The Formation Processes of an R&D Network: A Case Study

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Abstract

Because of fundamental changes in the competitive environment the amount of resources and knowledge needed in R&D activities has become overwhelming for a single organisation. Thus there is a strong need to perform R&D activities effectively in networks. This study increases the understanding about research and development networks by presenting an empirically grounded process model of formation processes of R&D networks. The model has three main elements; the initial conditions, the network webber and the cycle of sub-processes through which the formation proceeds. The process model highlights the importance of a single actor – the network webber – both in triggering the formation process and in managing the process. Moreover, the model suggests a view of the process that is cyclical – the sub-processes of enabling the network, joining, assuring continuity, formal structuring, learning and developing commitment – do not follow each other in a certain order.

1 Background of the Study

Nowadays both companies and research & training institutes share a strong need to perform research and development activities effectively in networks of many actors. There are several reasons that explain why the change from internal R&D activities to R&D networks has taken place. Firstly, fundamental changes in the competitive environment have resulted in a situation where the amount of resources and knowledge needed in R&D activities has become overwhelming for a single organisation. Technological fragmentation, the increased cost and importance of knowledge, developed information and transportation technology and positive previous experiences of co-operation are among the reasons that have increased the feasibility of external R&D activities [22]. Even in large multinational companies networks have replaced the traditionally market based and vertically integrated structures with more dynamic R&D networks.

Secondly, different companies and research & training institutes lack different resources or knowledge. Thus there is a need to form networks of actors with complementary resources and knowledge. Therefore, R&D networks often include different types of actors; competitors, suppliers, customer companies, research and training institutes, which perform R&D activities jointly [9]. Through intensive co-operation with research and training institutions companies can keep up with new technologies and the advancement of science. Companies gain an indirect contact with the international scientific community, which provides them insights in latest basic research and an access pool of technically and scientific sophisticated personnel [22]. Reciprocally R&D institutions receive vital external funding from companies as well as from national funding agencies. A network formation can even be a prerequisite for such external funding [12].

Thirdly, performing R&D activities in networks can also produce extra value for the participants. Formation of dense networks of contacts improves innovative capacity and fosters economic growth [22]. The result of this tendency is that the source of innovation is no longer a single actor or an inventor, but a network of interrelated actors. According to Easton [7, p.24] “inventions and innovations occur in networks not within but between firms”. This being the case, there is a great need for knowledge about how to manage an R&D network effectively, so that each actor in the network creates and receives value.

The question of managing in networks (see eg. [21]) can be approached from two different angles. A strong research tradition in strategic networks or strategic nets (e.g. [16][11][21]) endorses and accepts the idea of a single actor influencing the structure of the network and the positions of the companies within the network. From this perspective a network can be initialised (e.g. [4][3, p. 176]) or managed by single operating actor. In other words, one company can manage, in addition to its own actions, also the actions and reactions of all the other actors in the network.

A contradictory view is suggested by the Network Approach (see e.g. [7][8][13]). The approach argues that networks as such cannot be managed nor designed by a single individual or even by a single company. The argument is that networking is essentially acting, interacting and reacting and an actor cannot dictate the reactions of other actors in the network [8]. A company within network must accept that the outcome of networking is a synthesised result of all companies involved in network. The outcome of any action by a single actor is seldom restricted to actors’ original aims. Håkansson & Ford [8] claim that although a company may initiate change in the network, the achievement of the change is still dependent on approval and actions of others. Thus the actors within network have to adapt their goals to the goals of other actors in the network continuously [8].

When looking at the two above mention approaches on network management together, there is a major contradiction between them. The contradiction of networks’ inherent characteristics of being self-evolving

and unmanaged and on the other hand, the possibility to manage R&D networks forms the starting point of this research. Our research focuses on the early stages of network development, in other words on the formation of R&D networks. The model generated in this study relates strongly on strategic network literature and previous research on R&D network formation (e.g.[4][3]).

2 Purpose of the study

This study increases the understanding about managed formation processes of R&D networks. Thus we focus on engineered formation processes [4] and develop an empirically grounded process model of engineered formation of an R&D network. We build the model in three sections. The first part of the model describes the *initial conditions* of the engineered formation process. The second part discusses the role of a single actor, i.e. *a network webber* in managing the network formation process. The final part of the model describes the *activities* performed during an engineered formation process of R&D network..

In the following sections we first describe the method through which the empirical grounding of the model has been taken place. The empirical data is gathered from a members of a research and development network in Finland. Thereafter, we present the empirically grounded model of engineered R&D network formation and discuss each of the three parts of the model more thoroughly. The paper concludes with a discussion of the merits and demerits of the model that pave ways to further research.

3 A Case Study of Network formation

We conducted a longitudinal single-case study to provide data for the empirical grounding of the R&D network formation model. The existing research on R&D network formation is mostly retrospective. Therefore, we chose to conduct the data collection as a follow-up study, enabling us to analyse the whole formation process real-time.

The case is an engineered formation process of a R&D network. The focal network designs and develops mobile, context aware mobile multimedia services to end-consumer environment. The networks is financed from two main sources. The most remarkable stakeholder is the National Technology Agency of Finland, TEKES. The rest of the funding comes from the private companies that have joined the network. The network consists of technology companies, software companies, content providers, City of Oulu, local retailers (small ones through their joint non-profit organization), and research groups from the University of Oulu as seen in Figure 1. Each actor group is connected directly to the research groups and indirectly to other actors via the research groups. The dash line rectangle around the research groups points out the border between research and business consortium in the network.

The formation process of the network begun early 2002 among the researchers at the University of Oulu. The network can be roughly divided into two consortiums. The research consortium consists of researchers from faculties of Technology, Economics and Business Administration, and Education. The business consortium includes local, international and global companies. Thus the actors that form the focal network are versatile and heterogeneous both on their capabilities and their needs.

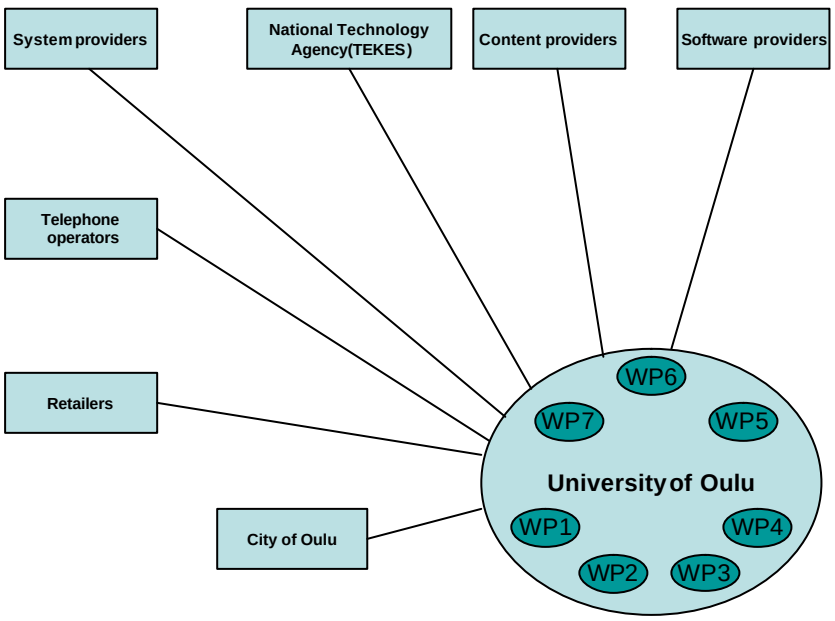

Figure 1. The overview of the case network

Gathered data consists of various types of information from the case network. Data were gathered through several personal focused interviews (see [20]) from different actors within the network under formation. The reason for utilising interview as a method for data gathering was the possibility to direct the focus of discussion during the interview. By interviewing it is possible to reveal the motives behind the actions of the interviewee. Focused interviews offer several advantages compared to other interviewing methods [20]. The interviewees can be selected among those that are knowledgeable of the issues under research attention. Secondly, the researchers have the opportunity to guide the structure of the situation with the use of theme lists. Focused interviews enhance the possibility to react to the responses of the interviewee and probe more deeply into interesting issues.

We selected four companies and two research groups to be interviewed on the basis of their membership in the network and the importance of their role in the network. The seven individuals interviewed were important contact persons of their company or research group, namely a CEO of a software company, a sales director of a software company, a sales manager of a global hardware provider, a CEO of a non-profit organisation representing the local retailers, a research director responsible of the whole research project (later referred to as PhD Timothy), and two research directors from different research groups (PhD Ann, PhD Philip), representing different scientific approaches and orientations. All interviews (in total 265 minutes) were tape recorded and transcribed producing in total 58 sheets.

In addition to the interview data we gathered empirical data through participation observations, as both authors took part in several official and unofficial meetings that took place between the members of the network. We also had access to all written material produced during the network formation, such as project plan, e-mails, PowerPoint slides, status reports, minutes of meetings, and press releases.

The nature of follow-ups study obscured the time span of data gathering for this study. The majority of data were gathered during 9 months, from August 2002 until the end of April 2003. Having said this, we have to admit that some important events took place a few weeks later and we have included them into the empirical data as well. We feel that, to restrict the data gathering tightly to certain dates would not have been the best solution in this case. The development of a network is never-ending continuous process and that is why any restriction to the dynamic process is always an artificial one. The ending of network formation or any other phase in network development can not be stated exactly, hence the data gathering has to be flexible. This way the rich data enabled us to form a comprehensive picture of the initial conditions, formation processes, and the role of a single actor managing the network formation activities.

4 The Process Model of Engineered R&D Network Formation

Before introducing the model of R&D network formation, it is essential to discuss the approach this study applies when it refers to a process. Process refers to a sequence of events or activities, which describe the development over time [24]. In this study process is considered through a teleological perspective as we see the process of forming a network as a purposeful cooperation of the actors (see [24][25]). Applied in the focal case, a teleology process sees the network as a purposeful and adaptive entity, which has a jointly preferred end state towards which it reaches. The network thus pursues such actions that move it closer to the end state, which in this case is the formation of R&D network to produce an innovation. However, the process is seen as a multiple streams of activities, not as a continuous stream of sequences or phases. In addition, the network's recourses and environment may limit the process. This is why the outcome of the process is not known in advance, because the actions of the actors may also change the goal.

As pictured in Figure 2, the process model of engineered R&D network formation depicts the three main elements in R&D network formation; *the initial conditions* of the R&D network under formation process, *the role of the network webber*, and *the cycle of sub-processes*. The initial conditions, i.e. shared interest of the actors, interdependence among the actor, and the existence of a network webber influence each other as well as the network formation. The role of network webber is emphasised - the reason for doing this will be explained later in the paper.

The cycle of sub-processes contains six intertwined series of activities that take place during the network formation: enabling network formation, joining, assuring continuity, formal structuring, learning, and developing commitment. Together the sub-processes form the network formation process. Each sub-process is affected by the initial conditions and each sub-process may also influences other sub-processes. The intensity of a certain sub-process as a part the network formation process can vary from low to high. The higher the intensity, the more important the sub-process is.

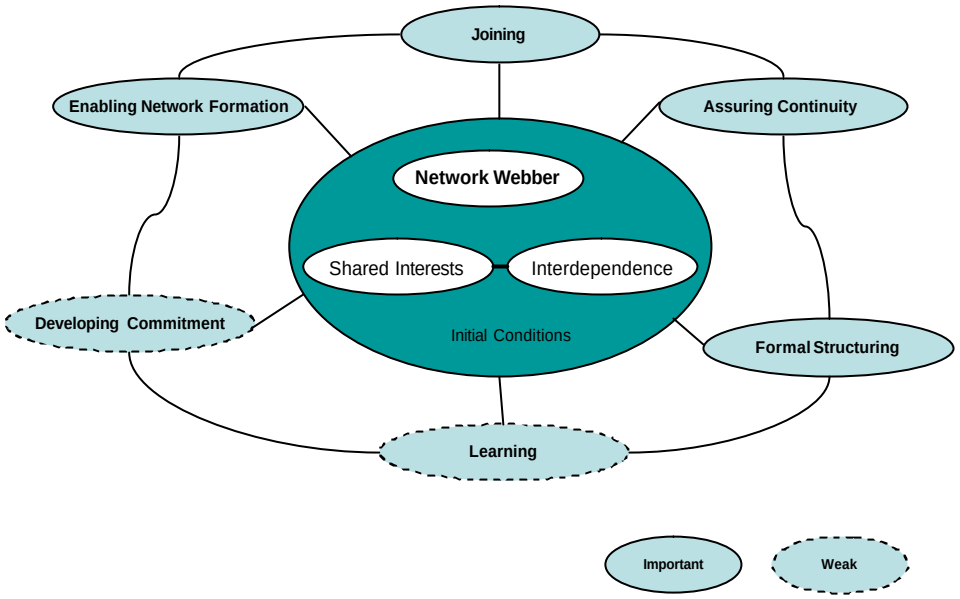

Figure 2. The Process model of engineered R&D network formation

The existing research (e.g. [4]) suggests that the sub-processes or stages of the network formation follow each other like steps in a staircase. We argue that this is not the case. Based on the empirical grounding, we are able to show that some of the sub-processes can take place at the same time, over a long time period and sometimes the process may return to previous sub-process forming loops within the process. Thus we suggest that there is no clear order of appearance in the sub-processes, they may take place simultaneously and partially, as well as that the network actors may repeat the sub-processes during the formation process. In the following sections each of the elements of the model will be discussed more thoroughly also in the light of the empirical data.

4.1 The Initial Conditions

According to existing literature on co-operative R&D processes (e.g. [4]) the network formation process is dominated by three sets of initial conditions. First initial condition is the actors' perception of interdependence caused by variety forms of change in the surrounding environment (e.g. [26][23]). Second initial condition is the existence and recognition of joint interests among the potential members of the network. Thirdly, the intervention of single energetic actor, which we call the network webber may trigger the formation process of R&D network.

4.1.1 Interdependence

Interdependence as initializing condition refers to the needs and willingness of single actors to perform R&D activities with other members forming the potential network. Existing research (e.g. [4][24]) has also shown that companies tend to respond to their perceptions of interdependence by collaboration. The level of interdependence may of course vary significantly depending on the company. It is relevant to consider the level of interdependence, because the more the actors perceive their environment and the changes in the surrounding environment similarly the more willing they are to co-operate. If the changes of surrounding environment are not perceived the same way, the initialisation of network formation requires external influence typically provided by network webber.

In the case network, there are significant differences among the actors of the network. This diversity is related to the heterogeneity of the actors and their perceptions of their environment. Thus the incentive to join the network and the source of interdependency varies among the different type of actors. Small software companies seek marketing related benefits from co-operation. The companies have limited marketing resources and they expect to gain public relations benefits by operating jointly in nationally funded research and development network that attracts the public interests. University's research groups and technology companies' interests lie in the latest knowledge that the research project can provide. In addition, university research groups lack funding, and research networks are a way to attract outside funding, both from companies and form governmental sources. E.g. the National Agency of Technology (TEKES) requires co-operation with business life from any university research project for it to receive

funding. Research groups may also receive technological resources from companies. Scarcity of R&D resources combines both corporations and university research groups. University research groups can gain access to business context via technology companies. On the other hand, the companies need research groups to provide rigorous scientific research, which for the small companies is not possible because of the lack of resources. The following quotations illustrate how the actors perceive interdependence in their case.

PhD Timothy: *"Nowadays the persons that are responsible for R&D in certain companies receive so many project proposals…the change has been radical, if we compare to the past decade… they can compare and select only the ones they perceive interesting"*

PhD Ann: *"In fact we have… studied this area theoretically before this project and this is a quite logical extension to that. On the other hand, the mobility and mobile applications in our field are coming into the focus, but it is still quite shallow… which provokes severe criticism from a researcher. In a sense we have looking for this type of project earlier."*

In the focal case, the level of perceived interdependency was relatively low. Our view is that the reasons for this were the heterogeneity of the actors (e.g. high technology companies vs. small local retailers, international vs. local companies) as well as the task of the network, which is difficult to understand for the local retailers lacking the basic skills and knowledge in mobile systems. Our conclusion is that the level of interdependency was not high enough to alone initialise the formation of the network, but it was high enough to get the actors interested in the potential co-operation, once the opportunity was offered to them.

4.1.2 Shared Interest

The initialisation of R&D network requires also interest similarity between actors. The actors with pre-existing relationships, common industry origin, similarities with organisation structures and positive previous experiences in co-operation in R&D activities tend to recognise the interest similarities more effectively than the ones lacking similar experiences. The actors should be able to identify significant shared interest to initialise the network formation [4].

CEO of a Software Company: *"Actually we joined the project for the sake of interest. We like to be in a project, which in a certain way investigates the development of this business from customer's and service provider's perspective. Naturally, because we belong to this distribution chain we are interested to hear how the other members of the chain operate and what kind of expectations they have."*

4.1.3 Network webber

Third initialing condition in R&D network formation is the influence of the network webber. Network webber refers to a single actor in network, which proactively identifies even weak interdependencies and interest similarities among other potential members and communicates these findings to the actors persuading them to join the network, in other words to perform the R&D activities jointly. It is very common that a central organisation or a central firm takes the role of the network webber (e.g.[18][5][14]) Also individuals or groups of individuals (e.g. [15], which potential actors find legitimate, justified and neutral initiators (e.g. [3]) can act as network webbers.

The network webber operates in a structure hole (e.g.[1]) combining relevant potential actors to form the network but also restricting irrelevant actors outside the network. The role of the network webber extends to also the later sequences of network formation, as the collaboration initiator may also possess an assuring role among network actors [3, p.177].

In the focal case, the heterogeneity of actors affected the relatively low level of interdependence joint perception of the surrounding environment. Thus an outsider was need to point out the potential actors that they shared common needs and that they may expect certain benefits from co-operation. In other words, a legitimate network webber was needed to trigger the formation process. In the case, it was very clear that the research director, PhD Timothy took the role of the network webber, as the following quotation illustrates.

PhD Mary: *"Without a doubt - Timothy has been guiding the formation of this project and research consortium."*

The other network actors may perceive the strong position and influence of network webber as a threat towards themselves and the fulfilment of their own interests. Any change within network is always a result of joint acceptance among actors involved. (e.g.[13]) and therefore the actions of the network webber have to be accepted by the other actors in the network. A network provides almost endless possibilities of combining actor's resources. However, any innovation is created among those actors who perceive a useful combination and seize it. The network webber perceives opportunity and shares the notion with other actors, which seize the opportunity. The actors in the network accept the required change, as long as they perceive that the benefits from the change are mutual ones. Therefore, as long as the network webber acts benefit the joint goal of the network, the role is accepted. The role may also be perceived as an opportunistic behaviour, which would not be accepted by the other actors in the network.

In the focal case, the actions of the network webber were considered as a positive and the other actors accepted them. The network webber also allowed the other actors right to make decisions concerning their own preferred line of action, and then tried to fit and adjust these decisions into actions that guide the network towards its common goal, also shared by the network webber.

PhD Timothy: *"As a Responsible Director I have to make the final decision. Naturally we seek consensus and we have a conclave of research directors in which we discuss the decisions, but somebody has to take the final responsibility. Thus you receive the power to make*

decisions."

PhD Timothy: *"We have had series of Research Group Directors' meetings and everybody have had a possibility to contemplate also independently. Naturally the technical framework, which we have created, defines in a sense what can be done, but outside that, it has been their responsibility and in their interests to define what they want to do."*

4.2 The Cycle of Sub-processes

The third element of the R&D network formation model is the cycle of sub-processes, which describes the activities undertaken during the formation process. The cycle consists of several series of activities: e*nabling network formation, acquiring actors, formal structuring, assuring continuity, learning* and *developing commitment*.

4.2.1 Enabling network formation

By enabling network formation we refer to such activities that aim to develop the fundamentals of co-operative action. Through enabling network formation the potential network actors create a consensus of network domain. (e.g. [4][3]) The network domain consist number of mutual definitions among actors about performance expectations, goals, participants of the network and scope of co-operation. Prior positive experiences between actors and trust tend to lighten these activities. [6][10]

The effect of the network webber (i.e. PhD Timothy) was significant in the case that we analysed, since he took care of more than one task in enabling the network formation. The network webber was the main source of the original idea of forming the R&D network. Therefore his first role was to act as a representative of a R&D network, which did not exist at the time. The network webber set up all the meetings and discussions, chaired the occasions and communicated the basic goals of the network, the performance expectations, and the scope of co-operation as he planned them in his mind. During the first discussion with the potential actors the goals, expectations and the scope of co-operation were negotiated and the voice of the actors willing to joint in the network was incorporated to the original idea, as illustrated in the following.

PhD Mary: "I would say that our goals remained quite the same, like they were at the beginning. Of course the restrictions related to the project, like the resources, timetables etc. had to be taken into account."

Some of the other actors counted on the network webber to enable the formation of the network and only wanted to react if the webber approached them. Some even considered the task of reaching a consensus over the basic elements of the network as a task solely for the network webber. These actors felt that it was not important for them to influence the basic premises of the research co-operation, since they were willing to accept them anyway.

PhD Ann: *" ….of course I have maybe wanted to be a little bit … or wished more just to follow from the background, than to be very proactive during the early phase, because the procedures follow more or less TEKES procedures, which define the rules or the game which relate more to the know-how of the Faculty of Technology than of ours."*

CEO of a retailers' non-profit organisation: *"Entrepreneurs from different lines of business, like retailers, restaurants, service providers etc have been involved. They have provided pointers, but more like in basic issues of doing business.*

PhD Mary: *"But maybe there is that MTeam (PhD Timothy's research group) has already gone quite a long way, they have done a lot of work outside the project. We cannot influence that much what they present as their project.*

However, there were many meetings where the University research groups had to discuss their goals and expectation related to the network, since there was a need to produce a common research plan to be presented to potential company actors as well as other funding agencies. The research plan included most of the definitions that the company actors as well as the funding agency accepted and therefore they perceived the network attractive and joined in. However, the research plan was deliberately left on a rather general level when addressing the co-operation of the company actors. This resulted in a situation that once the research plan had been presented to the funding agency and accepted by it, the network started to negotiate with each of the company members their specific role in the network. Thus the time span during which the network formation enabling actions were performed was rather long.

4.2.2 Joining

The sub-process of joining includes all the actions that the actors in potential network perform to seek and persuade other potential actors to join the network as well as the actions of actors wishing to join in. The sub-process consists of several activities of attracting new potential actors, selecting suitable actors among all the potential ones and restricting improper actors outside [4][3, p.177] The task in selecting potential members is not to find the best possible individual actors, but find the ones that perform best together. As Lundgren [19,p. 211] puts it, the challenge is to create policies that foster technological evolution on whole rather than of the parts. It is not difficult to find companies, research organisations or university research groups that are capable of performing R&D functions. The key is to find such actors that have the ability to joint decision-making concerning the task and goals of the network [3, p. 177][4].

In the focal case, the network webber made direct contacts to each and every actor that joined the network. However, the network webber was neither the only nor necessarily the first to take a contact. The actors joined to the network via three alternative routes. Firstly, network webber evaluated group of potential actors and contacted them directly offering them the possibility to join in. Secondly, actors willing to join in the network contacted

the network webber directly, since they had heard rumours about the project. Thirdly, some members of the network knew or found out about other potential members and contacted them directly. After the first contact, potential member was put into contact with the network webber. Also actors interested in the network contacted network members, which directed the potential ones to the network webber.

The webber was the main decision maker who accepted actors as members, if the actor itself was willing to join in. Thus the network webber had two roles during the sub-process of joining. The webber both persuaded potential members to join in and dissolved relationships with some actors willing to participate but not considered suitable. Although many of the network members took part in acquiring new members, only the network webber had the role of restricting actors.

PhD Ann: *"Timothy contacted Eric (another research director) and he knew us based on previous projects and he like knows what our research group does.*

Sales Manager of a hardware producer: *"Our co-operation started when PhD Timothy contacted us to discuss the opportunities our WLAN solutions would offer. We discussed and reached a successful agreement that enhanced the start of the co-operation."*

CEO of a Software company: *"Well, the joining the project was really an accident… I heard that there was a new professorship at the university… and I thought that since it was related our line of business I will contact him and ask if we he could share his views with us. He then told me that the there is one project that is starting and it would be an opportunity for co-operation. The professor then asked me to contact PhD Timothy and we agreed that I will continue the discussion with him."*

PhD Timothy*: "In a way, Company X operated as a bridge to Company Y."*

Although the influence of the network webber in the focal case was considerable in acquiring the actors, there were also cases were the webber did not succeed. Some actors that were contacted by the webber and asked to join in refused to invest resources in the co-operation. There were also some environmental constrains restricting the acquisition of new members. A local department store was actively involved in enabling the formation of the network. However, the store did not join in the network since the local manager of the store had to get approval from the head office of the chain, which unexpectedly forbid the store manager from joining in. There were also other similar situations where the real decisions-makers were not local. Since the network webber could not get into contact with the decision-makers, the company did not consider joining the network useful for them and thus refused the invitation.

PhD Timothy*: "We even had a group from Organisation Z that developed a certain technology, but it did not lead to… And then the connection to Z became weaker and weaker. I wouldn't say that it broke down, but… At the moment it seems that the Organisation Z will not join the project. I am sure they will not."*

4.2.3 Assuring continuity

The sub-process of assuring continuity in the network formation process refers to all actions directed towards creating and communicating perception of the future benefits that the co-operation will offer as a reward for the investments of resources. Thus the members should share positive expectations of the co-operation in order to continue investing time and money into it ([3, p.177][4]). One essential element in the positive expectations is trust between the members of the network. Trust is gained through preventing opportunism either by sanctioning it in the contract [4], referring to a partner's reputation of being trustworthy [10], or referring to the history of successful past co-operation between the members [2]. The actors within network under formation may not have a history of co-operation and therefore the signs and conditions that raise the reliance on each other are vital for the network's future success [4]. The willingness to adapt and continuity of actor policies and priorities communicate credibility in joint operations [3, p. 178].

In the focal case, the most important precondition of continuity was the acceptance of the major funding organisation, TEKES. However, the acceptance is always based on the funding that other network actors, in this case the private companies and the city of Oulu provide for the network. Thus to assure major funding, the companies had to perceive that the network had a good chance of being accepted by TEKES, as all the funding from it is competitive and there is a large number of projects than do not receive funding.

In addition, in spite of the uncertainty of major funding the University research groups prepared for the project by investing their resources and setting up the infrastructure needed for the network. Thus the network webber was able to show concrete results of the network already during its formation. This way the University was perceived by the potential members of the network as a reliable research partner, that probably would also during the project deliver what it promises.

PhD Ann: *"Well of course the financial issues, as usual. Also, I think that everybody has pondered if and when we will reach the point of not understanding each other. This kind of multidisciplinary is always a possibility, but it is also a threat, since we have to respect the fundamentals of each discipline any way. We think that we know what the other work group is doing, but we cannot fully understand it, because it is a different discipline."*

4.2.4 Formal structuring

The last activity, which possesses a strong effect status in our model, is formal structuring. Formal structuring refers to actions designed to create structures that enhance co-operation, decision-making, communication, and learning [4]. Formal structure may consist of written or verbal agreements (e.g. a research agreement, a project plan) between actors, decision-making procedures or joint decision making organs. Formal structures can also include procedures through which conflict situations are resolved and exits from the network are accepted.

In the focal case the level of formal structuring was relatively low. During the nine months period that we followed the formation process intensively, the companies did not sign any agreements. However, the research groups needed to write a research plan and a project plan to apply for funding from TEKES. The documents also included plan of the formal structuring, namely designs for the steering groups, operative steering groups, project meetings, meetings of research directors, documentation procedures etc. All the companies that had orally agreed to join in and finance the network were listed in the documents, although they had not signed anything. Thus a high level of mutual trust was present and the members did not expect to meet any opportunistic behaviour from other members.

CEO of retailers' non-profit organisation: *"We have not made a written contract at the beginning.… …we have an oral agreement which divides our responsibilities between MTeam and our organisation. However, we have discussed our co-operation and ways of working together among our board members and internal committees."*

Since the network formation process took a long time, and there were no pressures to contribute financially until the national funding organisation accepted the application the companies could rely on oral agreements. After the acceptance from TEKES arrived during summer of 2003, all the involved actors had to agree on the terms of the research agreement and sign it officially. This process was still going on in the autumn of 2003. However, the plans to organise the project management that already appeared in the application documents were immediately put into practise once the funding was accepted. The steering group was set up (one member from each member) and in the first meeting, chairpersons were elected as well as individuals in other management groups.

As far as the research groups are concerned, their work became formally structured much earlier. Research directors meeting was the location where the groups co-ordinated their plans and efforts in the network.

PhD Timothy: *"In the research directors' meetings we have discussed work packages and the funding application as a whole. This means that everything that we have agreed on should be in the funding application and in the contents of the work packages. To the best of my knowledge, there were no discussions outside the meetings. It has progressed during the meetings."*

In the following sections we will discuss two of the sub-processes, learning and developing commitment that remained less important in our case example.

4.2.5 Learning

A company has to have an ability to learn from other actors if it wants to receive its share of the benefits that the co-operation in the R&D network brings. Inability to learn and adapt may even endanger the continuity of co-operation and lead to a dissolution of the joint activities [4][2]. The nature of any network is stable but, not static [7], meaning that even existing networks change, but the change is rarely quick and radical. Since the actors joining an evolving network face a high level of change, e.g. new members joining in and thus changing the network, the need to adapt is also high. Thus the inability to adapt may easily lead to re-evaluation of the position of the actor in network. The level of interdependence and shared interest as initial conditions of network formation also affect the actors' abilities to adapt and learn from other each other. The actors perceiving high levels of interdependence and similar interest tend to be more capable of learning than actors that have joined the network solely because of network webber's efforts.

The network actors' learning in the focal case was not extensive. We suggest that during the formation process, the co-operation between the members of the network did not reach such an intensive and concrete level that would enhance learning from each other. However, in the relationships between software companies and the research group that PhD Timothy is responsible of, we could find clear indications of learning, since they had reached a concrete level of co-operation already during the network formation phase.

Sales director of a software company: *"For us the co-operation has already given a chance to exchange knowledge on technology. We have received feedback concerning the bugs in our software and some new ideas for further development of the software."*

CEO of a software company: *"Indeed we have received some pointers and thoughts concerning the direction to which the services are planned to develop. Through that we have learned new visions for the future."*

4.2.6 Developing commitment

The last activity of the activity cycle is labelled as developing commitment. Commitment development includes all actions to increase the awareness of single actor about their significance as a member of R&D network under formation. Through increasing awareness among actors each individual actor notices the importance of other partners as well as their own significance in R&D network. Successful collaboration starts feeding itself. Through establishment of a common ground between actors over time and fulfilling the commitments it is also possible to increase the scope and duration of co-operation [3]. This can lead to a positively reinforcing circle, where the attitudinal commitment leads to behavioural commitment and when the goals of the behaviour are achieved, this enforces the attitudinal commitment.

Communication is an important antecedent to enhancing commitment. All the important events in the network, such as goals achieved, delays or obstacles in action, overcoming the obstacles should be openly communicated to the members since this increases the members' reliance in co-operation. Open communication increases commitment and investments into the co-operation. [17]

In the focal case, the actors showed various levels of commitment. The research groups became committed to the network even before the first company members

agreed to join in. The commitment lead to finding new and extended possibilities for co-operation, as the following quotation reveals.

PhD Mary: "*It really has led to something concrete. We were preparing an EU-project, to which our department and two other departments, which are members of the network had prepared a separate application each. Thus we combined the applications. Because, based on this network, we knew that the research groups address the issue a bit alike.*"

The company actors' commitment was more in an attitudinal level, since most of the companies did not have to perform any concrete tasks before signing the research agreement. However, there were also such companies, e.g. software producers, who also acted upon their commitment and invested human resources even before the funding decision was announced. These were also the ones that showed signs of learning as discussed above.

Discussion

This research has put forward an empirically grounded model of engineered R&D network formation process. The model has three elements: the initial conditions, the network webber and the cycle of sub-processes. The model offers two contributions to existing knowledge on R&D network formation. The first contribution concerns the strong role of a single actor, the network webber, in managing the network formation process. The second contribution concerns the nature of the formation process – it is a cyclical process.

The role of a single actor - *the network webber* - emerged from the data as highly influential and more extensive than research has indicated so far. The network webber not only initiates the formation of R&D network but also affects all the sub-processes of R&D network formation. The network webber triggers the engineered formation process when the initial conditions are not strong enough to trigger the process. However, the role of the network webber does not end here. The study shows clearly that the network webber was very active during the most important sub-processes through which the network became existent. The network webber enabled the network formation by pointing out to the potential members that they share interests and that those interests could be served in co-operation. During the acquiring actors sub-process, the network webber attracted, approved and disapproved potential members. The network webber was also a main assurance for continuity, since based on previous experiences he enjoyed a reputation of being reliable and was able to orchestrate the compiling of the research and project plans, which earned the major funding for the network. Also, during the formal structuring, the network webber acted as a major designer of the organisation, which actualised itself once the funding application was accepted. Besides being a major actor in the most important sub-processes, the network webber also was active in providing opportunities for learning and the development of commitment.

The suggested model presents six sub-processes, namely enabling network formation, joining, assuring continuity, formal structuring, learning and developing commitment, through which the formation process proceeds. We argue that the network formation activities do not follow a predetermined path as suggested by existing research. On the contrary, the model presented in this paper suggests that the activities appear in cyclical structure. Based on the empirical grounding, there is no clear order of appearance in the sub-processes and they may take place both simultaneously and partially. Moreover, the members of the network may repeat the sub-processes during the formation process. Fox example, actor acquiring was a sub-process that was ongoing throughout the duration of the formation process.

As any research, this also involves restrictions that pave ways to further research. Our focus was on the engineered network formation process and therefore it is natural the role of the network webber is strong. R&D networks can also evolve without a strong network webber, if the initial conditions are strong enough. However, we do not know how often the networks start without the triggering actions of network webber.

The empirical grounding of the model was based on a case study on a network formation, which included members from both academia and business life. Although we can assume that whenever the task of the network involves developing new technologies, the network includes research organisations that are government funded, there are also R&D networks that consist of private companies only. Even if the private company networks would receive government funding, we expect that in cases where the role of a network webber is held by a private company or representatives of one, that alone influences the process. In the focal case, the network webber was considered as a neutral actor, who acted upon the behalf of the whole network and not only behalf of his or his organisation's interest. This of course, had an effect on the formation process. However, it is logical to assume that the sub-processes would be much the same, although the outcome of e.g. joining would be different. Thus it would bring us new knowledge to compare the formation processes of different kinds of R&D networks, to see in what was they differ, if at all.

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