW	Bavaria	BW
Regional system and cluster organization in medical technology field	<ul style="list-style-type: none"> • Launched in 2007 • 16 cluster organizations based on 8 leading markets are designed • 5 different ministries supervises some of the 16 cluster organizations • Official of the Ministry responsible for each cluster. • Cluster organization: managed by a cluster manager who is veteran in the field. Professional staffs are employed for project management and administration • Financial support by the state government for operating cost of cluster organizations • Competitive fund for R&D from the state, national government. and EU • InnovativeMedizin NRW, which focuses on medical technology field, is one of the 16 cluster organizations. The organization is supervised by the ministry of innovation science and research 	<ul style="list-style-type: none"> • Launched in 2007 • 17 innovation cluster organizations consistently on the 5 large central Megatrends (future markets): digitization, energy, health, materials and mobility • Specialized unit/officials for each cluster in the state government (Ministry of Economic Affairs, Energy and Technology) • Bayern Innovative: supports cluster organizations as an affiliated organization of the state government • Structure of each of the cluster organizations: cluster spokesman (selected by the state government), managing director (selected by the spokesman), board (from business and science), staff (up to around 10, recruited by the managing director), members • Financial support by the state government for operating cost of cluster organizations (plus membership fee and consulting fee) • Competitive fund for R&D (from the state, national government. and EU) • Cluster Medizintechnik: a project organization which is one of the 17 clusters. Founded in 2006. Operated by two cluster organizations; Forum MedTech Pharma e. V. (600 members, focusing on state, federal, international activities) and The Medical Valley EMN e.V. (185 members, focusing on local activities). The two are independent but closely cooperate 	<ul style="list-style-type: none"> • Launched in 2006 • 25 fields of technology and 120 cluster organizations • Supervised by Ministry of Economic Affairs, Labor and Housing • Cluster Agency BW is a service provider affiliated to the Ministry • Top manager of Cluster Agency BW is appointed by the ministry and the staff is dispatched from partner organizations (VDI/VDE Innovation + Technik GmbH, the Steinbeis-Beratungszentrum GmbH, BW International GmbH) • ClusterAgency BW is co-financed by the European Regional Development Fund (ERDF) • No financial support by the state government for each cluster. organization • Source of (competitive) fund for R&D from the state, national government and EU • Six cluster organizations of medical technology field are enrolled in Cluster Portal BW. Entitled to apply for the public fund and Quality label BW (accreditation program for cluster organizations). "Mannheim Medical Technology Cluster" is one of the six medical technology clusters in BW

and medical technology companies into a network, especially for Mannheim and the Rhine-Neckar metropolitan region.

The Initial Conditions and Actions in the Initial Period

The Initial Conditions

Tables 6–8 show the details of the initial conditions based on the category of positive and negative factors of the macro-environment, social network, and micro-environment. Table 9 shows the details of the actions taken in the initial period.

Table 5. Overview: medical technology cluster organizations

	InnovativeMedizin NRW (NRW)	Forum MedTech Pharma E.V. (Bavaria)	The Cluster Medical Technology Mannheim (BW)
Medical technology cluster	<ul style="list-style-type: none"> • Founded in 2011 • More than 300 members (Not its own members but total amount of those of the three local associations for medical technology: See below) • Number of staff: 5 (full time equivalent) and 3 (part-time) • Structure: An association (GBR) founded by local cluster organizations (Health Region Cologne/Bonn, MedEcon Ruhr and MedLife) with the support of the state government. The 3 organizations are employers and decide employment of InnovativeMedizin NRW • Service (Activities): mandated by the state government (the ministry of innovation science and research) to promote the 4 fields of innovations (Biologization, Digitalization, Human-Technology-Interaction, Personalization) (1) Creating network between industry, government, academia and users (2) Promoting innovations (3) Supporting young companies and research associations for transferring innovations to the market (4) Offering a wide range of events for transferring knowledge and exchanging expertise • Budget for operating cost: financial support by the state government (2.5 million Euro/3years) 	<ul style="list-style-type: none"> • One of the two cluster organizations (see Table 4) • Nuremberg-based non-profit association • Founded in 1998 • Over 600 members including 16 countries in Europe, America and Asia (8% from foreign countries) • Number of staff: 10 (full time equivalent) • Member structure: 68% companies, 10% research institutes, 9% hospitals, 4% law firms and lawyers and 4% associations and insurance funds etc. • Management and facility support by Bayern Innovative • Budget for operating cost: the fund from the state government, members fee, consulting fee • Main topics: Medical equipment, Mobile & Digital Health, Biomaterials, Diagnostics, Electronics, IT & Manufacturing Technology, Pharma • Service (Activities): (1) Consulting & Support (Including Financing Information and Advice) (2) Local industry meetings (3) Expert working groups (4) Specialist conferences & workshops (5) MedTech Summit and various programs (6) Exhibition in Trade Fair (7) Cooperations and international markets (8) Education and training in medical technology 	<ul style="list-style-type: none"> • One of the six medical technology cluster organizations in BW (see Table 4) • Founded in 2011 • Legal form of the cluster initiative: Department of Economic and Structural Funding, City of Mannheim (100% financed by the city) • 100 members • Number of staff: 3 (full time equivalent, employees of the city), the team can be expanded by additional staffs of the city government • Member structure: SMEs: 90% / large companies: 3% / universities/colleges: 6% / business development agencies and intermediaries: 1% • Budget for operating cost from City of Mannheim • Geographical scope: Heidelberg, city district / Mannheim, city district / Neckar-Odenwald / Rhein-Neckar-Kreis, covering a radius of around an hour's drive around Mannheim. • Service (Activities): (1) Networking through events, specialist seminars, trade fair appearances, etc. (2) Individual consulting of Mannheim companies (3) Collaborative projects in research and development (4) Construction of innovation infrastructure and settlement of companies (5) Start-up support

Regarding the positive macro-environment, all state governments provide support programs and direct the activities of cluster organizations. In Mannheim, the city government also promotes the cluster program and builds the cluster organization. On the other hand, all states face regulatory barriers that must be overcome to promote the business.

Concerned with the social network, prior interactions between industry and academia are observed in some of the states as a positive factor (like launching the cluster organizations). On the other hand, although negative effects by the embeddedness of the social network are not observed in the three states, they face the problem of lack of coordination between different sectors (for example, research and industry, industry, and hospitals) to promote collaboration.

Table 6. The initial conditions (macro-environment)

		InnovativeMedizin NRW (NRW)	Forum MedTech Pharma E.V. (Bavaria)	The Cluster Medical Technology Mannheim (BW)
Macro environment	Positive	<ul style="list-style-type: none"> · (2006-) Cluster program was launched: Supporting leading (Leitmarkt) market with high potential (including medical technologies), encouraging networking & collaboration between firms, research institutions, universities, and public sector · Mandate by the state government to promote the focal topics in medical technology: four fields of innovation (Biologization, Digitalization, Human-Technology-Interaction, Personalization) etc. · Progress management and sharing direction with the state government · Policy change of the state government toward enhancing collaboration with external partners for implementing measures to promote new industry/business · Cross-sectoral collaboration is the requirement for application to competitive fund by EU and the state government 	<ul style="list-style-type: none"> · (1995-) Foundation of Bayern Innovative: supporting "Innovation through cooperation", financial and founding support to industrial networks · (2006-) Cluster Program: Support by the state government on focal areas (17 innovation clusters consistently on the 5 large central Megatrends; See Table 4), encourage cross-sectoral collaborations, and keep close interaction & communications between cluster organization and the state government · Annual monitoring by the state government based on the performance of activities of each cluster. Evaluation by the state government at the end of each stage (4-5 years) by inviting the third party and the continuity of the support by the state government is considered · Cross-sectoral collaboration is the requirement for application to competitive fund by EU and the state government 	<ul style="list-style-type: none"> · (2006-) Cluster Program which targets professionalization of cluster/network management, increasing innovation and competitiveness: Cluster Dialogue (2006), Start of cluster funding (2006), Regional Cluster Atlas (2008), Cluster Data Base (2010), Cluster Portal BW (2013), Quality Label BW (2012), Establishment of Cluster Agency BW (2014) · "Linked with the direction by the state government through events for information sharing (e.g. Cluster Dialogue), re-examination of the list in Cluster Portal BW based on performance of each cluster (which entitles each cluster to apply for project fund by the state government and Quality Label BW) · Structured support by the city government based on the result of the survey in 2009 (Recognition by the city government on the critical mass of the triangle composed of companies, research institutions, and hospitals for developing medical technology industry) · Cross-sectoral collaboration is the requirement for application to competitive fund by EU and the state government
	Negative	<ul style="list-style-type: none"> · Strict regulations: e.g. difficulty of approval for reimbursement · Different regulations between countries · (Recently) Change of the certification process (new Medical Device Regulation; MDR) 	<ul style="list-style-type: none"> · Strict regulations: e.g. difficulty of approval for reimbursement · Different regulations between countries · (Recently) Change of the certification process (new Medical Device Regulation; MDR) 	<ul style="list-style-type: none"> · Strict regulations: e.g. difficulty of approval for reimbursement · Different regulations between countries · (Recently) Change of the certification process (new Medical Device Regulation, MDR)

Finally, turning to the positive micro-environment, all states have many medical institutions such as hospitals and rehabilitation facilities, research institutions, and small and medium-sized enterprises (SMEs), which are essential for promoting innovation in the medical technology field. Moreover, the three states have large internal/external markets, and at the same time, face severe competition from outside, which pushes them to promote the collaborations. The high potential of the growth of the medical technology industry and the complementarity of a variety of sectors for promoting innovation in the field are recognized in the three states. The change in business environment by IT and digitization also plays the role of driving collaboration. However, as shown above, all states face

Table 7. The initial conditions (social network)

		InnovativeMedizin NRW (NRW)	Forum MedTech Pharma E.V. (Bavaria)	The Cluster Medical Technology Mannheim (BW)
Social network	Positive	• Interaction between local associations for medical technology	• Meeting held by Bayern Innovative and opportunities to interact between industry-academic-government	<i>(Opportunistic industry-academia interaction are observed in the case when public-private-research grant calls offered. However, not contributed as a positive element)</i>
	Negative	• Lack of coordination (and network) between different sectors (e.g. research and industry, industry and hospitals)	• Lack of coordination (and network) between different sectors (e.g. research and industry, industry and hospitals)	• Lack of coordination (and network) between different sectors (e.g. research and industry, industry and hospitals)

the problem of a lack of coordination between different sectors. This appears to contribute to the lack of a clear vision of the domain for collaborations in the medical technology field.

Actions in the Initial Period

The actions taken in the initial period, which are performed by each cluster organization in response to the initial conditions, are described in Table 9. The experience of the cluster organizations in the three states shows that, with the support from the public sectors, the survey for understanding and sharing the initial conditions are conducted by the core parties who are involved in the foundation of the cluster organizations. They also promote the interaction and involvement of key stakeholders from industry and academia. Moreover, when cluster organizations are founded, these stakeholders are invited as board members of the cluster organizations. The cluster organizations, as examined later, intervene on the establishment/refinement of the field based on the recognition of the initial conditions and change in environment, etc. The organization also intervenes on emerging interactions toward cross-sectoral inter-organizational collaborations.

Established/Refined Field and Intervention

Established Field and Refined Field

Table 10 shows fields that are established and refined in the three cases. All the cases experienced the establishment of field, then to the refinement of fields after a certain period of activities. The common features of fields established in the three states are databases that aim to allow members/external people access to the partners, events for all members to interact and share ideas, and events for specific members (like workshops which provide a certain topic). On the other hand, refined fields are varied between the states.

Intervention for Establishment and Refinement of Field

The case studies show that the cluster organizations intervene to establish and refine the field by calling openly or selectively approaching potential members, setting up types of fields (like workshops and events), and directing members with the introduction of concepts/areas to focus. The interventions for refinement of the field are implemented considering the business environment, communication with

Table 8. The initial conditions (micro-environment)

		InnovativeMedizin NRW (NRW)	Forum MedTech Pharma E.V. (Bavaria)	The Cluster Medical Technology Mannheim (BW)
Micro environment	Positive	<ul style="list-style-type: none"> • Large number of medial/health institutions (20% in Germany) • Many Research institutions (Universities, Fraunhofer etc.) • About 400 SMEs in medical technology (many "hidden champions") • Patents and R&D projects in medical technology • Large internal/external growth market (largest in healthcare spending, population and number of medical institutes; 1/5 in Germany, High growth in export) • Economic integration in EU, globalization (locational advantage), competition from overseas • Supplier industries for metal/plastic processing as potential entrants • (2014-) Shift to enlarge the scope of activities such as ICT for promoting innovations in healthcare sector 	<ul style="list-style-type: none"> • Many large companies, SMEs, Universities, and Research institutions in Medical Technology Field • Many medical related institutions (Hospitals etc.) • Supplier industries (as potential entrants) • Recognition of large internal/external growth market (high export rate), the cost pressure and the globalization of the markets • Economic integration in EU • (Recently) Dramatically changing business models under digitalization (where the product is only one part of the value chain) > need support, especially for small firms, to be a part of the health care process • (Recently) Main topic (challenge) shift from technology to regulation, digitalization and change in business model, therefore, innovation process 	<ul style="list-style-type: none"> • Many SMEs, Universities, and Research Institutions in Medical Technology Field • Many medical related institutions (Hospitals etc.) • Supplier industries (as potential entrants) • Recognition of large internal/external growth market, the cost pressure and the globalization of the markets • Economic integration in EU • Large internal/external growth market (high export rate), number of medical related institutions • Competition from overseas, especially from cheaper production site around the world to traditional BW medical device (surgical instrument etc.) • Potentiality to collaborate with large IT companies located in BW (SAP etc.) for further innovations
	Negative	<ul style="list-style-type: none"> • Lack of coordination between different sectors and lack of a clear vision of the domain to collaborate 	<ul style="list-style-type: none"> • Lack of coordination between different sectors and lack of a clear vision of the domain to collaborate 	<ul style="list-style-type: none"> • Lack of coordination between different sectors and lack of a clear vision of the domain to collaborate

members and other stakeholders (like board members and public sectors such as the state government), and reflection on the results of experienced activities toward the formation of the collaborations.

Notable Efforts of Each State

With regard to the establishment and refinement of the field, some notable efforts are conducted in each state.

(InnovativeMedizin NRW) As is shown in Table 6, InnovativeMedizin NRW is mandated by the state government to promote innovations in four fields (Biologization, Digitalization, Human-Technology-Interaction, and Personalization). After a certain period of activities of the staff of InnovaiveMedizin NRW and through the consultation with the state government, "structured method," which pursues more efficient/effective ways to intervene in the formation of project consortia, was introduced in 2016. The method is composed of five steps, one of which is to set up a field (for

Table 9. Actions in the initial period

	InnovativeMedizin NRW (NRW)	Forum MedTech Pharma E.V. (Bavaria)	The Cluster Medical Technology Mannheim (BW)
Actions in the initial period	<p>1. Members of the local associations knew each other through interaction at a trade fair etc. and agreed to build a state wide network. Then, three local associations requested the state government for support</p> <p>2. The state government, with participation of the local cluster organizations and (later) core staff of InnovativeMedizin NRW, conducted a survey on the situation/conditions and potentiality of medical technology industry in NRW in order to identify the strength in NRW such as patents, R&D project, publications, students in the field of medical device. The aim of survey was also to justify the foundation of InnovativeMedizin NRW</p> <p>3. Contract between the state government and the three local associations for promoting state wide promotion of medical technology</p> <p>4. Foundation of InnovativeMedizin NRW by the three local association with the budget from the state government in 2011</p> <p>5. Inviting board members from industry, universities, and hospitals etc.</p> <p>6. Survey after the foundation: for grasping companies and their types of business and technology, movements in the community, successful areas and topics in the region. Then, identifying innovation traits, strength/competencies in the region, and finding the focal points for further support</p>	<p>1. Survey on medical technology industry by the state government (including Bayern Innovative): made decision to make more investment in the industry and establishment of a society (E.V.) to promote technology transfer and innovation through involvement of universities, hospitals, and insurance companies</p> <p>2. Repeatedly convening a conference for interaction between industry, academia, and medical institutions etc. in the medical technology field at Bayern Innovative. Then, sharing the initial conditions and the sense of necessity to promote the industry, discussing the approach for promoting the industry through cross-sectoral collaborations, and communicating the intention of the state government (and Bayern Innovative) to support</p> <p>3. Foundation of Forum Medtech Pharma in 1998 with participation of 55 members</p> <p>4. Inviting board members from industry, academia etc. (The present structure of medical technology cluster; 'Cluster Medizintechnik' composed of Forum Medtech Pharma and Medical Valley EMN, was founded after the state government launched the cluster program in 2006.)</p>	<p>1. Prior survey by the city government of Mannheim (2009) for considering economic strategy of the city and identification of 3 potential industries to support (medical technology is one of them)</p> <p>2. The Committee for Economic Affairs, Labor and Social Affairs of the Mannheim Municipal Council (in its public meeting of December 1, 2011) adopted a corresponding concept for the expansion and management of the Medical Technology Cluster and approved the establishment of the Executive Board (Legal form of the cluster initiative : Department of Economic and Structural Funding, City of Mannheim). Invited those of high value chain impact (e.g. companies doing medical device research, production, and sales) as board members</p> <p>3. Inviting board members or appointing Practice Advisors from universities, hospitals, and research institutions to support</p> <p>4. Listed by the state government as one of the medical technology clusters of the state</p>

Table 10. Established and refined field

	InnovativeMedizin NRW (NRW)	Forum MedTech Pharma E.V. (Bavaria)	The Cluster Medical Technology Mannheim (BW)
Established field	<ul style="list-style-type: none"> Database: containing about 700 stakeholders and opening it on website Location marketing: event for introduction/appeals of thousands of firms and clinics, universities and infrastructure in the region and participating event for attracting potential partners and customers Events and conference: aiming to make members understand the benefit to participate and increase the possibility to build collaborative projects through interaction and information exchange Workshops for building projects: workshop to build up communities where potential participants of projects interact and start projects in the focal topics (four fields of innovation; See Table 6) 	<ul style="list-style-type: none"> Database: containing about 600 members and opening it on website Industry meeting expert working groups (for networking) Matchmaking events (annual events) Expert circles: small group workshop to discuss a topic to identify challenges, benefits, competences, strengths as well as lags, weak points within the community, then, to bring points of interest on the platform Branch meeting: a conference is held at a hosted company where all the participants meet and focus the competences of that company and its idea for the project. Then, the collaborative project is initiated by the hosted company 	<p><u>Focusing on the 'virtual' infrastructure (-2014):</u></p> <ul style="list-style-type: none"> Database: containing about 100 members and opening it on website MEDTECH DIALOGUE: a networking event held for every 3 months, inviting every members under a certain line of topics (e.g. technology, marketing) DELIVER: promoting internationalization, market access INSPIRE - DIGITAL HEALTH DEVELOPMENT AND TESTING PLATFORM: systematic and organized access to knowledge, technology, and support for startups as well as SMEs
Refined field	<ul style="list-style-type: none"> (2016~) Reorganized events, workshop, and meetings (conferences) in accordance with the "structured method" (See "Intervention on the emerging interaction toward inter-organizational collaborations" below for the details) 	<ul style="list-style-type: none"> (Recently) members from clinics, hospitals, academia, and science to increase their percentage (Recently) platform to deal with the shift the topic (challenge) from technology to regulation, digitalization, and change in business model (Recently) digital platform showing pictures like a technology radar, roadmap for very specific subjects which can be visited and viewed by stakeholders and members, and clients. That helps to identify the paths to work on and where could be their part in this path with transparent and efficient manner (Recently) digital platform for interactive Q&A 	<p><u>Focusing on the 'real' infrastructure (2014~):</u></p> <p>Innovation ecosystem by creating a physical place where startup entrepreneurs, hospital physicians, medical researchers, and technical researchers work together in one room under one roof for developing medical devices</p> <ul style="list-style-type: none"> Cubex41: 1800 square meter office and laboratory space → (Expansion of its scale) → MMT campus: 20,000 square meter office and laboratory space, funded from the city, the Federal State (EU fund), and private investors

Table 11. Intervention for establishment and refinement of field

	InnovativeMedizin NRW (NRW)	Forum MedTech Pharma E.V. (Bavaria)	The Cluster Medical Technology Mannheim (BW)
Intervention for establishment of field	<ul style="list-style-type: none"> Approaches to firms: explaining the benefit of participation (e.g. opportunities for innovation, administrative support) Constructing database Focusing on 4 fields and setting-up field (event, workshop etc.) 	<ul style="list-style-type: none"> Call for members (open recruitment) Constructing database Conducting technology scouting and setting-up field (event, workshops) 	<ul style="list-style-type: none"> Call for members: starting from 'proactive approach': making catalogue of medical technology companies, engineering service providers, hospitals, and universities, then, sending letters and visiting to invite as members. The approach is based on the value chain impact. "Reactive approach": accepting people who wished to be members Constructing database (~2014) Focusing on "virtual infrastructure" and setting-up field (event, workshops)
	(Both for establishment and refinement of field) <ul style="list-style-type: none"> Decision based on research and experience, consultation with the local cluster organizations, board, external expert, and the state government 	(Both for establishment and refinement of field) <ul style="list-style-type: none"> With the consultation with key stakeholders (e.g. board) (In refinement of field) Developing format for creating types of field through communication with members 	(Both for establishment and refinement of field) <ul style="list-style-type: none"> Continuous loop of validation for creating concept of field with the practice advisors and the executive board
Intervention for refinement of field	(2016~) Introduction of the "structured method" and reform of running fields (e.g. workshops, meeting etc.) reflected with preceding (inefficient) process toward collaborative projects (See "Intervention on the emerging interaction toward inter-organizational collaborations" for the details)	Approach by visiting and asking to clinics, hospitals, academia, and science to increase members of these fields with consideration of current composition of members <ul style="list-style-type: none"> Strengthening/increasing individual consulting in order to deal with the shift of topic/challenge to regulation, digitalization and change in business mode 	(2014~) Focusing on "real infrastructure" reflected with increasing number of participants who wish to collaborate

example, building a community through events and workshops that target persons interested in a certain topic). The details of the structured method are explained in "Intervention on the emerging interaction toward inter-organizational collaborations."

(Forum MedTech Pharma in Bavaria) The activities and the formats for types of field (for example, events and workshops) are developed by staff in the office of Forum MedTech Pharma. The staff conduct technology scouting on their own to identify trends and challenges in the medical technology field. Moreover, refinement of the field is implemented through close communication with the board and members. The staff always visits member organizations or meets them during workshops and enquires about their needs (for example, support for their business and support for shortening from innovation to the market). Then, the staff receives the critical points and feedback for refinement of the field from the members. Moreover, there is also an opportunity to bring the point of interest for refinement of the field through discussion in the "Expert Circle," which targets a certain topic to discuss the challenge in a small workshop. Therefore, the process of defining the topics and developing certain formats is promoted through trial and error, and then examined to

see whether it is successful or not. One of the results is the shift of the main topic/challenge from “developing technology” to “facilitating innovation process” (including dealing with regulatory barriers), digitization and change in business model, and market entry. The field is transformed to provide opportunities to share information/knowledge about the new topic/challenge and to strengthen or increase individual consulting to facilitate interaction in the new direction.

(The Cluster Medical Technology Mannheim in BW) The first effort is implemented in the initial period of the establishment of the field when they call for members. Basically, they open the door to those who wish to join. However, they also rank the potential members based on the value chain impact and approach them by visiting and sending invitation letters. The ranking is based on the following criteria:

- First Approach (Impact 1): Companies performing medical device research, production and sales.
- Second Approach (Impact 2): Companies that do not have the full value chain of their market segment: either not to develop but to produce and sell, to develop and produce but not to sell, or to produce critical components of medical devices.
- Third approach (Impact 3): Specialized expert service providers, such as regulatory service providers, health technology assessment service providers, reimbursement service providers, market research service providers, and highly specialized service providers for R&D, lab operations, or others.

The second effort is to refine the field through an expansion of the real infrastructure (physical places). The measure started in 2014, three years after they launched the cluster program, when they saw the growing number of people, entry of companies, and startups. The aim was to secure the development and position of the city as the hub of the medical technology industry by building facilities/spaces (see Table 10 about the details) where entrepreneurs and startups collaborated with doctors, engineers, and scientists and were able to gather under one roof, enhance the ecosystem, and develop medical devices.

Intervention on the Emerging Interaction Toward Inter-Organizational Collaborations

The intervention on the emergent interaction toward inter-organizational collaboration in the three cases is described in Table 12. It is observed in all the cases, based on the established and refined field, interventions are implemented by the cluster organizations to facilitate emergent interactions between members or members and external actors from various sectors to facilitate the formation of cross-sectoral projects. The notable efforts of the individual case are listed in Table 12.

InnovativeMedizin NRW

The structured method is introduced above. This is an integrated measure with refinement of the field and intervention on the formation of inter-organizational collaborations. The method consists of the following five steps.

Step 1. Definition of the status and analysis of the situation (stakeholders in NRW) as stocktaking in a specific field: This is conducted through survey and hearing to experts in specific fields (for example, implants). Here, the staff of InnovativeMedizin NRW talks to experts, for example, scientists and clinicians, and finds a specific demand for the product. Then the existence of a critical mass of the market in the region is considered. Based on the survey, the topic for the cross-sectoral project is defined.

Step 2. Build up community with events, workshops, interviews: First, people who work on or are interested in the defined topic are identified by utilizing the network or by contacting potential partners (including those in other fields like biotech, patient organizations, and health insurance companies). Then, the interests of the partners to participate in the project are confirmed. Second, meetings and

Table 12. Intervention on the emerging interaction toward inter-organizational collaborations

	InnovativeMedizin NRW (NRW)	Forum MedTech Pharma E.V. (Bavaria)	The Cluster Medical Technology Mannheim (BW)
Intervention for facilitating emerging interaction	<ul style="list-style-type: none"> · Support for matching process with consideration of all the requisite conditions from the initial step (through direct approach by the staff of InnovativeMedizin NRW, supporting firms in approaching potential partners, announcing and supporting application for competitive fund etc.) · Basic elements to promote collaborations: clarify the common goal, help to communicate between the different sectors (moderating and translating) · Implementing the "structured method" to promote the collaborations (See the details in 'InnovativeMedizin NRW' below) 	<ul style="list-style-type: none"> · Three-step approach as a general framework for promoting funding projects: support for whole value chain (See the details in 'Form MedTech Pharma in Bavaria' below) · Overcoming the different time scale (e.g. between medtech and other companies) and approaches (e.g. between clinics and companies): bringing together specific workshops and conferences which are to deal with the difference through discussing the expectation from each other and improving sensibility of each to the challenge of other side in order to realize successful cooperation 	<ul style="list-style-type: none"> · Demand oriented approach: visiting and talking, proposing and supporting to make the appropriate link based on member's demand · Project oriented approach: forming a research consortia by supporting the building of a project consortium based on the ideas of members (e.g. new diagnosis and treatment proposed by a research institution), or by initiating the consortium as a project manager (e.g. project of INSPIRE)

workshops are organized by inviting all these people, and the more concrete topic and participants who are interested in implementing the topic as a project are identified. If it is confirmed, the manager invites them to exchange their opinions. Moreover, in case there are calls for projects that provide competitive funds from the state government, the federal government, or the EU, the staff screens them, and if they fit the project, the staff contacts potential participants and arrange some meetings.

Step 3. Setting up a strategy with whitepaper: If they trust the partners and agree to participate, then the structured processes for the project are defined, and a white paper is drawn up. This paper is the strategic paper to promote innovation in a certain field (about 15 pages), which is also utilized for applying for competitive funds. The paper is drawn up by the staff of InnovativeMedizin NRW by integrating the opinions of the participants (and experts) and is brushed up through interaction and feedback from members.

Step 4. Conference to set up the project: If the proposal is approved, the project consortium is formally built, and they begin work.

Step 5. After the project's inauguration: Even after they start the project, the staff supports the members, for example, administrative work, to operate the project smoothly and ensure devotion to the project work itself.

In addition to the steps above, after the phase of a funded project that focuses on R&D, to transfer the achievement (the developed technology) to a business model, an additional partner is sometimes sought, and the staff continuously supports the member of the new consortium in the commercialization phase.

Forum MedTech Pharma in Bavaria

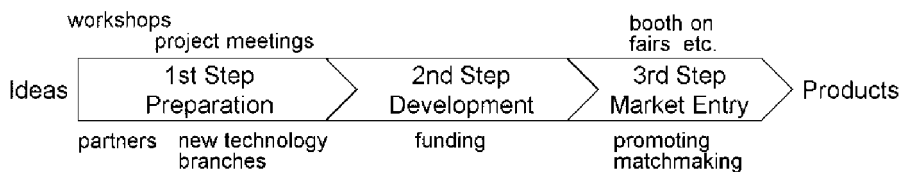
The three-step approach is similar to the structured method above, which aims to form a consortium of a specific field, but with the general framework for implementing intervention effectively on the whole value chain (from the idea phase to the production phase).

Step 1. This is the preparation and idea development phase. For example, if a client company has ideas for a new product and needs partners, the staff of Forum MedTech Pharma supports them in several ways. In case the idea is very confidential, the staff individually contacts persons who might be interested in it. On the other hand, if it is a general idea and the client company wants to discuss it more broadly, then the staff sends mail to members and organize small workshops to bring together potential partners from other technologies and sectors. Partnering can also come into effect from networking events and branch meetings (see Table 10). At the meeting with the potential partners, the client company, who has the idea, gives lectures to identify the best and then moves to the project meetings.

Step 2. The next step is to launch the project. Here, the staff support identifies the possibility of funding and supports the application process. This step is initiated by the partners themselves. The product is developed in this step, and normally, the product is demonstrated.

Step 3. To support the market entry of the product, the staff helps organize booths on fairs, helps organize matchmaking for promotion, and organizes communication through online and paper tools (Figure 3).

Figure 3. The three-step approach by Form MedTech Pharma



The Cluster Medical Technology Mannheim in BW

Demand-oriented and project-oriented approaches are employed by the Cluster Medical Technology Mannheim for implementing the intervention on the emerging interaction toward inter-organizational collaboration.

The demand-oriented approach is implemented through visiting and talking with members and providing support (for example, matching partners) based on their request.

The project-oriented approach supports building project consortiums based on the idea of members through, 1. Matchmaking between members to establish a consortium that confirms the value chain, 2. Using a database to make the information (for example, project aims and technology developed by members) visible either in a broad or in a selective fashion to members, and 3. Inviting and having a small conference to discuss whether the idea has a high potential and impact. If so, the partners form a consortium and start a collaborative project. In that process, there exists the case that a staff of the Cluster Medical Technology Mannheim is appointed as a project manager and leads the consortium.

ANALYSIS AND INTERPRETATION

The aim of this study is to consider the management to facilitate the self-organization process of inter-organizational collaborations characterized by complexity (Fuchs, 2003; Heylighen, 2013; Plowman et al., 2007). The case study of the three states in Germany shows differences in the path and methodology of intervention. However, it is commonly found that the management layer (in the case study; cluster organization) implements goal-directional intervention to facilitate the self-organization process (Imada, 2008) by focusing on the initial conditions, field, and emerging interaction toward the collaborations. This is, as Gray (2008) explains, to increase the driving factors for alliance success (therefore inter-organizational collaborations) by influencing the interaction between parties concerned. More specifically, in the following section, the results of the case study are discussed based on the conceptual model.

Intervention on Learning the Initial Conditions and Fostering Felt-Need

Intervention on learning the initial conditions aims to learn and share it, and foster the felt-need by involving the parties concerned through collaboratively observing and understanding (Dickens & Watkins, 1999).

First, all cases show that surveys to understand the initial conditions were conducted by the core parties involved in the foundation of the management layers. These are the state government (in the case of NRW and Bavaria), the city government (in the case of Mannheim in BW), and the core staff of the management layer (all cases). Learning the initial conditions helps individuals reflect on and obtain new insight into the totality of the situation (Burnes, 2004). In reality, the survey helps them learn macro and micro environments (Whetten, 1981; Chen, 2008; Bryson et al., 2006; Gray, 2008; Bryson et al., 2015) and social networks (Granovetter, 1985; Gulati, 1998; Gulati & Gariulo, 1999; Lazzarini et al., 2008) related to the business in the medical technology field. Based on the survey, they could grasp the potential of the industry, clarify the challenges to overcome, and justify supporting the promotion of the industry and foundation of the cluster organizations.

Second, concerning how to foster felt-need, the core parties described above tried to involve key stakeholders from industry and academia, through convening, approaching, and inviting them as key constituent members (for example, board, committee, and contracted external expert/advisor). This is, as Dickens and Watkins (1999) explain, to involve parties concerned and foster the change. In reality, the stakeholders collaboratively participated in the process to share and learn the initial conditions, discuss, and share felt-need and direction toward launching the activities of the management layer. This, in turn, facilitates cross-sectoral inter-organizational collaborations.

Lastly, after a certain period from launching activities, it is also observed in all cases that the management layers lead to recognize the change in the environment (therefore, change in the initial conditions), feedback from members, and experienced activities. Therefore, in this stage, industry and academia who are enrolled as members are also directly/indirectly involved in the process of learning the change and fostering felt-need for the new and reconceptualized direction. This leads to the refinement of the field (Itami, 1999), as shown below.

Intervention for Establishment and Refinement of Field

The establishment and refinement of the field are facilitated by the interventions of the management layer, as Itami (1999) proposes, from the setting-up approach. Moreover, it is found from the case study that the management layer is organized before that.

Organizing the Management Layer

A notable finding, which should additionally be included in the conceptual model, can be observed in “Actions in the initial period” in the case study above. Here, based on the felt-need and agenda/purpose, it is observed in all cases that the management layers are organized. These include not only

recruiting staff but also inviting key stakeholders who influence each field (like industry, universities, and medical institutions) as key constituents of the management layer. This appears to contribute to the management layer to satisfy some requisites for the establishment of field (Itami, 1999; Gray, 1989), such as specifying appropriate stakeholders, setting agendas, maintaining legitimacy, authority, fairness, and justifying the layer to intervene.

Establishment of a Field

It is commonly observed that the establishment of a field is facilitated through the intervention by the staff of the management layer through 1. presenting the goal and (either selectively or openly) calling for members, 2. constructing a member database, and 3. holding general meetings (like annual conferences) for sharing trends (topics) and facilitating interaction, 4. holding events and workshops targeting certain members (including external parties) to exchange and interact to pursue the collaborative project in a specific field or realize a specific purpose (like displaying in the trade fair). The intervention by the layer satisfies some requisites for the establishment of the field (Itami, 1999; Gray, 1989), such as selecting members, setting and sharing the basic elements (agenda), enabling members to understand the purpose and the value of collaborations, by utilizing the layer's power to convene and skill to carry out the process. The intervention to establish a field in the initial period is implemented based on the interaction and agreement between the staff of the management layer and the key constituent members.

Refinement of Field

Intervention on the refinement of the field by the management layer varies in terms of timing and method between the cases; for example, setting the field based on the "structured method" (NRW), approaching new members (Bavaria), introducing new topics and setting new fields (Bavaria), constructing digital platforms (Bavaria), and building physical spaces (BW). In the refinement phase, it is commonly observed that these interventions are not only based on the interactions and the agreement between the staff of the management layer and the key constituent members, but also reflect the change in environment, feedback from members, or the lessons learned from the experienced activities toward the inter-organizational collaborations. Here, the layer facilitates the refinement, as Imada (2008) proposes, through reading new vectors and goals, clarifying the role and allocation of personnel/social resources, structural incongruence, and fluctuations in the system in steering toward a new direction, which enables the field to sustain the continuous state of adaptation (Burnes, 2004) through the cyclical process.

Intervention on the Emerging Interaction Toward Inter-Organizational Collaborations

All cases show that the management layers, based on the direction of the established/refined field, implement interventions to facilitate emergent interaction toward cross-sectoral inter-organizational collaborations. Although each case has its own approach (for example, degree of structuration), the common points are observed as follows.

First, interventions are implemented to facilitate the emerging interaction toward inter-organizational collaborations. It is observed in the case study that interventions that appear to correspond to the role of the intervener, introduced in the review of related literature, are performed by the management layer. These are:

1. Visioning (Gray, 2008) through presenting/sharing the domain of the collaborations (like clarifying the demand for product and sharing the ideas proposed by a member).
2. Networking/matching through convening and approaching potential partners to support the organizing process of collaborative projects. This is implemented through brokering, convening,

and organizing professionally to enable members of diverse interests to enjoy meaningful participation (Gray, 2008; Kaats & Opheji, 2014; Koschmann et al., 2012).

3. Clarifying the agreement (for example, “white paper” in the case of NRW) for institutionalizing it by the text (Gray, 2008; Koschmann et al., 2012).
4. Coordinating between partners (for example, bridging the gap of the approaches, moderating, and helping/translating to facilitate communications), which ensures brokering and avoiding conflict (Gray, 2008).
5. Structuring (or designing) the process for enabling participants to structure the problem, enhance group dynamics, and promote sense-making (Gray, 2008; Kaats & Opheji, 2014).

These interventions are to facilitate the process from the emergent interaction between individuals to the entity established with a defined role, established project, and the form disseminated to the broader public and audiences (Schacter, 1951; Turner, 1962; Hartman & Johnson, 1990; Nicotera, 2013).

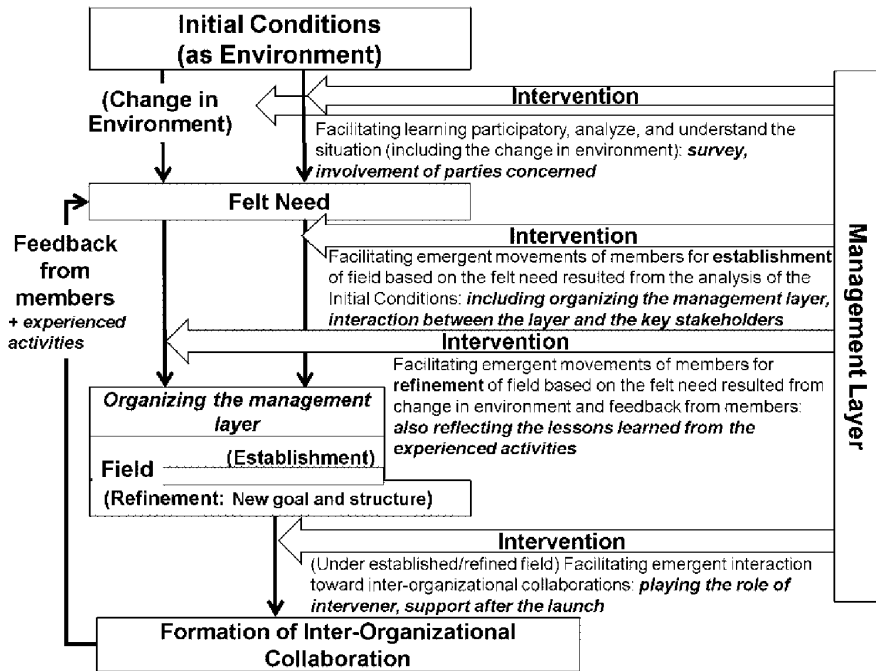
Second, in addition to the emerging interaction toward inter-organizational collaborations, it is also observed that the management layer also supports the operation of the collaborative project after the launch if requested. Support is provided by helping the operations (for example, administrative work, matchmaking support in the commercialization phase, or playing the role of a project manager) to smoothly promote the project.

CONCLUSION

In this study, to consider the management to facilitate the self-organization process of diversified actors toward inter-organizational collaborations, first, the formation of inter-organizational collaboration, a type of network organization, is considered by focusing on the self-organization, which is featured by complexity. Then, with reference to Imada (2008), the role of the management layer is discussed, and it is proposed that intervention, which is the reflexive control to facilitate bottom-up movements, is required to direct the process toward the collaboration. Considered with a unified view of a planned approach to change by Burnes (2004), key elements for facilitating the self-organization process (“initial conditions,” “field,” and “emerging interaction”) are identified as the targets of intervention. Lastly, intervention by the management layer is discussed in the context of leadership under complexity, and it is proposed that action research-based intervention, which enhances self-reliance efforts, is required. Here, first, intervention on the initial conditions is meant to facilitate participatory learning of the situation and to foster felt-need toward inter-organizational collaborations. Second, intervention in the field is to create an environment that works as a device to facilitate emergent interaction toward the collaborations by facilitating the establishment and refinement of the field. Third, intervention is also implemented on emergent interaction toward the collaborations, and the role of the intervener is discussed.

Through the case study, although variations in the paths and methodologies are observed, commonality is also found in the management of inter-organizational collaborations. First, intervention on learning the initial conditions, which aims to foster felt-need, is implemented through involving the parties concerned. This leads to intervention in organizing the management layer and the establishment of the field. Then, based on the direction of the established field, the management layer implements interventions to facilitate emergent interaction toward inter-organizational collaborations. Second, the management layer, by expanding the involvement of concerned parties (like members), implements intervention for learning based on the change in the environment (therefore, change in the initial conditions), feedback from members, and experienced activities. This leads to modification of the felt-need and intervention in the refinement of the field. Moreover, based on the direction of the refined field, the management layer implements interventions to facilitate emergent interaction toward inter-organizational collaborations. Based on these findings from the case study, the conceptual model is

Figure 4. Modified Conceptual model: management to facilitate self-organization process of inter-organizational collaborations



modified (with bold italic letters), as shown in Figure 4. Here, “organizing the management layer” is added to the model, and the findings from the case study are described.

These findings show that action research-based intervention is implemented to facilitate the self-organization process toward inter-organizational collaborations. This approach enables parties concerned to be exposed to the problem and take structured action. Moreover, as Elden and Chisholm (1993) explain, the approach also enables them to increase adaptive capacity, ability to innovate, and competence in self-design of the system through participative learning, which fosters “felt-need.” The process is also accompanied by experimentalism. Intervention is also implemented, as Gray (2008) proposes, with being tested and refined.

The conceptual model reflects the view above and is supported by an empirical study with some modifications. The model proposes a comprehensive management approach for facilitating the cycle of the self-organization process in which the established field gives a certain direction to move. Moreover, as the stage model proposes, the approach enables members to unfreeze the assumption of actions, to move toward the refinement of field, and to refreeze emerging interactions toward the formation of inter-organizational collaborations under a reconfigured field that shows a new direction. Therefore, it displays continuous adaptability and robustness in a dynamic environment. The management proposed by the model, in other words, is the intervention to facilitate the self-organization process, which is often accompanied by fluctuations and featured by complexity, of a number of diversified and autonomous but mutually dependent actors toward cross-sectoral inter-organizational collaborations. This aims to adapt to changing business environments and to create innovative businesses by combining deliberate and emergent planning.

Through the case study, a certain result could be achieved by extracting some findings about the management approaches. Moreover, the study also provides practical insights for promoters who consider facilitating cross-sectoral inter-organizational collaborations toward new and competitive industries. On the other hand, to consider more about how to facilitate cross-sectoral collaborations and deepen the theoretical basis, the following must be considered for further development of the study. First, with the theoretical framework introduced in this study, continuing the case study by expanding the scope and time span is necessary to examine further findings. For example, considering the above findings that organizing the management layer satisfies some requisites for field establishment, although it is not clearly observed in this case study, it is probable that the layer is restructured as a part of the refinement of the field. Second, as an additional research question, management resources, and structure of the management layer should be examined to consider the sustainability of providing management support to facilitate cross-sectoral inter-organizational collaborations.

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