

# Inter-Organizational Network Management in an Innovation Context: Combining ego and Whole Network Perspective

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**Abstract:** Although there is growing interest into the research field of inter-organizational innovation networks, few attempts have been made to develop systematic methods for the active management of such networks. This is especially true for approaches combining the view of single actors and the network as a whole. In response to this gap, this research presents a new method for the management of inter-organizational networks that can help to increase innovation outcome. The introduced approach accomplishes two goals. Firstly, it provides guidance for the measurement of the current collaboration status of a network, its optimal future collaboration status and the gap between them. Secondly, it provides systematics for the development of clear network management strategies for each network actor for closing this collaboration gap. As a result, better exploitation of existing collaboration potential is expected to increase innovation output. The method builds upon work by Kohl et al. (2015) who approached network management on a whole network level providing a solution for the management of entire networks and Ojasalo (2004) who suggested a network management method taking the perspective of a single network actor on the so called ego level. The novelty value of the presented method lies in the demonstration of how these different levels of network management can be combined. The two levels of analysis are linked through reliance on the same data set. The developed method is demonstrated through a case study. The analysis builds upon a questionnaire asking network actors for an estimation of the current collaboration status and a future collaboration potential amongst them. Social network analysis software was used to calculate network measures such as the level of density and to visualize the network graphically. As a result customized strategies for improving collaboration within the investigated network are presented.

**Keywords:** innovation networks, network management, network assessment, ego network perspective, whole network perspective

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## 1. Introduction

There is increasing consensus amongst scholars that collaboration in inter-organizational networks has a very significant and positive influence on innovation (Coleman 1988; Burt 1992; Powell et al. 1996; Rowley et al. 2000; Ahuja 2000; Baum et al. 2000; Reagans and Zuckerman 2001; Tsai 2001; Owen-Smith and Powell 2004; Schilling and Phelps 2007; Raesfeld et al. 2012). Hence, it appears worthwhile to investigate in what way and under what conditions collaboration in networks is beneficial to innovation and how this can be fostered. Inter-organizational networks and their impact on innovation has been well researched already, which is documented by a variety of literature reviews dedicated to networks (Borgatti and Foster 2003; Brass et al. 2004; Provan et al. 2007; Ozman 2009; Zaheer et al. 2010; Phelps et al. 2012). The research field of network management on the other hand is relatively young. A first literature review has been published by Huuskonen and Kourula (2012). They note a strong, recent increase in publications concerned with the topic of network management. Still, they conclude that only a very small share of publications has developed concrete methods of network management. In response to this scarcity, the authors of this research have previously presented a network management approach that facilitates the definition of an optimal future collaboration status for inter-organizational networks (Kohl et al. 2014, Kohl et al. 2015a, 2015b). Following, this method will be referred to as *Network Collaboration Improvement Method*. A gap between the current collaboration status of the network and a potentially optimal future status can be identified via this method. While managers are encouraged to intensify collaboration according to the provided analysis, so far the approach did not provide a detailed strategy on how to reach the defined goal. The current paper suggests how this limitation can be overcome by combining the method with a second network management approach by Ojasalo (2004) labeled *Key Network Management*.

The *Network Collaboration Improvement Method* addresses network management on a whole network level, meaning that it is concerned with the entire inter-organizational network and outcomes on the whole network level (Zaheer et al. 2010). *Key Network Management* as introduced by Ojasalo (2004) discusses how single actors can manage their individual network and thus addresses network management on the so called ego level. Building on these two approaches to network management, the paper at hand discusses the possibility of setting goals for future collaboration in networks on the whole network level, while providing strategies for working towards this goal on the ego level. Thus, the main contribution of this work lies in illustrating how network assessment on a whole network level and network management on an ego level can be integrated. The approach is demonstrated by the means of a case study.

## 2. Network management

Network management is a young research field, which developed during the last three decades. The term 'network management' has been increasingly used since a publication by Thorelli 1986 on networks as a form of organizing between markets and hierarchies (Huuskonen and Kourula 2012). Network management may be described as a managerial approach for designing and managing networks (Huuskonen and Kourula 2012). This has also been studied explicitly in the context of innovation networks (Dhanaraj and Parkhe 2006). Huuskonen and Kourula (2012) identify in their literature review six dimensions of network management: (1) management functions, (2) network and management strategies, (3) management tasks, (4) management structures (5) network and management roles, and (6) management capabilities. The paper at hand focuses on the dimensions management functions in terms of identifying partners for networking and forming networks and on network and management strategies in terms of providing guidelines for strategic choices on networking. Its novelty value lies especially in connecting the ego and whole network perspective of network management. Following, the approaches to network management by Kohl et al. (2014, 2015a, 2015b) and Ojasalo (2004) are presented and discussed in the context of these two perspectives.

The *Network Collaboration Improvement Method* as described by Kohl et al. (2014, 2015a, 2015b) suggests a three step process for defining a future target status for inter-organizational networks:

- Assessment of the current collaboration status of the respective network as perceived by its actors.
- Assessment of a potential future collaboration status in five years according to collaboration potential perceived by the network actors.
- Definition of the collaboration gap, meaning the difference between the current collaboration status and the potential future status of fully leveraged collaboration potential.

The result of this three step process is an overview over the network that provides a clear image of how network actors see the current collaboration status of the network, how much they believe collaboration could be extended towards an optimal future status and the difference between these two states. The approach is valuable for goal setting and draws a clear picture of what whole networks and their actors should aspire to. Figure 1 summarizes the approach. Each step is described in more detail as part of a combined approach in section 3.

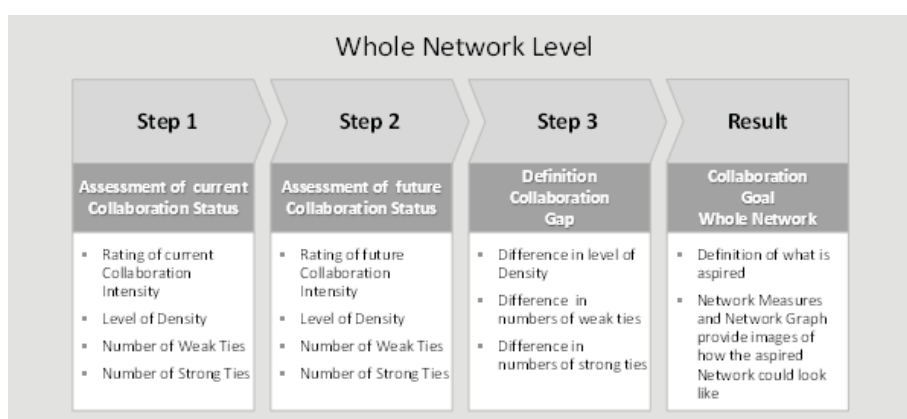


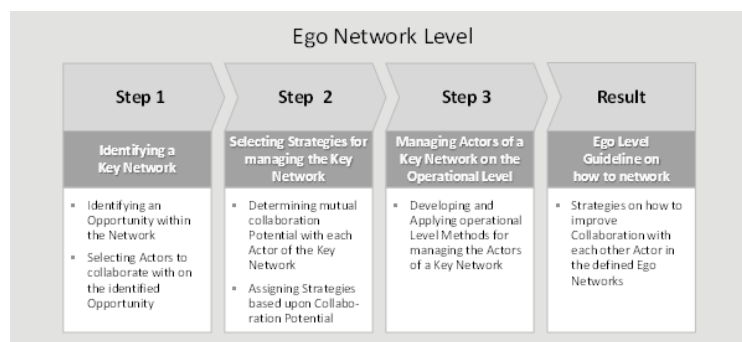
Figure 1: Network management according to Kohl et al. (2015a, 2015b) on the whole network level

Despite knowing their goal, individual network actors cannot derive strategies from this analysis on how to overcome the identified collaboration gap. In order to provide such strategies, an extension of the method is necessary. A potential candidate for such an extension may be *Key Network Management* (Ojasalo 2004).

*Key Network Management* as introduced by Ojasalo (2004) suggests a three step process of how single actors can develop strategies for managing their individual networks:

- The focal actor selects other actors to build a so called key network in order collaborate on an identified opportunity.
- One of four basic strategies that recommend different intensities of collaboration is selected for managing each actor of the key network.
- On the operational level methods for managing the actors of the key network are developed and applied.

As a result of the three step process an actor obtains strategies for managing their network contacts. It can be inferred whether to intensify, maintain or abandon certain connections in order to optimize the collaboration within the network. Figure 2 summarizes *Key Network Management*.



**Figure 2:** Network management according to Ojasalo (2004) on the ego network level

*Key Network Management* provides a guideline for individual actors on how to manage a key network. It is therefore valuable for network management on the ego level. What it cannot provide is a strategy for setting goals on a whole network level or for managing a whole network.

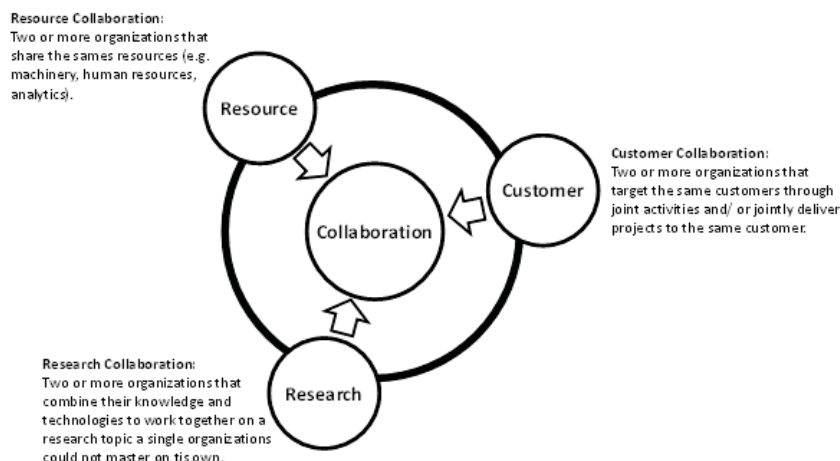
### 3. Combining the network collaboration improvement method with key network management: Two level network management

The network management approaches by Kohl et al. (2015a, 2015b) and Ojasalo (2004) may be viewed as complementary. The approach by Kohl et al. (2015a, 2015b) describes how collaboration goals can be set on the overarching whole network level, but it is limited in the sense that it does not provide a strategy for reaching this goal. Ojasalo (2004) describes how network actors can take decisions on the individual ego level on how to reach a better collaboration status, but the approach is limited by the fact that it does not consider the impact of the taken decisions on the whole network level. This research suggests combining both to a method that sets goals on the whole network level and provides strategies for reaching it on the ego level. Following, the method will be referred to as *Two Level Network Management*.

The following describes a way in which the two approaches may be integrated and applied jointly. The *Two Level Network Management* method that results from this combination is constituted by six steps. Each is based on either a single step of the *Network Collaboration Improvement Method* or *Key Network Management* respectively or integrates elements from both. While the first three steps rely solely on the *Network Collaboration Improvement Method*, the consecutive steps rather build on *Key Network Management* but rely on data gathered in step one to three.

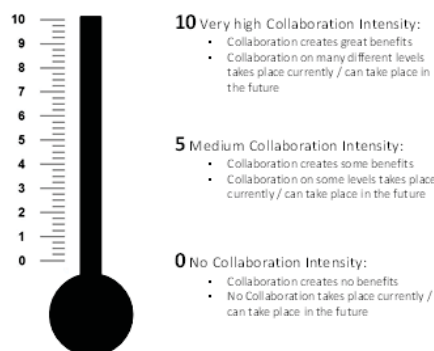
**Step 1:** In a first step the current collaboration status is assessed. This happens on three different collaboration levels. Namely customer collaboration, research collaboration and resource collaboration as defined by Kohl et al. (2014). Customer collaboration is characterized by two or more organizations that target the same customers through joint activities and/or jointly deliver projects to the same customer. Research collaboration is defined by two or more organizations that combine their knowledge and technologies to work together on a research

topic a single organization could not master on its own. Resource collaboration describes two or more organizations that share the same resources (e.g. machinery, human resources, analytics). This classification follows a definition of innovation activities provided by the OECD (2005) which highlights scientific, technological and commercial steps as important elements of the innovation process. Scientific activities are interpreted to take place on the research level, technological activities on the resource level and commercial activities on the customer level. Figure 3 illustrates the three different collaboration levels.



**Figure 3:** The three collaboration levels according to Kohl et al. (2014)

Via a questionnaire the network actors are asked to estimate the collaboration status with every other actor on a scale from 0-10. A value of 0 indicating no collaboration intensity, a value around 5 indicating medium collaboration intensity and a value near to 10 indicating high collaboration intensity. Figure 4 illustrates this. The data obtained from the questionnaire is then interpreted in terms of network density, defined as the percentage of potential ties within the network that have actually been established (Ahuja 2000), and tie strength, defined by the collaboration intensity that two actors perceive between them (Kohl et al. 2015a, 2015b). Ties with a collaboration potential of 3-5 are defined as weak ties, while a collaboration potential of above 5 implies a strong tie. Ties with a collaboration potential of 2 or less are neglected because of being too weak.



**Figure 4:** Scale of collaboration intensity

**Step 2:** Step 2 basically repeats step 1 but asks for an estimation of future collaboration potential in five years. This step is the basis for the projection of a future collaboration status.

**Step 3:** In a third step the collaboration gap is defined as the difference between the future collaboration potential and the current collaboration status. By assessing both situations as suggested in terms of strength of ties and network density, the collaboration gap can be expressed as the difference between the respective values.

**Step 4:** In the fourth step the key networks of each actor are defined. The *Network Collaboration Improvement Method* assesses networks on the three different Collaboration Levels customer, resource and research

collaboration. *Key Network Management* considers different collaboration opportunities. This research suggests combining both by interpreting the Collaboration Levels of the *Network Collaboration Improvement Method* as collaboration opportunities in the sense of *Key Network Management*. Thus, one may speak of the collaboration opportunity of resource exchange for example.

*Key Network Management* suggests to rate whether the capabilities of an actor to contribute to a key network are high or low. This is not very specific, since this scale does not allow for intermediate values and no exact criteria are defined of how to assign a potential partner to one of the categories. The 0-10 scale provided by the *Network Collaboration Improvement Method* is rather suitable for providing a more detailed assessment of the collaboration potential between two partners. Here, a network tie is defined as disposing of a collaboration potential between two actors of above 2 on a scale 1-10.

While the *Network Collaboration Improvement Method* infers tie strength from collaboration potential, the same method may be applied in order to infer an actor’s capability to contribute to a key network. Thus, the Collaboration Assessment Scale can be used as orientation for choosing the actors for a key network. Since a collaboration potential of above 2 on the scale 1-10 was defined as a threshold for defining ties, this can serve as a selection criterion for key networks as displayed in table 1.

**Table 1:** Selection criteria for key networks

Opportunity	Actor Selection Criteria
Resource Collaboration	Mutual future Resource Collaboration Potential > 2
Customer Collaboration	Mutual future Customer Collaboration Potential > 2
Research Collaboration	Mutual future Research Collaboration Potential > 2

**Step 5:** In a fifth step strategies are defined for each actor of the considered key network. Here again the combined method relies on data gathered according to the *Network Collaboration Improvement Method* and on evaluation according to *Key Network Management*. The assessment of network connections which was used for the selection of actors also serves as a basis for their categorization. Four categories are defined according to the 2-on-2 matrix suggested by *Key Network Management* (see figure 5).

Collaboration Potential the focal actor perceives regarding the partnering actor	High	Grow/ Invest	Develop/ Selectively Invest
	Low	Maintain/ Manage for Earnings	Abandon/ Manage for Cash
		High	Low
		Collaboration Potential the partnering actor perceives regarding the focal actor	

**Figure 5:** Strategies for the management of key network actors

The vertical axis displays values of the focal actor’s perception regarding the collaboration potential with the partnering actor, while the horizontal axis reversely displays values of the partnering actor’s perception regarding the collaboration potential with the focal actor. This is not exactly in line with *Key Network Management* as introduced by Ojasalo (2004), who suggested rather an evaluation of the match between an actor and a key network, than an evaluation of the match between two actors. The *Network Collaboration Improvement Method* does not assess the capability of a Key Network to contribute towards the goals of a certain actor. Neither did Ojasalo (2004) define clear measures of how to evaluate this. Instead, this research suggests replacing the value for “capability of a key network to contribute to an actor’s goal” through the collaboration potential that the respective actor perceives regarding another actor. In other words, the vertical

axis still maps the values for the capability of an actor to contribute to the focal actor's goals (its collaboration potential perceived by the focal actor), while the horizontal axis maps the values for the capability of the focal actor to contribute to the respective other actor's goals (its collaboration potential perceived by the other actor).

Building on Ojasalo (2004) *Two Level Network Management* suggests that when both sides perceive collaboration potential to be high (values 6-10), a grow/ invest strategy should be followed by the focal actor. When the focal actor sees high collaboration potential in a partner (6-10), while the partner does not reciprocate this estimation and rates the focal actor's collaboration potential rather low (3-5), the focal actor is recommended a develop/ selectively invest strategy. In the reverse case, when the focal actors sees low collaboration potential (3-5) and the partner rather high collaboration potential (6-10), a maintain/ manage for earnings strategy is recommended according to the model. When both sides assume collaboration potential to be low (3-5), the most suitable strategy for the focal actor is to abandon the connection or to manage it for cash.

**Step 6:** The last step calls for the development and implementation of operational level methods for managing the actors of a key network according to *Key Network Management*. Since this is highly case specific (Ojasalo 2004), no general recommendations can be given. The actors may consider the areas suggested by *Key Network Management*: products and services, organizational structure, information exchange, and individuals and take decisions appropriate to the situation.

Figure 6 summarizes the *Two Level Network Management* Method.

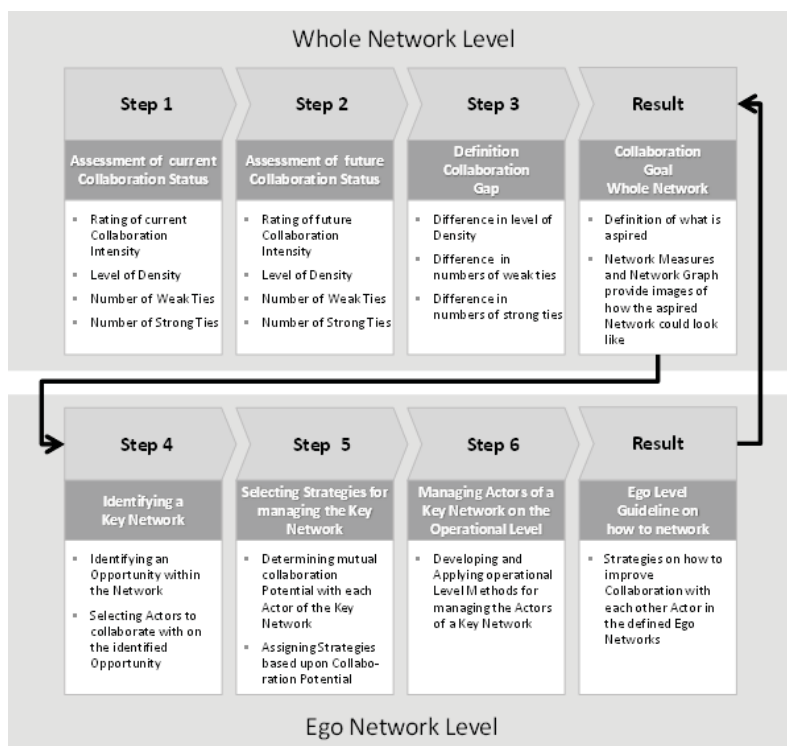


Figure 6: Two level network management method

#### 4. Case Study

In order to demonstrate the method, an innovation network of 20 research institutes has been analyzed. The collaboration status and potential was rated according to the *Network Collaboration Improvement Method*. For this purpose questionnaires were sent out to the institute directors. The participants were asked to rate the current collaboration status and future collaboration potential on the described scale from 0-10. Due to a partnership between the investigated innovation network and the Fraunhofer institute -to which three co-authors of this work are affiliated- a response rate of 100% could be reached. The results have been anonymized in order to assure data protection.

**Step 1: Assessment of the current Collaboration Status**

In a first step the current collaboration status is assessed according to the *Network Collaboration Improvement Method* as described by Kohl et al. (2015a, 2015b) through an evaluation of the questionnaire results. For the current network on an aggregate level the result is a level of density of 9%, constituted by 15 strong and 50 weak ties resulting in a strong ties / weak ties ratio of 0.28. Table 2 provides an overview over the network measures, including the individual values of the respective key networks of customer, research and resource collaboration. Data provided for the overall network has been summarized on an accumulated level. The values of the key networks therefore do not add up to the summary values.

**Table 2:** Current collaboration status

Level of Collaboration	Current Status	
	Density	Strong Ties/ Weak Ties
Customer Level	8%	14/50 = 0.28
Research Level	8%	14/51 = 0.27
Resource Level	12%	19/70 = 0.28
Summary	9%	15/50 = 0.28

**Step 2: Assessment of the future Collaboration Status**

The assessment of the future collaboration potential follows the methodology of step one. On an aggregate level the potential future network reaches a level of density of 46% and a strong ties / weak ties ratio of 1.39, constituted by 152 strong and 109 weak ties.

Table 3 provides an overview over the potential future network, including the key networks.

**Table 3:** Future collaboration status

Level of Collaboration	Future Potential	
	Density	Strong Ties/ Weak Ties
Customer Level	47%	131/146 = 0.9
Research Level	46%	140/127 = 1.1
Resource Level	45%	122/141 = 0.87
Summary	46%	152/109 = 1.39

**Step 3: Definition of the Collaboration Gap**

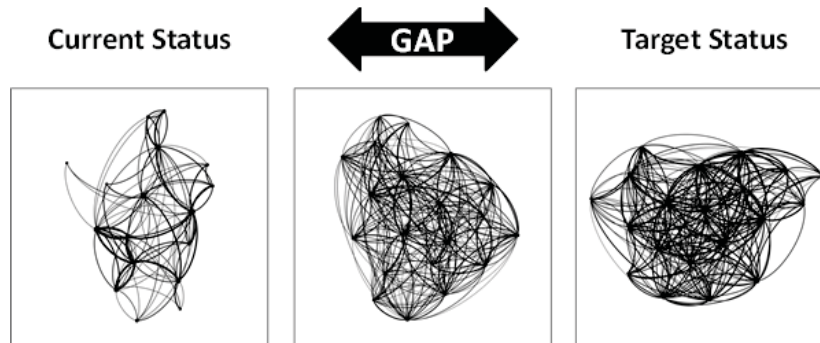
When comparing the two network structures the differences are striking. While the current network is relatively sparse and characterized by a high share of weak ties, the opposite is true for the potential future network. Moreover, an evolution of the networks becomes obvious. While the level of density develops very similarly for all three levels of collaboration, the strong ties / weak ties ratio differs across levels in the future network. The ratio took almost perfectly equal values for the current status but the future projection displays a significantly higher share of strong ties for the research collaboration level compared to the resource and customer level. This shows that although the three levels of collaboration seem to be tightly connected, there is still value in observing a network on different levels, since collaboration can evolve with a different intensity according to the area of collaboration. The Collaboration Gap shows the tremendous unleveraged collaboration potential of the investigated network. Strengthening existing ties and establishing new ones according to the analysis must be the goal for the whole network in order to increase innovation outcome. Table 4 displays the collaboration gap in numbers. For example in the customer collaboration network there is the potential for 117 more strong ties, 96 more weak ties and the potential to leverage additional 39% of the theoretically possible maximum network density.

**Table 4:** The collaboration gap – comparing current and potential future collaboration status

Level of Collaboration	Gap (comparing values of current and future status)		
	Strong Ties	Weak Ties	Density
Customer Level	131 - 14 = 117	146-50= 96	47% - 8% = 39%
Research Level	140 - 14 = 126	127-51 = 76	46% - 8% = 38%
Resource Level	122 - 19 = 103	141-70 = 71	45% - 12% = 33%
Summary	152 - 15 = 137	109-50 = 59	46% - 9% = 37%



Figure 7 seven visualizes current status, target status and gap between them by the means of network graphs. The tool Gephi has been used to create the presented graphs (Bastian et al. 2009).



**Figure 7:** Network graphs illustrating the collaboration gap

**Step 4: Definition of Key Ego Networks on Each Collaboration Level**

Step 4 calls for a definition of the key networks for each actor and each collaboration level. For illustration purpose the example of the key networks of one single research institute will be discussed here. Being an interesting case in terms of diversity regarding the key networks, institute 2 was chosen. Table 5 shows the collaboration potential that institute 2 perceives regarding the other institutes of the network (the first value of each cell) and reversely the collaboration potential that the respective other actor perceives regarding institute 2 (the second value of each cell). *Two Level Network Management* suggests including actors in a key network with which a mutual Collaboration Potential of 3 or higher has been identified. Value pairs that qualify for integration into the respective Key Network by providing at least this minimum level of collaboration potential are marked light grey, while those that do not are marked dark grey.

**Table 5:** Level of mutually perceived collaboration potential (light grey = sufficient, dark grey = not sufficient)

Institute Nr.	Resource Collaboration	Customer Collaboration	Research Collaboration
1	8 / 9	10 / 9	9 / 6
2	x	x	x
3	0 / 0	5 / 7	7 / 7
4	2 / 5	1 / 6	1 / 4
5	3 / 5	5 / 3	5 / 5
6	7 / 10	5 / 5	8 / 5
7	8 / 0	10 / 0	9 / 0
8	7 / 8	8 / 5	9 / 6
9	0 / 0	0 / 0	2 / 0
10	5 / 4	5 / 6	8 / 6
11	4 / 7	6 / 5	7 / 7
12	4 / 9	1 / 7	6 / 8
13	0 / 5	1 / 5	2 / 6
14	0 / 7	1 / 7	1 / 7
15	8 / 3	7 / 5	5 / 4
16	0 / 0	0 / 10	0 / 0
17	3 / 8	6 / 8	4 / 8
18	0 / 5	0 / 7	1 / 7
19	8 / 3	7 / 3	8 / 5
20	0 / 7	5 / 3	7 / 3

Based on an analysis of table 5 institute 2 should currently not include institute 4, 7, 9, 13, 14, 16 and 18 in its key networks, since at the moment there is not sufficient mutual collaboration potential for none of the three collaboration opportunities. Furthermore, institutes 3 and 20 should currently not be included in the resource collaboration key network. Institute 12 should not be considered for the customer collaboration key network. Exclusion from one of the three key networks does not mean that collaboration on the specific topic with a specific partner is out of the question. Especially since key networks need to be reevaluated frequently (Ojasalo 2004) and an excluded actor may be included again in the near future. It merely means that the focal actor



focuses primarily on different partners in the respective context. Following the evaluation of table 5 institute 2 may choose to collaborate in the respective Key Networks with the following actors as displayed in table 6.

**Table 6:** Actors of the key networks of institute 2

	Resource Collaboration	Customer Collaboration	Research Collaboration
Institute Nr.	1	1	1
	5	3	3
	6	5	5
	8	6	6
	10	8	8
	11	10	10
	12	11	11
	15	15	12
	17	17	15
	19	19	17
		20	19
		20	

**Step 5: Determination of Strategies for each Actor of the Key Ego Networks**

The choice of the correct strategy for managing each network actor is based upon the mutual evaluation of the two partners. Actors not included in table 6 have been excluded from the key networks of institute 2. The remaining actors are those that have been selected to be part of the key networks and now need to be managed. When looking for strategies, the matrix derived from *Key Network Management* is applied (see figure 5). Following the mutual collaboration potential displayed in table 5 and the strategy matrix presented in figure 5, institute 2 can be provided with strategies on how to manage each actor of their key networks. This can be illustrated for instance via collaboration portfolios as demonstrated for the case of resource collaboration in table 7. The partnering actors are represented by the numbers 1 to 20.

**Table 7:** Resource collaboration portfolio

Collaboration potential the focal actor perceives regarding the partnering actor	High	1, 6, 8 Grow / Invest	15, 19 Develop / Selectively Invest
	Low	11, 12, 17 Maintain / Manage for Earnings	5, 10 Abandon / Manage for Cash
		High	Low
		Collaboration potential the partnering actor perceives regarding the focal actor	

Table 8 provides a complete overview over how institute 2 should manage its three key networks following the evaluation of table 5.

**Table 8:** Strategies assigned to the management of the individual actors of the respective key networks

	Resource Collaboration Network	Customer Collaboration Network	Research Collaboration Network
Grow / Invest	1, 6, 8	1, 17	1, 3, 8, 10, 11, 12
Develop / Selectively invest	15, 19	8, 11, 15, 19	6, 19, 20
Maintain / Manage for Earnings	11, 12, 17	3, 10	17

	Resource Collaboration Network	Customer Collaboration Network	Research Collaboration Network
Abandon / Manage for Cash	5, 10	5, 20	5, 15

#### Step 6: Developing and applying operational Level Methods for managing the Actors of the Key Networks

Step six is highly case specific and refers to the operational level (Ojasalo 2004). This is where collaboration is executed on a daily basis. It opens up a whole new topic which is too complex to be included in this model in detail.

### 5. Discussion and conclusion

As the impact of networking on innovation has widely been recognized, there is an emerging and hugely unsaturated demand for methods of managing (innovation) networks. This paper presented a new method of network management as way of increasing innovation output. So far network management approaches that set goals for the overall network and provide guidelines to individual actors on how to contribute to those at the same time had been missing. The research at hand suggested bridging this gap by combining two methods that are respectively limited to one of those levels. In conjunction they can add to each other in a way that compensates those limitations.

The presented approach connects to a former model of innovation network management by Dhanaraj and Parkhe (2006), who also stressed the role of network structure and the importance of selecting the right actors for innovation networks. Other scholars have likewise suggested methods for rating the actors of a network portfolio that finally can be used for deriving networking strategies (Jüttner and Schlange 1996). This again links to the introduced method and furthermore to the concept of *network pictures* by Ford et al. (2002), which states that there is no objective network but only different perceptions of it held by its actors. Rating network connections may be viewed as a way of quantifying those *network pictures*. While the concept of assessing the potential future state of a network numerically is new, the idea of anticipating future network structure and planning accordingly has previously been discussed by other scholars (see Möller and Halinen 1999 and Tikkanen and Renko 2006). Furthermore, the development of specific management strategies for individual network actors has been suggested by previous research, too (Jüttner and Schlange 1996).

The discussed case study demonstrated how the two combined methods can indeed work hand in hand, being integrated to a new approach labeled *Two Level Network Management*. While the presented case has shown how strategies for reaching networking goals can be developed, it is limited in the sense that it cannot provide guidelines on how to implement those on an operational level. This is also true for guidelines for the identification of collaboration opportunities. Further, no measurement of innovation outcome has been considered for controlling for the effectiveness of the suggested innovation network management approach. This calls for further research. Especially practitioners could profit from further elaborating on the operational level of the method. Further, longitudinal research will be necessary to validate whether the developed network management method eventually accomplishes its goal of leading to an improved collaboration status and an increase in innovation outcome.

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