



Cluster Games II

About Cooperation, Selfishness and Joint Risks
in Clusters

Endre Gedai, László Á. Kóczy, G. Meier zu Köcker, Zita Zombori

Imprint

Institut für Innovation und Technik (iit)
in der VDI/VDE-IT
Steinplatz 1
10623 Berlin
Germany

Tel.: +49 30 310078-111

Fax: +49 30 310078-222

E-Mail: info@iit-berlin.de

www.iit-berlin.de

Authors

Endre Gedai

László Á. Kóczy

Zita Zombori

Layout: J. Büttner, A.-S. Piehl, VDI/VDE-IT

Copenhagen, Berlin 2015

Executive summary

This study introduces an entirely novel way to study the cooperative and noncooperative nature of clusters by looking at the selfish, profit-seeking interests of the actors within cluster initiatives. The approach provides a **game theory inspired framework** to study the dilemma of cluster actors between the fruitful cooperation with other actors and their own selfish – and possibly short-term – interests at three levels: intensity focussing on the overall cooperation effort; structure looking at the network of cooperation and balance discussing good ways to allocate resources. Characteristic models of cluster behaviour have been developed for all these aspects.

Interviews have been conducted among cluster actors of two cluster initiatives. Both were quite matured and well managed with similar core objectives. The methodology applied has revealed that the nature of cooperation among the actors and how the cluster initiative is managed is of surprisingly different nature although both cluster initiatives provide high added value by the cluster actors perspective. One cluster initiative can be characterised as a “managed cooperation cluster”, where the management has a central role to match actors, while the nature of the other cluster initiative is more “a peer-to-peer cooperation cluster” where cooperation emerges directly between cluster actors and the cluster management has another role. The results of the study lead to conclusions that there is not one ideal way how to manage cluster initiative. Furthermore the cluster actors cannot be seen as a homogenous group. Even if all of them have similar objectives like increased innovation capabilities, higher competitiveness, higher profitability etc. their intension why joining a cluster initiative and the readiness to contribute or just to benefit is very different. The cluster management has to understand what are the particular interests and to what extent a dedicated cluster is ready to contribute. Applying the game theory inspired analytical approach helps to gain important inside views for cluster management.

Furthermore the study shows that the way how cluster initiatives are set up and supported by public authorities does have a strong implication on the nature of cooperation and selfishness among the cluster actors. The conclusion from the study is, among others, that high public funding facilitates the creation of cluster initiatives, but also attracts free riders to join since the barriers to enter are quite low. Having such an interest group “on board” within a cluster initiative hampers further trust building and cooperative framework conditions since selfish actors dominate. Low public funding at the beginning of the life of a cluster initiative leads to higher barriers due to higher mandatory investments of cluster participants, but creates a cooperative environment since mainly those actors have joint that are really interested to cooperate and take common risks.

However, the study has shown that good cluster managements can deal with different cooperative natures among cluster participants, if they are aware of this and implement proper actions.

Table of Contents

1	Introduction	7
2	Theory	8
2.1	Game theory	8
2.1.1	Non-cooperative games	9
2.1.2	Cooperative games	9
2.1.3	Networks	10
2.2	Game theory in practice	10
2.2.1	Issues: rationality, complexity	10
2.3	Cluster actors	12
2.3.1	Rationality	12
2.3.2	Profitability	12
2.4	Cluster cooperation	13
2.4.1	Intensity	14
2.4.2	Structure	16
2.4.3	Balance	17
3	Research methodology	18
3.1	Fundamentals of decision making	18
3.2	Profitability	18
3.3	Network structure	18
3.4	Methodology of cluster analysis	19
4	Practical Part	20
4.1	The stages of our investigation	20
4.1.1	Workshop	20
4.1.2	Interview with the CM	20
4.1.3	Interview with the CAs	20
4.1.4	Analysis	20
5	The analysed CIs – a comparison	21
5.1	Clusterinitiative A	22
5.2	Clusterinitiative B	23
5.3	A comparison	24
6	Results	25
6.1	The assessment of the validity of the previous hypotheses	25
6.2	Determinants for CI development	26
7	Conclusions	30
7.1	Literature	30
7.2	The nature of cooperation in CIs	30
7.2.1	Value generation	30
7.2.2	Balance: value distribution	30
7.2.3	Structure	31

7.3 Implications for funding and managing cluster initiatives.....	31
7.3.1 Cooperation and funding.....	32
7.3.2 Managing cluster initiatives.....	33
7.3.3 Services offered by CM.....	34
7.4 Robustness	35
Acknowledgements	36
Bibliography	37
Appendix A: Questionnaire for cluster managers.....	38
Appendix B: Questionnaire for members	42
Appendix C: Main Results from second survey	46

1 Introduction

This paper introduces an entirely novel way to study clusters by looking at the selfish, profit-seeking interests of the actors within cluster initiatives. The approach provides a game theory inspired framework to study the dilemma of cluster actors (CAs) between the fruitful cooperation with other CAs and their own selfish – and possibly short-term – interests.

Clusters are defined as regional agglomeration of firms that compete and cooperate among each other (Porter, 1998). When it comes to organised efforts to increase networking and cooperation among cluster firms, often coordinated by a cluster organisation (cluster management, CM), the term “cluster initiative (CI)” shall be used. CI can be seen as joint undertaking of cluster firms, research community and government within a region, to increase growth and competitiveness (Sölvell, Lindquist, & Ketels, 2003). The main activities of a CI is driven by the cluster actors' (CAs') interests in staying competitive, improving competitiveness and obtaining high profits. Thus, from a company's perspective a CI can be considered as promising framework or a tool to satisfy these interests. That is also the reason, why the cluster approach is that high on policy makers' agendas since many years.

However, cooperation and the actors' selfish interests should be kept in balance or else the success of the CI is in jeopardy: its actors can lose both joint and individual profits. Organic relationships and cooperation among companies or a favourable business environment is, by no means, a guarantee for a successful CI. CIs operating at industrial concentration points, having a critical mass, a supporting environment, and a successful cluster CM may, despite all this, lack success. On the other hand, other CIs operating in suboptimal circumstances in theory, flourish and produce a high extra profit in practice. This puzzle cries for new models, new approaches for a better understanding of the opportunities and decisions that drive the CIs and their actors.

Seeing a CI as a marriage among the CAs, this study aims to provide mechanisms that reveal if the CAs are compatible and if not, how to prepare them for a successful relationship. But unlike in a marriage the personalities of the CAs may be easier to understand, and model by economic, especially game theoretic means.

The approach and methodology of this study is based on a previous, more theoretical-oriented work. As a result of this undertaking (Gedai, Kóczy, & Zombori, 2012) a dozen hypotheses about the way CAs operate in CIs had been developed. The main objective of the current study is to verify these hypotheses by applying a more practical methodology, based on the game theoretic approach (see section 6.1).

This work is based on the detailed study of two CIs. The structure of the paper is accordingly the following. First the theoretical background of the research is presented and the research methodology is described. In Part II the analysed CIs are introduced as well as the summary of the finding regarding these particular CIs. Part III is a brief section where the hypotheses are evaluated and in Part IV contains some implications, reflections and lessons learned.

1 In this document the following definitions for clusters and CM organisations are used:

Cluster is considered as a geographically proximate group of interconnected companies and associated institutions in a particular field linked by commonalities and complementarities' (Porter, 1998).

Cluster (management) organisation is a specialised institution which is responsible for managing a cluster (initiative). These institutions take on various legal forms.

Cluster actors (participants) are the companies and associated institutions that are gathered in a cluster.

CI are organised effort to increase growth and competitiveness of clusters within a region (Sölvell et al., 2003).

2 Theory

A CI is a complex cooperation system. To estimate how successful a CI may be in the future, we study the system and its part, the CA, as well. The link between whole and its part determines the future of the CI. If the CA forms the opinion that the CI helps its aims and the benefits of participation exceed costs and obligations, then this CA is interested in the survival and development of the CI. And conversely – if the CI does not offer better possibilities than those outside of it, the CA will not be interested in higher commitments. On the other hand we must also see if the CA is useful for the CI (or part thereof): if not, it must be left out, or it will become a deadhead.

In the following we describe the theoretical background of the study. We start with a brief introduction of the game theoretic concepts we use here then we describe how CIs work or should work according to the hypotheses outlined above. Our objective is to test these hypotheses, so the next parts describe the possibilities therefore and at last we present the actual research methodology that takes practical constraints into account, too.

2.1 Game theory

In this section we give a brief introduction to some concepts in game theory. It can safely be skipped for a general reading and only be used as a reference. For a more extensive discussion see (Gedai et al., 2012).

Game theory studies strategic conflict situations. What are the characteristics of these situations? Firstly, the parties are selfish: for a conflict of companies this simply means that they want to maximise profits although in general the utility of the conflict's outcome can manifest in various non-monetary forms, too.

Secondly, the conflict's outcome depends on the parties' actions. We call the conflict situation a game and the involved parties the players. The name probably comes from the fact that the father of game theory, the Hungarian genius John von Neumann was originally interested in developing a mathematical theory of bluffing in poker and his mathematical results found applications in economics and beyond only years, decades later (von Neumann & Morgenstern, 1944).

The strategy of a player determines his actions for every possible game scenario. As a result, given the strategies of the players, a game can be played and the outcome can be determined by a mediator or a computer. Therefore the payoffs, such as profits of the players can also be determined once the strategies are known.

We can describe a game in various forms, but there is one difference that divides games into two groups: cooperative and non-cooperative games. The difference is in the legal environment: noncooperative games are played in the absence of a legal framework, in an environment where agreements are only kept if the parties are interested in keeping them. In cooperative games, on the other hand we assume that it is possible to make binding agreements. Noncooperative games are best suited to study the detailed interaction of a few players, while cooperative game theory can handle the interaction of large groups of players. Before we move on to the theory let us consider a simple story (from Gedai et al., 2012).

Company A has a brilliant idea that could be developed into a very successful and profitable idea – with the right partners. The CEO of A meets the CEO of B at a reception and over a crab sandwich they realise that they have some common interests: B could help company A to materialise this brilliant idea. For reasons that we do not need to go into here B's help is not enough, at least two companies of this type are needed. Fortunately B has contacts with C and D, either of which can serve as a second company, in fact A, C and D could also realise the project. The CEO of A finds the plan good and suggests to share the expected extra profit of 12 million to be shared equally among the four actors of this CI. Will this work?

The shortest answer is: No. If the companies A, B and C can also do the project and obtain the same profit it would be foolish to include D in the project and pay it 3 million, wouldn't it? OK, D can stay on board, but with a much more modest share of the proceeds. Oh, but the same argument applies to B, or C that are of the same "type" of company as D. So, as a matter of fact A takes all and the substitutable members of the group get almost nothing. Moreover, even over the little payment they would get, they would start an eternal battle any two of these trying to skim the third company by kicking it out if the business.

We have only leaped over a tiny detail. A has no contact with C or D. A can only cooperate with these companies if B helps it, if B is on board, if you like: with B's permission. While companies A, C and D could realise the project, such a cooperation is simply not possible. But then B has a new, special role: B can connect A with the right people. If we look at it again, there are only two ways the project could be realised: A, B and C or A, B and D. As C and D can substitute each other, they will not get much of the (extra) profit, the profit is shared between A and B. They can share the profit equally as 6-6 millions, but if any other distribution emerges neither of them will have the possibility

to increase its share. After the offer of company A, B getting 9 millions is a likely outcome, for instance.

We have noted that C and D are perfect substitutes, in other words one of them is superfluous. So why did B suggest two partners at the first place? Consider the same setting when D is not there: Then only full cooperation of all the parties can realise the project. In such a setting B's role as intermediary is secondary, company C can rightly demand a share of the profit and this share is a loss to A and B. In other words A and B profit from having both C and D in the CI.

Finally note that the assumption that a company will cooperate for zero profit might sound unrealistic. Of course this is zero economic, rather than accounting profit where the company has been compensated for all production costs as well as its opportunity cost (the cost of doing this project rather than investing its resources elsewhere) and a compensation for risk. Getting a zero profit is therefore not the same as not getting paid, but a higher profit is naturally preferred. In practice a zero profit case will not arise due to imperfect substitutes, capacity constraints or switching costs, but these only mildly affect our conclusions.

2.1.1 Non-cooperative games

A non-cooperative game consists of three elements: the players, their strategies and a utility function that gives the welfare of each player when some particular combination of strategies is chosen. We are interested in strategies that give the highest possible profit to each of the parties and are therefore stable. A particular combination of strategies is a Nash-equilibrium of a game, if the strategy chosen by any of the players is a best response to the strategy of the others assuming that their strategies are fixed. Conversely, a strategy combination is not a Nash-equilibrium if any of the actors could improve its welfare by simply switching to a different strategy.

In a CI cooperation can be seen as a public good, where the actors of the CI can choose an effort level to contribute to this project. While choosing a high effort would be better overall, the individual actors prefer to free-ride on others' efforts and spend own resources on own projects ultimately leading to the breakdown of the project and a dysfunctional CI.

In real life we do see public goods realised, as self-enforcing mechanisms help to maintain cooperation: If the interaction lasts for more the one encounter the utility from a decision must also include the utility from future encounters. Mutual trust and mutual cooperation can be rewarded by future trust and cooperation. If the probability of future encounters is high

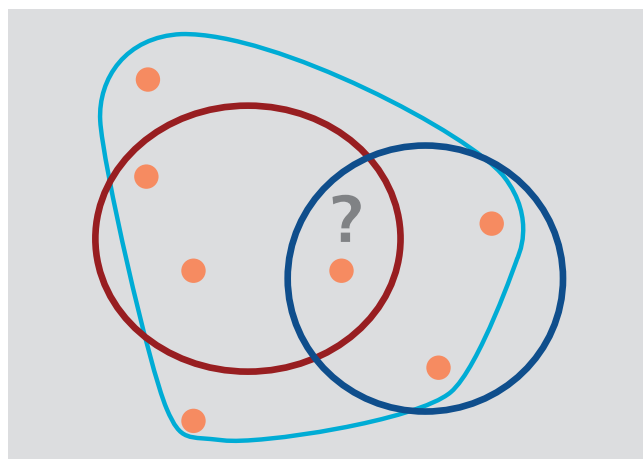
and value of future money is high (the inflation is not too high), it is less likely that a one-time defection and the corresponding high payoff is greater than the value of future cooperation.

Note that this value of future cooperation is only there if the game is played repeatedly forever or at least is repeated with high probability. A cooperation with a definite or likely end does not help: in the last period the cooperation breaks down removing the incentives in the previous period to cooperate, and so on.

2.1.2 Cooperative games

The main difference between cooperative and non-cooperative games is that in cooperative games players can make agreements they must keep and the interest is on the formation of coalitions and on the sharing of the benefits of cooperation rather than the means to achieve these. As shown in figure 1, in cooperative games strategies are limited to the choice of cooperation. In this example the player makes a choice between the "red" and the "green" coalitions - or staying with the ("blue") grand coalition.

Figure 1: Decision making in cooperative games

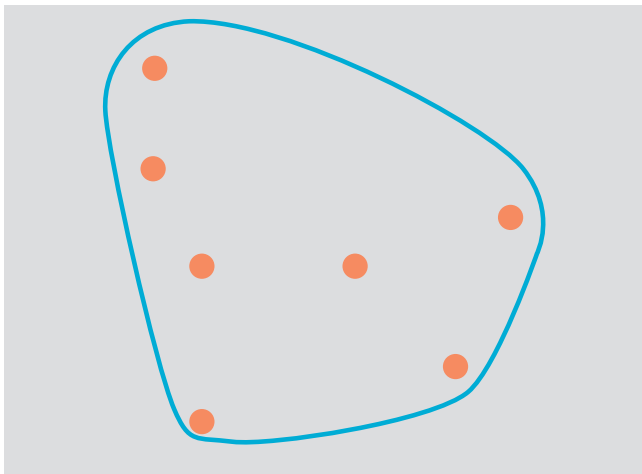


We still have a set of players and this set is denoted by N . Groups of players are the coalitions. Actions, strategies are limited to choosing players for cooperation. Instead of a utility function for individual players, we have a value V for each coalition. The characteristic value of the "red" coalition is classically defined as the minimal value obtained when playing against the complement coalition, that is, the coalition of the remaining players.

If we also make the assumption that members of a coalition can arbitrarily share this coalitional value then we talk about a game given in characteristic function form or simply a transferable utility (TU)-game.

What is the solution of such a cooperative game? In purely cooperative games we assume that the grand coalition forms where all players cooperate and the solution only specifies how the players will distribute the value of the grand coalition. In some situations the question is more complex: which coalitions form, and how do the members share their values. There are much more ways to solve cooperative games, and perhaps the most popular concept is the core.

Figure 2: A coalition of players

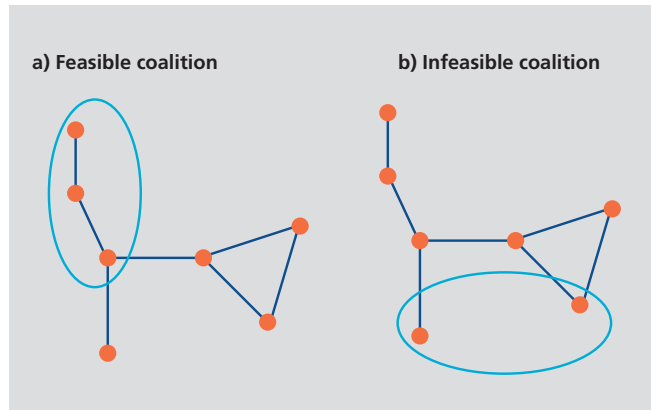


The core (Gillies, 1959) is the cooperative equivalent of the Nash equilibrium, but it allows also for coalitional deviations (Figure 2). The core collects distributions of the total profit such that no coalition could get more on its own than how much its members receive in total from the original coalition. While it may seem rather difficult to satisfy the demands of all coalitions most games have many imputations that satisfy them. Unfortunately there are also many that do not have any. We say that the core of such games is empty. To have an empty core means that the total resources available to the grand coalition are not sufficient to simultaneously satisfy all coalitional demands.

2.1.3 Networks

Coalitions are a greatly simplified version of reality as they lack internal structure (Figure 6). In some situations the structure of cooperation has a role, too. Where personal connections or trust play a role only cooperation between parties that are connected to each other personally or who trust each other are possible. In such situations a player can have a high value simply for connecting other, productive players (Borm, Owen, & Tijs, 1992; Herings, van der Laan, & Talman, 2005). The core can also be generalised to games where the connections among the players are important. For such TU games over a network we must have a value function and know the underlying network of players.

Figure 3: The difference between feasible and infeasible coalitions



In network games only coalitions that are connected make sense (Figure 3a). A disconnected coalition (Figure 3b) means that some of players cannot communicate and therefore coordinate. Such a coalition then clearly cannot form.

2.2 Game theory in practice

Game theory is a theory based on ideas formulated in the minds of some mathematicians and economists who developed this field. Can it be used at all to study reality?

For social sciences game theory is what Newton's Laws of Motion are for mechanics: a set of rules and mechanisms that describe the interactions of the various elements of the model. These rules may be imperfect, but over the last few decades game theory provided useful insights into an increasing number of problems ranging from market competition to university admissions. Its usefulness is confirmed by the large number of Nobel memorial prizes in economics granted to theoretical and applied game theorists in the last few years.

2.2.1 Issues: rationality, complexity

How to use game theory in practice? Are, for instance, players rational? Real life is more complicated than theory: Without perfect information players cannot exactly predict the strategy choices of others, may not be able to precisely estimate the effect of their decisions not to mention the limitations of a model to fully capture reality: we will surely overlook important aspects leading to imperfect models. At last we must note that evaluating complex games is costly and in the presence of simple rules of thumb that work reasonably well a detailed calculation leading to the best alternative is scrapped.

Unfortunately, when there are more than 2 or 3 players modeling their interaction leads to games of astronomical complexity

and even if we have a well-defined game, computing the solution is difficult. And so far we have completely overlooked the issue whether actors also realise these strategies and solutions.

Defining a game is not the end of the story. Solving games is (often) a computationally difficult, a so-called NP-complete problem. This does not simply mean that finding the solution is difficult as in a difficult maths problem, but that the solution may be very easy, but it takes a very long time, or would need more memory than what we have in the universe. Chess, for instance, is a very simple game from a theoretical point of view, but the universe is too small for finding its solution. Note: this does not mean that there cannot be simple heuristics that help computers to do better than any human could.

How can we then use game theory to study large CIs? We consider two approaches (or a combination thereof).

Table 1: Features of the sampling approach, where the evaluation is based on a small random sample of the actors

Pros	Cons
Exact predictions	Small sample size
	Very partial, non-representative
	Ignored interactions with others
	Only drastic reductions work

By sampling we reduce attention to a small subset of actors in the CI and for this small set we can have a precise definition of the game as well as a quantitative conclusion. By the modelling approach we give up studying the particular CI: instead we describe archetypal CIs, explore their characteristics and when looking at the actual initiative we merely test if either of these characteristics are present. By essentially linking CIs to these worked-out types we do not have to actually solve each game, but we can nevertheless apply general wisdom found for the archetype.

What are the main advantages and disadvantages of each of these approaches? Sampling effectively reduces the problem but only if the sample size is small. Here we really face a trade-off: for precise estimation we would like to have a large sample, but as soon as we have over 10 or even 6 actors, their interaction becomes difficult to model – this being the main limitation of this approach. The promise of quantitative outputs is nice, but picking 6-10 random points and restricting our attention to the interaction of these actors is extremely limiting, quite possibly they do not interact at all.

Table 2: Features of the modelling approach, where a theoretical model is tailored to the empirical data

Pro	Cons
Communicable to non-technical/non-academic partners	Difficult to include soft inputs
Soft, but well-interpretable predictions	Never a perfect match for reality

This is clearly not a problem in the modelling approach, but here our responsibility is greater as the models must be descriptive of CIs we find. There is of course always the possibility of returning to the desk and describing a new type if an atypical CI is found.

In practice the two models are naturally combined since we cannot count on a 100% response rate from the actors. When sampling is used to identify the type of the CI, however, there is no problem with large samples, plus we need not ignore those outside of the sample. The results obtained here are often qualitative and both the results and the method of obtaining them is more understandable for non-technical audiences, such as the typical policy maker or participant in a CI.

This is not much different from the path usually taken in the study of market interactions by the field of Industrial Organization. Simple models, such as Cournot oligopoly predict how markets with certain number or concentration of firms will behave, what are the implications on prices, welfare or innovation. Then regulators use concentration indices to evaluate proposed mergers – without necessarily going in depth of the actual proposal.

The benefits of the modelling approach outweigh the disadvantages so this is the approach taken. This suggests the following research strategy followed in the sequel. First identify key aspects of CIs and identify relevant game theoretic models to understand these. Use the solutions of these games to explain possible patterns of behaviour as results of different strategies taken or perhaps due to different stages of development. Develop interviews to understand the rationale behind decisions taken by the actors, their goals and methods as well as the achieved results – which may be very different from what was intended. Using the theory, evaluate the results and possibly formulate suggestions to the managers of the CI. In the following first elaborate on the cluster models and identify types of CIs.

2.3 Cluster actors

The novelty of our approach lies in the very simple idea to model CIs from the CAs' perspective. Only if and when the CAs find cluster participation profitable and more profitable than other opportunities will they be interested in actively cooperate in the CI. In this section we go over various aspects of participation of actors in CIs starting with very basic ideas, such as the rationality of decision makers.

2.3.1 Rationality

Much of the work looking at the strategic interaction of firms assumes that players act in a payoff-maximizing manner. In situations where there is a conflict between the private and public interests this assumption may lead to some odd, unexpected or even paradoxical theoretical results. The Prisoner's dilemma is a popular example, where actors' selfishness leads to an undesirable outcome of the conflict, resulting in lower payoffs, while the Bertrand paradox is a well-known result where firms competing in prices with similar products and similar costs and no capacity constraints should get a 0 profit.

Rationality has also been questioned by economic experiments where people have been observed to give up money to punish non-cooperative play and even take revenge on others. The literature often cites these examples as cases where the rationality assumption fails; placing the situation into a bigger picture explains the decisions as parts of a longer term strategy. On the other hand the contradicting examples always contain humans, but here we deal with companies that are supposed to exhibit no emotions nor to have an agenda to teach moral lessons.

Rationality has two aspects and we intend to investigate both. First, rationality vis-a-vis irrationality: we investigate whether CAs make profit maximizing decisions or decisions that are difficult to support with economic arguments are also made. This aspect of rationality is generally assumed in game theory and if it is not satisfied game theory is not a very useful modelling tool.

Secondly, rationality is vis-a-vis emotions or intuition. It is not enough if CAs make favourable decisions, but we want to know if these decisions are results of a conscious decision making process or are merely lucky ad-hoc decisions. We do not want to downplay the importance of intuition in business interactions, especially as some of these "intuitive" decisions are results of the same thorough analysis– in the mind of a business genius. This is to be distinguished of *ad hoc* decisions that lack the complex business planning and modelling and the strategic analysis of cooperation opportunities.

2.3.2 Profitability

As a direct implication of rationality a firm should only participate in a CI if this brings it additional benefit. The participation is a decision of the company only, so it is (almost) completely free to make this decision. This assumption is referred to in game theory as *individual rationality*.

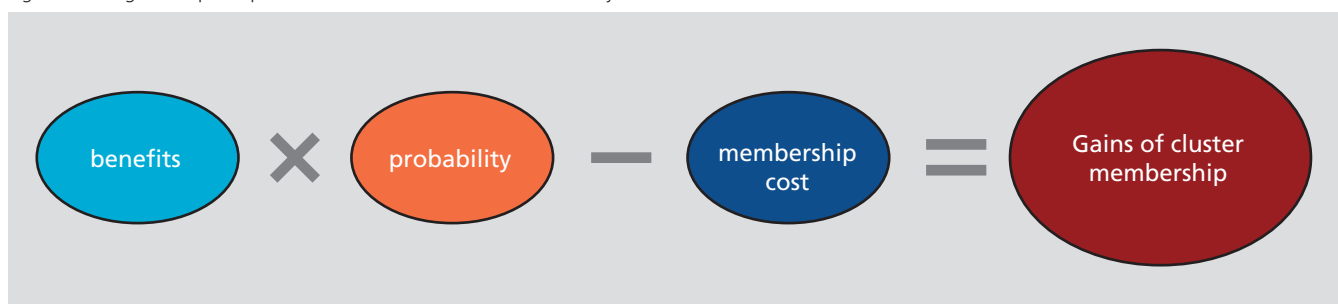
"The findings of the Cluster Impact Analysis provide information to the cluster management showing whether companies derive benefit from networking activities and if so in which fields. Thus, the Cluster Impact Analysis aims at identifying the achieved effects that can be contributed to cluster and networking analysis." (Kind & Meier zu Köcker, 2013)

"The present value of the awaited profit is being decreased not only by the time-factors but by risk of the distrust ... The more risk is recognised by the cooperating partners the less but immediately provided advantage (profit) make them give up the cooperation." (Gedai et al., 2012)

Why is a CA still sticking to a CI? The belief in the facts that it is worth doing it but is this belief based on established analyses or on the sixth sense of a leader?

The result of each CA could be summarized as well as statically studied but the only one way to get the global picture is if the results are projected on the cluster-network.

Figure 4: The gains of participation in a CI and its value is influenced by different determinants



The gains of participation in a CI and its value (s. Figure 4) is influenced by ...

... the benefit of the CI:

- ▶ activity level of the CI
- ▶ nature of the benefit (knowledge transfer, the advantage of manufacturing and developing, the supports etc.)
- ▶ location in the production value chain and the competences of the CA (e.g the profits and motivations of distributors or pig-farming cooperatives are completely different in a prosciutto CI)
- ▶ possibility of the self-supporting realization
- ▶ value of the partners: relevant competences and profit prospects from cooperation
- ▶ position within the network

... the probability of the returns that depends on:

- ▶ past experience
- ▶ returns horizon – the later, the riskier
- ▶ trust level of partnerships
- ▶ validation/force of agreement and understandings
- ▶ position within the network
- ▶ outside opportunities

... the costs related to participation in the CI

- ▶ actual costs, such as participation fees,
- ▶ time commitment as cost
- ▶ level of the knowledge transfer
- ▶ forgone possibility of doing something else – opportunity cost

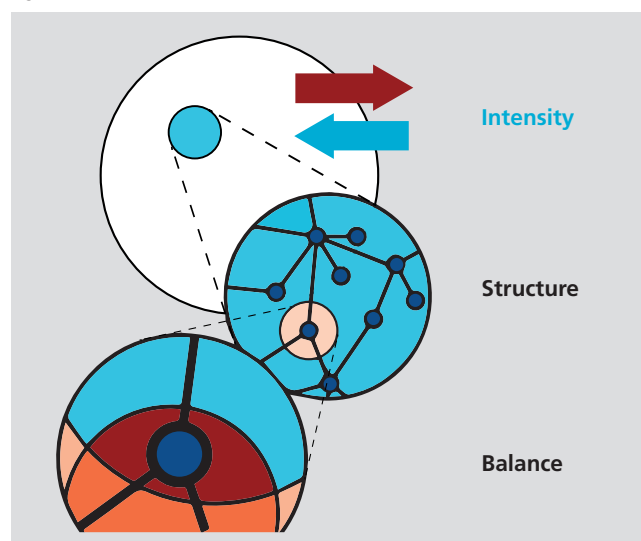
2.4 Cluster cooperation

Now we are going to study the future of the cooperation in the CI especially the impact of the objective and observable characteristics influencing this future. This way the future expectations of the CAs and their impacts will be analyzed from the perspectives of both the CAs and the CI itself.

The evaluation of the CI, following the method of data collection, will have three levels: intensity, structure and balance. Intensity is about the overall cooperation effort of the CI (Figure 5). Structure reveals the network of cooperation identifying the different roles of CAs and identifying key players. Balance is about the balance of power within the CI and the resulting tensions or conflicts of interest – if any.

In the following we elaborate these aspects in some detail.

Figure 5: Levels of evaluation for the CI



2.4.1 Intensity

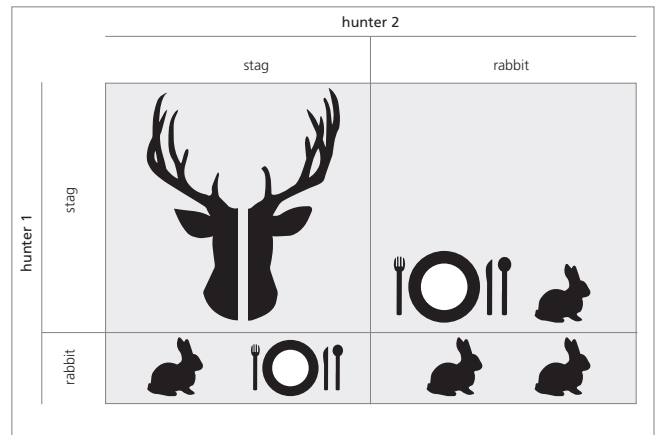
This section is about the overall benefit the CI generates: both the potential and the efficiency to use that potential.

While we see CIs as cooperation networks, the sheer mass of concentrated firms may bring benefits. While economies of scale may allow firms to operate more efficiently by sharing facilities, purchasing together or even by buying services, such as organising workshops that a single firm could not afford. Any sufficiently large group of firms could get such benefits, but CIs are networks of cooperation and so in the following we focus on the cooperation aspects of CIs. We have already talked about the public good nature of cooperation effort in a CI. By sharing information a CA creates benefits to others, but only gets the benefits that others have shared. There is a clear multiplication effect: the information provided by one is useful for many but giving up the privileged access to a piece of information and sharing it with a potential competitor only pays off if the 'sharing circle' is large enough.

This is similar to the so-called stag hunt game (Figure 6): Two (or more) hunters have two choices: hunt a stag or rabbits. The two choices are mutually exclusive: either/or. The stag is a far more valuable prey, but requires the cooperation of several hunters. The rabbit requires no cooperation, but is less valued. This game has two equilibria: hunters may go for rabbits (the no-sharing noncooperative equilibrium), but there is a much better, cooperative equilibrium where they go for the stag. Clearly the latter is preferred as it gives a bigger profit to all parties, but it is difficult to get cooperation when starting from a noncooperative status quo and cooperation more risky. A slight miscommunication will leave stag hunters with empty plates – the same cannot happen to rabbit-hunters.

The stag hunt in a CI corresponds to profitable multi-actor projects: participating firms must devote time and resources for the joint project – these cannot at the same time be used for private

Figure 6: Stag hunt game



projects. The Table 3 displays a summary (technically: a projection) of such a game. Whether the chosen level of cooperation effort of an individual CA pays off depends on the decisions of other CAs. One would need a multi-dimensional table to include the strategic decisions of all the players, so here the decisions of other CAs are aggregated, the individual only sees (and cares about) the total number of other cooperating CAs. The joint project can only succeed with sufficient (total) effort requiring cooperation among firms. Since this game is noncooperative, firms can sign cooperation agreements, but it is very difficult to monitor if they are actually allocating their resources to this project. The joint project will only succeed in the presence of an elevated level of trust and coordinated cooperation, where many firms choose the public over the private projects, where these firms actually commit their resources and trust that others do the same and last but not least trust in long-term cooperation, believe that no or few firms will quit cooperation leaving many to participate.

It is easy to see that a general belief in the success of the project, that is, a scenario where already many are cooperating will attract additional participants who prefer the increasingly certain higher profit. On the other hand, if the general understanding

Table 3: Cooperation game in the CI

		<i>Many others make effort</i>		<i>Few others make effort</i>	
CA chooses:	CAs choosing...	effort	no effort	effort	no effort
effort	other CAs	HIGH returns	low returns	LOST effort	low returns
	CA	HIGH returns		LOST effort	
no effort	other CAs	HIGH returns	low returns	LOST effort	low returns
	CA	low returns		low returns	

is that the project may fail even those so far participating will quit. Creating the right atmosphere for cooperation is one of the – difficult – tasks of the management in the CI.

Some collaborative projects require ‘opening up’ and sharing confidential information: creative or technological ideas or market insights with other team members. An actor who cooperates initially, but pulls out later may be able to use this information to its private benefit. In such a setting a cooperation effort is a private good that is transformed into a public good, where some make – potentially – no contribution to it. Such situations create strong incentives for free-riding.

Table 4: An example of a cooperation game with free riding

	Active CAs, key drivers; trust, cooperation	Reactive CAs, free riders; no trust, non-cooperation
Active CAs, key drivers; trust, cooperation	5, 5	0, 10
Reactive CAs, free riders; no trust, non-cooperation	10, 0	1, 1

Real life interactions are richer, miscommunication is common. The signal whether other actors are making a cooperation effort or not is blurred, the uncertainty is greater. In a CI cooperation is more likely if the multiplier effect works well and there are high rewards to cooperation.

Table 4 describes an example a cooperation game with free riding. A reactive CA benefits from active CAs efforts, while saves own efforts to own projects. When all are reactive large scale projects (stags) cannot be realised. Active CAs benefit from the project, but have costs, too, overall giving them a profit of 5. When only some of the CAs work on the project, the effort are higher consuming all profits. Reactive players, on the other hand, benefit from the project without the associated effort, which is, instead spent on a private project (the “rabbit”) giving them a much higher payoff. When no-one works on the joint project, it is not realised so the much lower profits come from the private projects. The result is a typical prisoners' dilemma type game where individuals' selfish attitude destroys the much higher common benefit. While this game is artificial, games like this are considered simple, but accurate models of the general problem of voluntary provision of public goods.

It is interesting to note that already a small membership fee has a dramatic effect on the way this game is played. While without

the membership fee (Table 5) we have a Prisoners' Dilemma, where free-riders are always better off on the short run and cooperation is difficult to sustain, with membership fees CAs will prefer to quit the CI rather than playing this Nash equilibrium. The second table only differs in the subtraction of 2 as a membership fee for each actor. This membership fee is higher than the (additional) benefit in the private projects and therefore it is not worthwhile to be a CA and only do private projects. Leaving the CA is not indicated as a possible strategy, but this gives a payoff 0, which is still better than making a loss. Actors of noncooperative CIs will desert. The same happens to active members in the presence of free riders. Doing all the effort is still acceptable as long as the returns pay for the costs. The introduction of the membership fee pushes such benevolent firms in the red, too. In sum only clusters with cooperation may sustain and only if CAs have trust in long-term, cooperation. Free-riders may hit and run, but a CI can only survive if such moves are rare.

Intensity also looks at the CI at the aggregate level and estimates the average significance of the CI for CAs. Theoretical models to detect (mathematical) clusters from network data are based on the assumption that links are more likely to form within a cluster than between clusters (Copic, Jackson, & Kirman, 2009). When studying a CI our position is different: here we already have the CI, but at the same time we also have data about network connections within and to some extent outside the CI. From these data we can calculate an intensity index that expresses the ability of the CI to intensify intra-cluster cooperation.

The probability of forming links within the cluster is not only interesting when compared to the same probability between a CA and an outsider firm the actual probability values are informative of how clustered the CI is.

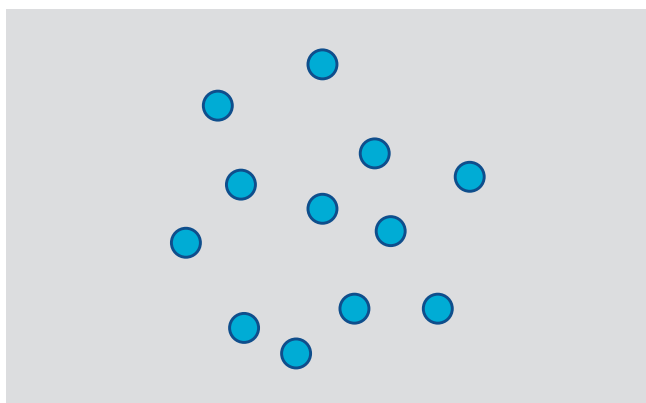
Table 5: The above example of a cooperation game with free riding augmented with membership costs of 2.

	Active CAs, key drivers; trust, cooperation	Reactive CAs, free riders; no trust, non-cooperation
Active CAs, key drivers; trust, cooperation	3, 3	-2, 8
Reactive CAs, free riders; no trust, non-cooperation	8, -2	-1, -1

2.4.2 Structure

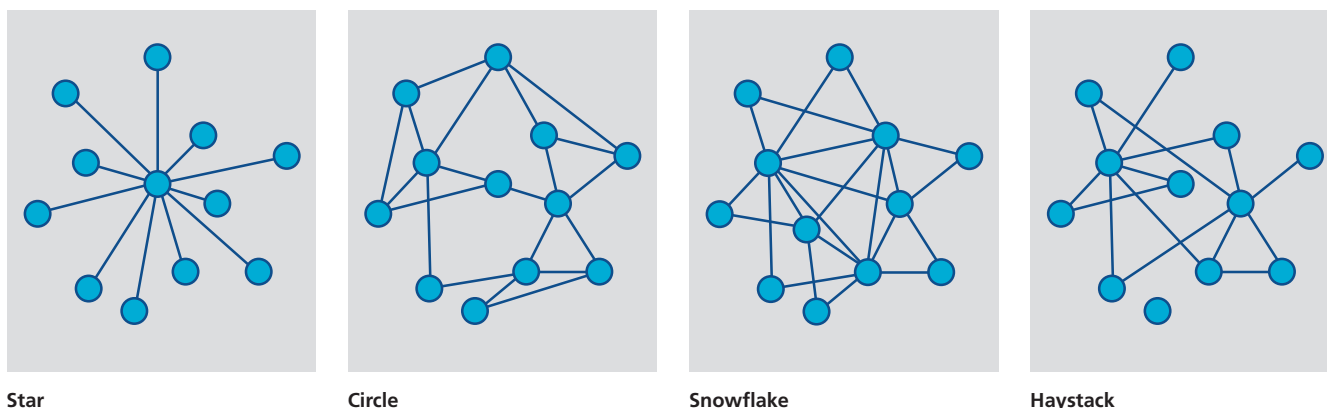
The second aspect we look at is the network of cooperation among actors in the CI. It would be very difficult to imagine a project or CI whose CAs do not have contact with each other, therefore we only consider connected projects, connected coalitions. The network of connections within (or outside) the CI therefore plays a key role on which projects may emerge.

Figure 7: A cluster of firms without connections



The intensity index uses cooperation network data, but ignores the actual structure of cooperation within a CI. Studying the more important business relations within the CI, we draw two types of conclusions. Firstly, we can look for critical nodes and links within a network and study it from a vulnerability perspective (Shen, Nguyen, Xuan, & Thai, 2013). At the same time centrality measures allow us to identify key (central) and peripheral actors of CIs – critical and key CAs are often the same, but need not be. Both types require special attention. Key CAs may have a dramatic influence on the CI, a too great of a reliance on such CAs makes the CI vulnerable to economic and management shocks. On the other hand CAs that are only connected to one or two other CAs risk to completely lose their link to other CAs if those few links become weaker: Peripheral CAs bring the risk of erosion.

Figure 8: Characteristic network structures



Star

Circle

Snowflake

Haystack

When obtaining detailed information on connections it already helps to identify problems or risks in a CI if we identify the general characteristics of the network. While there could be many possible underlying structures for CIs, we consider four possible characteristic network structures and discuss their characteristics: star, circle, snowflake and haystack. These structures differ in the number and position of key actors and have characteristically different cooperation and growth possibilities. These differences are elaborated in the following (s. Figure 8).

The **“Star”** network emerges when there is a very strong or very active leader in the CI. All CAs know the central player, but cooperation, projects are only possible via this central player. If the central player knows the other, peripheral players well, there is an explosive potential for forming cooperation as this player can act as an intermediary, and there is a very short path connecting two players. The benefits of such a coordinative CI are mostly related to its size: sheer size bring scale benefits in organising trainings, maintaining databases, gathering and sharing market information or act as a lobby group. On the other hand, in larger CIs being an intermediary may become a serious burden, it may adversely affect its ability to make own initiatives. The reliance on this central player is a serious risk for the CI on the long term. A young CI may have a star structure, but if no direct links are formed on the periphery, the central player is nothing, but a service provider and we can hardly talk about a *cluster*.

The **“Circle”** is just the opposite: there is no central player with all the advantages and disadvantages thereof. Without a leader CAs are likely to have only information about their connections and perhaps the connections of their connections, but forming more extensive collaborations, such as connecting to firms across diagonals is difficult. A CI with a circle shape has a more limited growth potential and together with the lack of leadership also limited options for renewal. Old CIs may have this structure; CAs should try to attract new partners to revitalize cooperation and get something like the next structure.

The **“Snowflake”** structure combines the advantages of the star and the circle. A snowflake has a densely connected core – a group of active firms who know each other very well. Moving out we see firms who are connected to some of the core firms, but are typically less well connected, while firms on the periphery have even fewer connections, typically to more active firms. This is the structure of a CI with a natural inflow of new CAs – also an outflow of retiring CAs. While there is no central oracle who would be able to connect any two CAs, with the help of one or more central players the connections are easily made and there is a good potential to form new connections. With several key CAs the responsibilities are distributed and playing the role of an intermediary is less of a burden especially as CIs of such a shape have a natural tendency to develop a hierarchy where a key CA looks after a dendrite (‘arm’) of the snowflake. In such a case the departure of such a key CA may result in the disconnection of some of the CAs, but the whole CI is not in jeopardy.

The **“Haystack”** is a network without a real structure or a combination of the structures above. In a haystack there may be well connected local communities that, on the other hand, are hardly connected to each other. A haystack cluster, as a whole, is probably dysfunctional, with a continuous threat from densely connected subclusters to start their own life. A cluster in the reverse process: the merger of subclusters may exhibit a similar network pattern, although, if the merger is at their own initiative most likely the key players of the merging CIs are well connected eventually forming a larger snowflake.

The best way to distinguish between these models is by identifying the key actors of the CI. A star has a single key player (often the cluster management within CI), the circle has none, while the snowflake and the haystack structures have many. The latter can be distinguished by the connections between these key CAs: in a snowflake such connections are common, for the haystack they are not.

2.4.3 Balance

Given a network of cooperations and their position, CAs have different roles, duties and benefits, different influence on the CI. As an extreme case we have already looked at the central player in a star cluster – such an exceptional role is not common, but there may be players who have a higher involvement and influence in the CI. Their participation is critical for the CI, so we look at their case mainly.

During the study the key actors can be seen as the group of persons feeling really committed to the idea of the CI.

Such key players typically have many connections and therefore

much influence on CI decisions even if they do not formally have any decision power. So by key actors we mean those CAs who make decisions regarding the objectives and strategies of CI.

Focussing on a sample of CAs we evaluate their expectations by themselves and within the CI, check if the in- and outputs into this relation are in balance. We strive for an evaluation of the entire web of cooperation and competition modelled by a cooperative game, due to the limited data obtainable, the analysis will be limited to a qualitative application of a simplified version of the core (Kóczy, 2007). In practice this means that we must understand if CAs, especially key CAs benefit as much from the CI as much they put in and if there are subclusters who could do better without the rest.

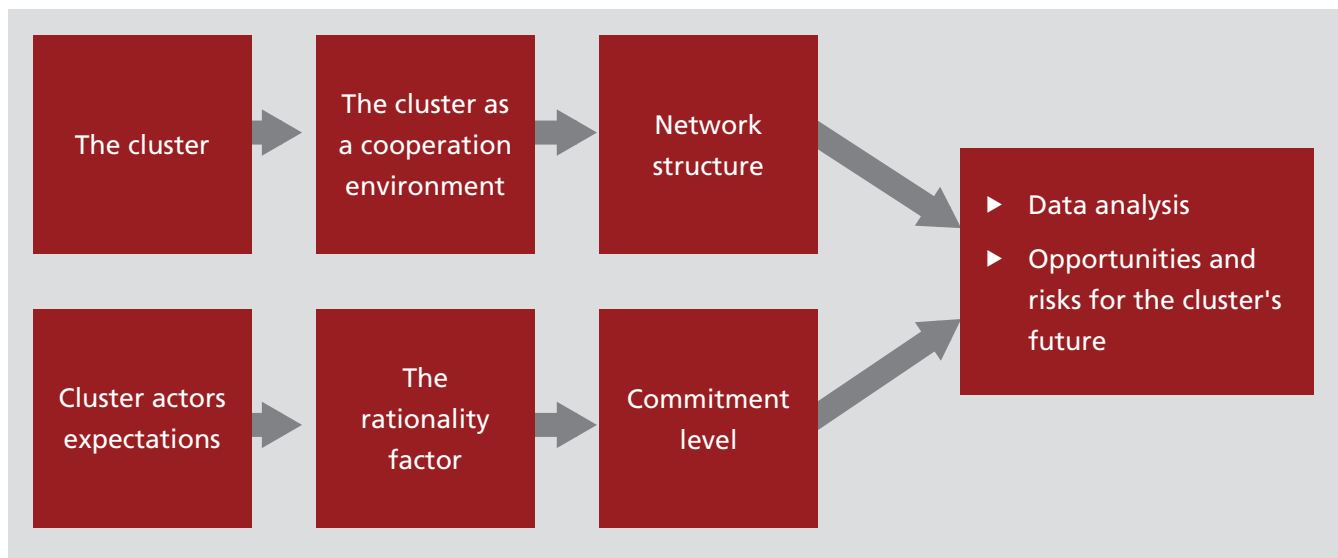
While for the key players the threat comes from the overwhelming choice for cooperation, for peripheral players the problem is the lack thereof. A peripheral CA may think that the limited cooperation it has within the CI would still exist without the cluster participation. If such players experience difficulties to develop new links or to integrate better into the CI the periphery that is to be seen as a chance for renewal in the CI erodes and the CI may become an aged circle.

At last players in the middle will have many connections forming many projects, but many of these go via some of the key CAs potentially creating an imbalance regarding working effort or profit distribution, which players in the middle may consider unfair. While a similar imbalance may exist towards peripheral players where middle players have a critical role, but the perception of unfair allocation can poison cooperation.

3 Research methodology

In the following we outline how the information required for our analysis could be obtained (s. Figure 9).

Figure 9: Research methodology



3.1 Fundamentals of decision making

In order to increase efficiency and impact of the cluster approach, we must, first of all, understand if the CAs make decisions along the rationality principles generally assumed in theoretical models. How are these decisions made? Consciously or intuitively? Answering these questions requires a detailed insight into the decision mechanisms of CAs as well as the organisation and code of the CI.

3.2 Profitability

While the above mentioned questionnaires help us to gain general information about decision making in CIs, the second group of data to measure the profitability is CI-specific. Ideally we propose to have a figure for the entire CI and all its subclusters that describe their profitability. This is an enormous amount of information that are not only sensitive data, but most likely this information is not at all available. In practice we cannot have and do not need all data; but CAs are able to identify valuable cooperations, if any.

In other words, we do not need to conduct extensive economic analyses for all the (exponential number of) subclusters, but only consider the valuable ones, as seen by the firms.

3.3 Network structure

At last, for an analysis that takes the social or economic network within the CI into account, we must have information about partnerships among CAs. We see three ways to gather such data. Firstly, when trying to obtain the value of subclusters, their CAs might simply respond that they do not know these people and therefore cannot give an estimate of the value or profitability of that CI. In practice, however, it is unlikely that such detailed information is available; the value of CIs must be estimated in some other way, which takes us to the other two options.

A well-managed CI is likely to have detailed and well documented information about past instances of cooperation as well as past business transactions. It may also have information on how the various CAs got involved, perhaps via other CAs. This is "hard" information on business relations and is informative not only about the existence of economic links, but also the intensity of these links.

At last, one may resort to questionnaires and interviews asking about business partners, although such "soft" information is more likely to be imprecise and incomplete and firms are likely to be reluctant to share such valuable information.

3.4 Methodology of cluster analysis

In our analysis we evaluate the CI as a cooperation environment. We identify the fields of cooperation, the valuable competences as well as the successful cooperation experiences the CI has accumulated. We collect information about the rules used for cooperation and for the internal and external decisions of the CI. The success management of the CA will be studied as well.

Research questions

- 1) What are the costs of participation in a CI?
- 2) Do firms make economically rational decisions when joining a CI?
- 3) What is the objective of the CI? Is cooperation a participation objective?
- 4) What is the structure of cooperation?
- 5) Do members invest into cooperation?
- 6) What are the CAs' perceived roles within the CI? Who are the key actors?
- 7) What are the risks CAs accept in exchange of the (profitable) operation of the CI or the hope thereof?
- 8) Are CAs ready to share?
- 9) Do CAs see CI participation as a conflict situation and to what extent?
- 10) What are the internal/external threats of cooperation? Is joining another cooperation a feasible alternative?
- 11) Are competences balanced within the CI?

4 Practical Part

4.1 The stages of our investigation

The CI has been met on three types of occasions. At the beginning, the goals of these meetings have been elaborated as well as how these meetings are organised.

4.1.1 Workshop

Our contact with a CI begun with a workshop with the CM and the CAs to explain out the motivation for our project, a brief introduction to our models and a description of the foreseeable results of our investigation including the potential benefits for the CI and the CAs.

Here we have already talked about the main line of the questionnaire that will be used during the interviews.

4.1.2 Interview with the CM

Following the workshop we interview the CM and the chair of the CI. On the one hand the CM can provide us with general information about the CI, but also specific information about CAs. Many of the questions we hope to get answers from the manager we ask the CAs: whether the views of the manager and the CAs agree say a lot about their relation.

We ask the manager to identify key players in the CI, explain how these firms are related to each other (business, or personal connections) and how the remaining CAs connect to these CAs. The shape of the emerging graph is very informative about the robustness of the CI. We use network analysis tools to evaluate the network properties.

For larger CIs the manager may be unable to provide information on each of the possible relations. (For instance, with 10 key and 100 other players we ask about $10 \times 9 / 2 = 45$ key and some 1000 satellite relations.) By using an "I do not know" option the manager reveals that he does not know/care about these CAs. We expect the loosely connected CAs' share to increase with CI size.

Obviously such "superfluous" CAs do not have much influence for the success of a CI, so to a great extent they can be ignored (although it would be interesting to understand their motivations for joining the CI).

The managers' questionnaire is presented in Appendix A.

4.1.3 Interview with the CAs

As a typical CI will have dozens of CAs, it is usually impossible to personally interview all. Instead a sample is chosen based partly on the managers' advice and on a preliminary questionnaire sent out after the workshop to ensure that we talk to all types of CAs.

When making the interviews with the CAs we try to talk to the decision makers rather than the cluster delegates in case the two are different. Our interviews have a formal protocol following a script, but can be adjusted to have a natural conversation. We try to have the interviews personally or over Skype: on the one hand seeing us helps to build trust. If the interviewed persons trust us we hope to get more genuine answers. On the other hand by seeing them giving the answers we can follow their body language and detect hesitation that is perhaps not present in words. Indeed our main concern is that firms will try to make reality nicer than it really is by giving biased answers. For instance, when asked, whether they make sensible, economically well-founded decision mechanisms firms would be inclined to say yes even if this is not the case just to draw a better image of themselves.

To explore the internal structure of the CI discovering the bi- and multilateral businesses and actions within the CI we ask questions such as

- ▶ Which CAs do you consider important business partners?
- ▶ Which CAs do you consider valuable business partners?
- ▶ Which CAs do you consider important potential business partners?

Based on the answers of the CAs we can establish a cooperation network. We will research the internal interest-system of the CAs and we will analyze it in connection with the whole network.

4.1.4 Analysis

After the answers to the questionnaires and interviews have been collected we evaluate them according to the points discussed in the theoretical part: We look at the individuals' perspectives and then the effect of individual interests on the CI level cooperation. Where possible we draw the cooperation network – as long as not all CAs have been interviewed, these networks are merely to identify the typology of the initiative-wide cooperation.

5 The analysed CIs – a comparison

We have conducted dozens of interviews with CAs of two CIs with proven management excellence, which are introduced in the next subsections. The interviews were sufficient to have a broad understanding of the CIs at hand – unfortunately data from two CIs are insufficient to form general conclusions, which we try to do anyway. Information from two CIs may not be sufficient to identify general patterns, but enough to pinpoint false theories.

We believe that our analysis of the two CIs at hand had the potential to provide useful feedback to the managers. Unfortunately the response rate was a little lower than expected, especially in the CI where we did not have the opportunity to start with a workshop or send out preliminary questionnaires. Overall the interviewees were friendly, but clearly did not see our work more interesting than any other form for statistics for the government.

While the response rate was a little lower than anticipated we were taken aback by the frankness and sincerity of the respondents especially where the interviews were held in person. Perhaps this would change if we would only have an electron-

ic questionnaire and no interviews although it was clear that some respondents wanted to waste no time during the interview and telling the truth is often the simplest. Interestingly other interview lasted much longer than planned – we see this as a sign for a sincere interest in the cluster cooperation.

The latter was confirmed by the fact that almost all respondents found being a CA a good thing and firms were very happy about the CM.

In the following we present the two CIs we have analysed.

Note: the analysis below is based on limited responses from only part of the CAs in each of the CIs. The answers are, by no means representative and therefore cannot be used to evaluate or judge the particular CIs at hand. On the other hand, while the answers are not representative in a statistical sense, they contained a good mixture of both active and passive, large and small CAs, making the respondents a good test group nevertheless.

Table 6: The main characteristics of the studied CIs

	CI A	CI B
Sector	Lifestyle	IT
Age	12 years	8 years
Participation type	Letter of intent	Membership
Number of CAs	389	45
Share of SMEs	89%	96%
Share of firms with less than 50- employees	76%	95%
Origins	Professional management attracting relevant firms	Past business and personal relations
Growth	Calls for participation in workshops & trainings	Via business and personal relations
Cooperation focus	Breadth	Depth

5.1 Clusterinitiative A

One of the CIs we have studied is a lifestyle CI of some 389 firms based on the existing cooperation of firms in the textile and furniture industries. Additional firms joined after participation in one of the many activities: trainings, workshops organised by the management with profiles ranging from design to architecture. There is no cluster membership - also no membership fee, - the firms participating at events are the actors.

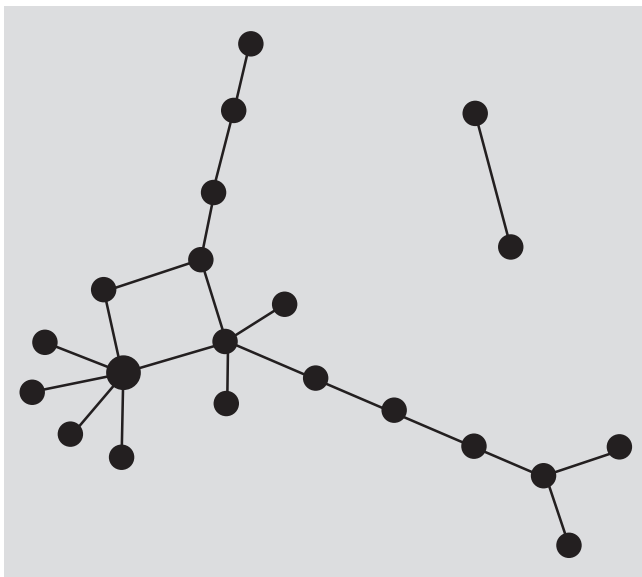
There are also no CI meetings or CI code as such, CAs meet at the aforementioned events. In the absence of cluster events we could not organise an introductory workshop, contact with the CI started with an interview with the CM. The information provided there was – we understand – passed on to (some) CAs. The CM gave us a list of CAs with a classification based on their activity level and we selected interviewees so that we can talk to different types of members, overall we had 19 interviews.

Rationality and profitability

Many CAs found the programmes organised by the management tremendously useful. Since there is no membership fee, it is clearly a good deal.

On the other hand participation costs do not only include membership fees, but also the costs and time committed to cluster activities. Taking these into account three respondents reported costs – including actual and time/opportunity costs – around €1000 for his participation in a single workshop. This respondent was positive about the workshop, but admitted that his costs exceeded the benefits.

Figure 10: Cooperation map of CI A. The cluster management is denoted by a larger dot.



Intensity

The CI includes some of the larger, international companies active in the lifestyle sector as well as small and even micro enterprises. Interestingly, the CI also includes for instance consulting firms and others outside the main profile. These firms gave rather different answers referring to the CI as a business opportunity and described their participation as contracted by CAs and/or the management. Apart from such firms CAs could not mention cooperation that did not exist prior to the CI or that was due to the CI. With these in mind we conclude that the peer-to-peer cooperation intensity of the CI is very low currently, but we see good growth opportunities once we look at the structure of cooperation.

Structure

We have asked CAs of CI A to choose the stylised structure of their structure. Most have chosen the snowflake and indicated that they are on the periphery.

We have also asked them to list the key CAs as well as the CAs they cooperate or plan to cooperate with. A significant part mentioned the management as the key player, most of them as the only key player (s. Fig. 10). Very few CAs (mostly consultants) could at all name another CA. The structure is therefore more likely a star, where very few peer-to-peer connections have been made yet and most cooperation is managed at the centre of the star. Figure 10 is not an ideal star since many interviewees did not consider the CM as a core partner (although, in fact, it is).

Balance

Here participation – attending workshops, etc. – comes with no strings attached. CAs are not committed at all, some were even a bit confused when asked about their cluster activities as they are involved in various programmes. The low response rate also confirms this.

On the other hand competition is not with ties here, but with the quality of events and the management of CI A has impressed its actors a great deal.

Summary

CI A has its programmes supported by regional, national or European sources: CAs recall some activity organised by the “government”, but do not remember that this was a cluster event. CAs enjoy the services of the management, benefit from the managed cooperation effort, but take these for granted. In our view the CI is still very young. It has been able to attract much interest with its various programmes, but has not built a brand yet. In a sense the sandwiches have already attracted many people to the party, so let's start dancing. So far we do

not see actions that would support networking, but with such a large pool to start with the chances for peer-to-peer connections are good.

5.2 Clusterinitiative B

CI B is active in the IT sector and has 45 CAs, all SMEs, of which 16 have been interviewed (Figure 11). The cluster was set up at the initiative of one of the owners inviting firms with similar profiles usually via a personal contact to participate. Since then many other firms have joined, but a similar number has been turned down due to the lack of relevant competences. Now let us evaluate the results in the same structure as our theoretical model has been built.

Rationality and profitability

We must discuss these two aspects affecting the individual CAs together. The reason is that, while the CI has benefited from funding in the past, currently the management and all the activities are financed from membership fees. Currently all CAs agree that their expected profit from participation exceed the membership fees by far so any formal cost-benefit analysis is superfluous. One of the smaller companies, noted that a three times higher fee would make serious calculations necessary.

Intensity

As the CAs are all relatively small companies and the IT profile makes cooperation with companies of very different profiles possible, the CI occupies a small, but noticeable part of their activities. On the other hand most CAs see the CI as a brand and CAs meet regularly making the CI more important in the life of these firms than its market weight would suggest.

On the other hand larger CAs also commit time to other similar organisations – not yet CIs, where an even more intense cooperation is observed. These outside options appear attractive due to their geographical proximity and may pose the (remote) threat of departure for a key CA.

Structure

The CI has a closed membership, each CA is approved by a steering committee. In turn CAs know each other very well; most can name at least a third of the CAs, many more than half (an average of 9.2 cooperating partners mentioned, although the variance is high – the corrected sample standard deviation is 6.6), but certainly the firms in the steering committee (71% named at least 3 of the top 5 CAs as key actors, Figure 13).

With several key players who know each other well, the cooperation structure of the CI has that shape of a snowflake (Figure 12). Starting originally from a star structure it has been very successful in getting a ring of key players involved more actively in building connections between these key players – connections that go well beyond the administrative duties in the steering committee, but involving players on the periphery often remains a challenge. It is also true that the original central player – currently the chair of the CI – is still ‘more equal than others’. In current discussions this CA wants to reduce the CI’s reliance on it in the near future.

Note that in this structure there is no clear centre: the management is not even on the map. Managed cooperation is therefore very rare.

Due to current CI accreditation rules the CI is a bit locked-in with its membership: while they would be happy to grow they

Figure 11: CAs’ and respondents’ size-distribution by the number of employees in CI B

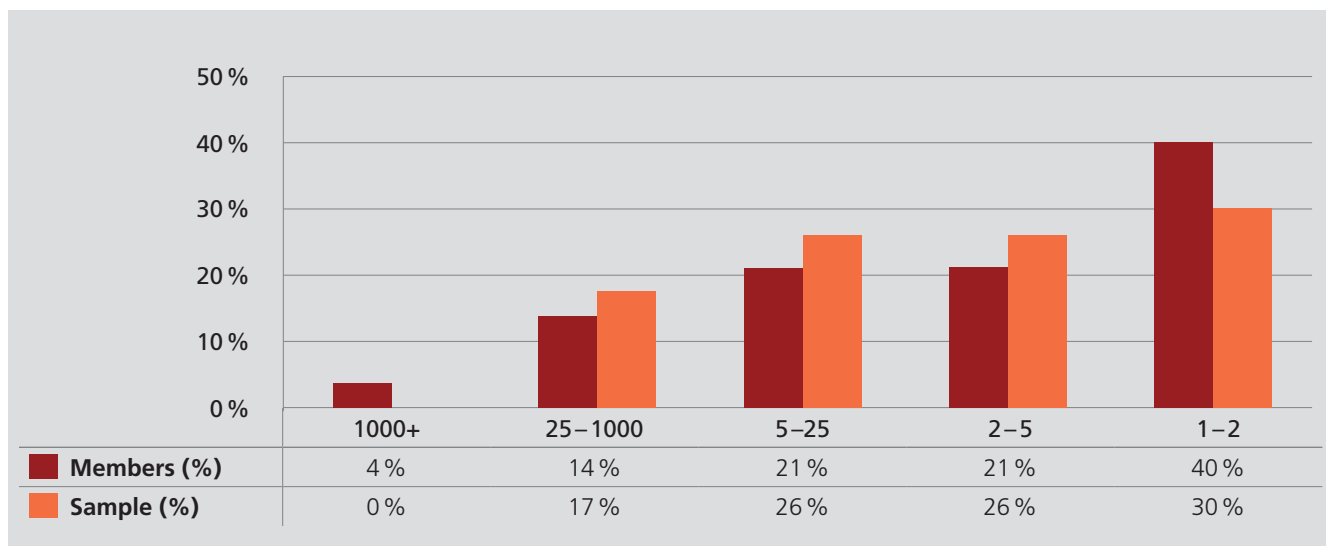
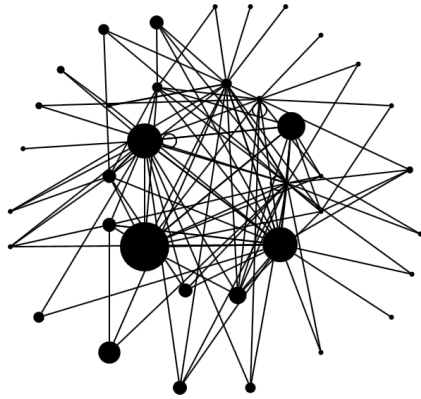


Figure 12: Cooperation map of CI B based on 16 responses. The size of nodes indicates how many CAs labelled the corresponding firm important for the CI



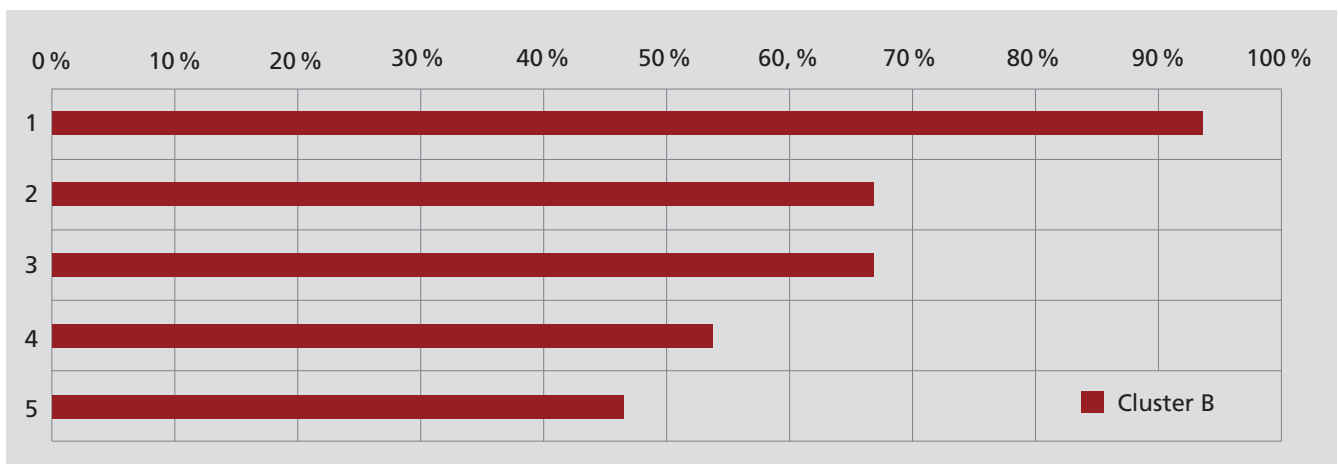
must follow a very conservative growth model and only take in firms they are absolutely sure about. A failed attempts for cooperation with an entry followed by an exit soon after can easily lead to losing their accreditation.

Balance

This CI focussed on deeper, rather than wider cooperation. With only a handful, though committed CAs the multiplier effect does not always work, the public good created by the input efforts is only to the benefit of a limited number of firm. Also, financing the CM is a substantial burden. In sum, participation is costly, net benefits are meagre and this carries the inherent risk of reducing cooperation effort or defecting to another CI or a similar organisation. The high effort of some of the key players makes partly up for this, but one wonders how are they rewarded for such efforts.

Internally still many of the CI projects go via the former central player creating occasional distributional tensions, but these seem to be secondary compared to the gains from the projects.

Figure 13: Frequency of top 5 key CAs mentioned as a percentage of respondents in CI B



Summary

This CI is coming of age with the initiator gradually retreating turning a star into a snowflake structure. The CI exhibits some genuine examples of cooperation within the CI. Conservative participation rules inhibit growth, introducing affiliate- or pre-membership status could overcome these difficulties.

5.3 A comparison

We have been fortunate enough to study two CIs with different backgrounds. CI B builds on past business and personal relations and tries to expand along the same lines. CI A has a professional management organising government-funded workshops and trainings that attract many participants. CI B is small with regular events where many CAs participate. As a result CAs know each other well and the goal is to form many CA-to-CA cooperations with the management helping from the background. CI A has few CA-to-CA cooperations (or at least CAs are not aware of these) as CAs' participation is often not more than attending a once off event or training – one respondent doubted if this can really be called a CI. On the other hand the management of CI A has much information about the CAs and with such a broad base conscious matchmaking can explode the number of CA-to-CA connections. Such growth is more difficult for CI B where CAs already know each other well and inviting new CAs may be the key for revitalising the CI. However, both CIs gain high CAs satisfaction and proved sygnificant added value.

6 Results

6.1 The assessment of the validity of the previous hypotheses

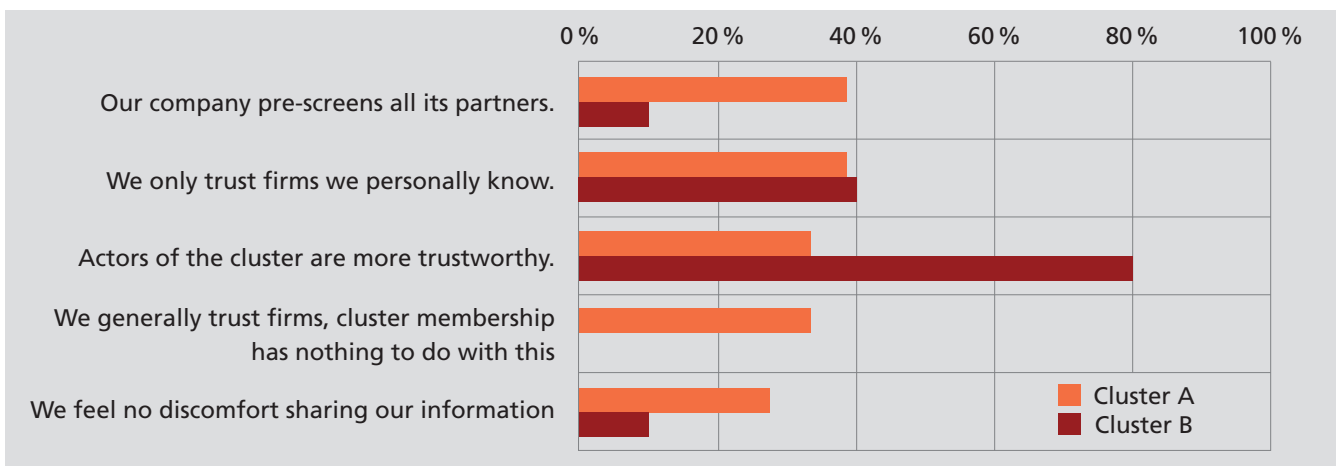
In the previous study, a set of hypotheses have been defined which were tested in this study. In the following the validity of these previously defined hypotheses.

The bases of decision making: Do actors like profit?

1. Companies join CIs as a 'homo oeconomicus', with the intention to harvest profits that could not be harvested otherwise. Other factors, such as the joy of creativity and collaboration facilitates this co-operation play but an auxiliary role and can also be expressed in financial terms.
 - ✓ While profitability is not always formally tested, among the reasons for joining CIs all respondents listed aspects that increase profits.
2. Companies take conscious decisions when joining CIs and this decision is just as formal as the decisions when joining any other co-operation.
 - ✓ Participation clearly depends on the costs and benefits.
 - ▶ CAs reported benefits that exceed the costs by far making a formal analysis superfluous.
 - ▶ It was also mentioned that a drastic increase in costs would make a more formal analysis necessary.
 - ▶ Higher mandatory investments lower the share of passive actors and free riders
 - ▶ High public funding creates an overdemand of CM services inviting CAs with unclear ideas and generally lower readiness to contribute. In the CI with membership fees (CIB) trust in other cluster members is much higher (80% vs. 33%).

3. Companies do a cost-benefit analysis comparing the cost of sharing confidential information with other CAs and the foreseeable benefits from the projects.
 - ✗ 95% of all respondents did not make a cost-benefit analysis.
 - ▶ The prevailing reason is that no considerable long-term (financial) commitments are required.
 - ▶ With high investments (e. g. annual membership fees) candidates are more reluctant, but as yet no such analyses are made, even for long-term CAs
 - ▶ Firms do not consider sharing information a cost, the main costs of participation are membership fees (in CI B) and time commitment.
4. CAs attach value to projects in the CI that are not yet realised.
 - ✓ Yes, 55 % of respondents in CI B mentioned participation as an investment into yet unrealised benefits. Participation benefits, however, include many other things, such as trainings, sharing information and other knowledge. Especially in CI A these are the major benefits.
5. The value of a CI for a particular company is the discounted money-stream within a given time horizon with a discounting reflecting the depreciation of the currency as well as the probability that the project or stream of projects will be discontinued.
 - ✗ No, such calculations are never made.

Figure 14: Responses to the question: Who would you share sensitive information with for potential benefits? Check all that apply. Answers to Q 22



Cluster code – structure: views on present and future alternatives

6. The cluster code addresses alternative outcomes.
- ✗ Cluster codes have the intention to rule the distribution of the profits and benefits among CAs on the cluster level rather than on an individual project base. None of the CIs involved had such a code neither there was any consciousness of the very most CAs that such code might be needed.
7. The cluster code regulates undesirable, but possible scenarios, such as conflict situations, too.
- ?
- If the circumstances are calculable, the actors do not pay attention to it. The actors of CI B are aware of the threat of secession and are considering steps to minimise the risk, but there seems to be no best practise in this field. In CI A there is no general cluster code, but formal model agreements tailored to each managed cooperation project.

Joining a CI: Do actors look for profit?

8. A company only joins a CI if this brings additional benefits.
- ✓ Yes, this is the driving force for participation, although what the “additional benefits” may be is often unclear. CAs join if their expectations are positive and they will be more or less fulfilled. Only 3 % of respondents reported participation where costs exceeded expected benefits.
9. If a company has the possibility to join one of two CIs the company will join the one that results in higher payoffs.
- ✓ CAs are continuously looking for a new and better opportunities. Interviews have shown that firms are open to move from one CI to another if this offers better profits. In CI B are considering to shift their focus on other industrial groups, in CI A some firms already participated in multiple – loose - partnerships.
10. A company should join the most profitable of all available CIs.
- ✓ Yes, they are considering other alternatives, but choice may be limited. On the other hand the lack of transfer mechanisms within CIs means that a CI may be ideal for one CA, but less good for others and vice versa for another CI. The decision ultimately depends on
- ▶ Choices of available CIs to join.
 - ▶ The allocation mechanisms in the potential CIs.
 - ▶ The certainty of expected profits.

- 10.1. A company should leave the CI if a more attractive participation offer becomes available in another CI.
- ✓ Yes, the companies permanently weigh it up. Participation is not exclusive.
- 10.2. A company only joins a CI if none of the subclusters offer better prospects.
- ✓ At CI A there is no competition for the sources, the benefits of cluster participation are not dependant on the presence of other CAs, but CI B is not ready to accept each and every application of new companies. Using the terminology of subclusters introduced earlier we can interpret a rejection decision as a subcluster “departing” from a (potential) larger CI. This is possible if the original CAs would not benefit from, or even would be harmed by the arrival of new actors.

How to keep all CAs happy at the same time?

11. The cluster code ensures that the gain of any subcluster exceeds its profit as an independent cluster.
- ✓ In general the risk of secession CI breaking up into smaller CIs is low because there is no exit mechanism and there is no fractioning within the CI, but in CI B the management is considering new mechanisms to increase the gain for companies with a risk to secede.

Social networks: How do projects form?

12. A (sub) cluster must be connected: Any other actor must be a friend's friend's friend.
- ✓ Knowing someone personally is as the key of trust has been highlighted by many (39 % / 40 % of respondents, see Figure 14).

6.2 Determinants for CI development

Based on the previous findings a set of determinants will be discussed, which might have a strong influence on the development of a cluster or cluster initiative.

High public funding may have adverse effects

Both CIs A and B have benefited from public funding in the beginning, CI A still finances its activities from such a public grant. Grants are very useful in setting up a CI and organise events that make the CI valuable for new CAs. These are the ‘sandwiches’ in our party example or a free rabbit for deer hunters in the stag hunt game. Unfortunately, one can very easily get used to such freebies and at a point stag hunters may just enjoy the free rabbit and forget that their original intent was to go

after the stag (s. Figure 15). In CI A we felt that the free actions distract the attention from the original idea of a CI.

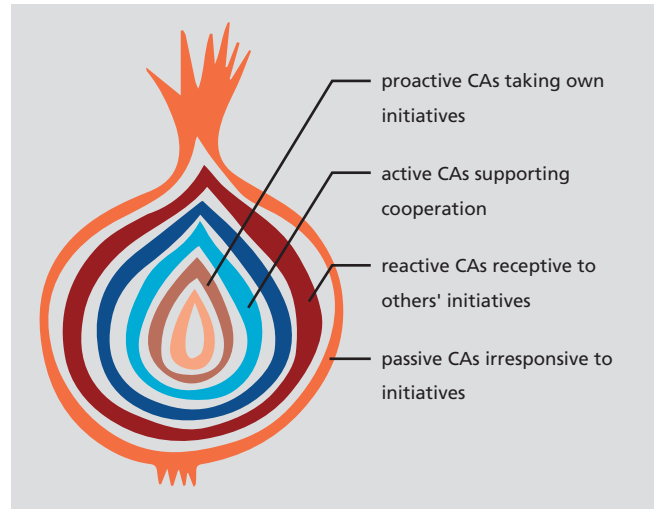
In CI B, where public funding is sparse and unreliable the management spends much effort in raising funds to cover its operation that is clearly wasteful from their point of view. At last we noted that firms try to get more out of a project they had to pay more for: a (high) membership fee makes CAs want to spend time with the CI. As shown in Table 5, introducing a membership fee makes participation less attractive for free riders. In CI A, the 16 respondents mentioned 40 out of the total 45 CAs as actual or expected cooperation partners, so at most 5 CAs are unattractive cooperation partners.

It is also interesting to compare the self-reported activity level of CAs. In the figure above one can clearly see that the proportion of passive members is 47% vs. 20% in favour of the CI with membership fees. While our figures are based on a biased sample, likely those are the more active CAs who responded and all the respondents of CI A have been classified as active or even proactive by the CM.

Cluster management must understand CAs' interests

The level of participation varies greatly within the studied CIs. When interviewed some had to be practically informed that they are CAs, while others literally called themselves part of the management. Cluster participation has a very simple rule of thumb: the more you put in the more you get. For those CAs who are taking an active role in the CI, the requested cluster services are richer, for the less active ones the costs of participation are the greater concern. Costs may be both time and money, and especially in the self-funded CI B, where activities are funded from membership fees different CAs find different trade-offs attractive between costs and services.

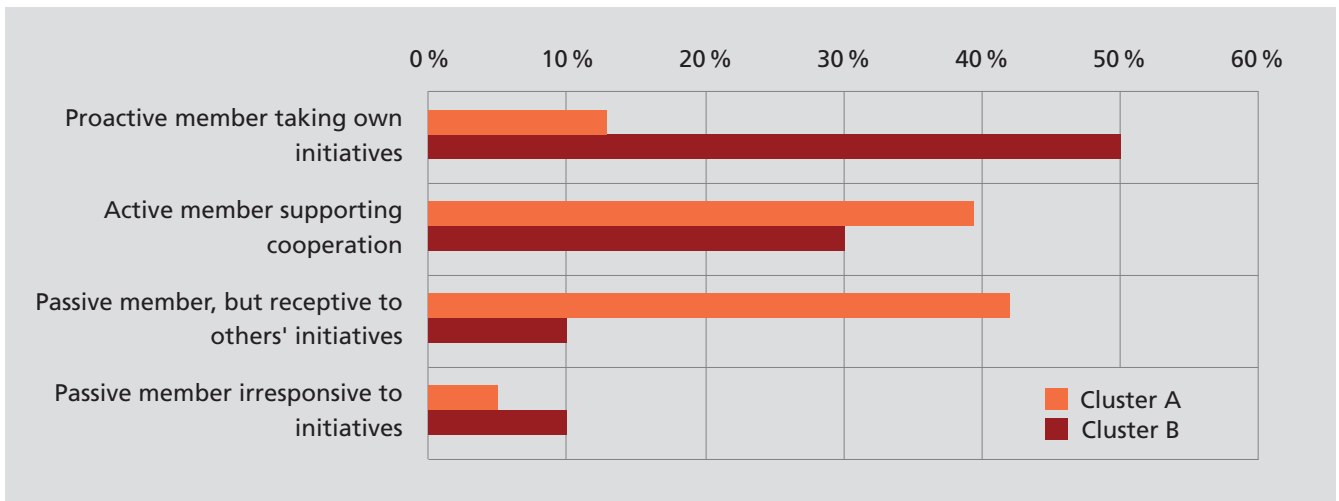
Figure 16: The different layers of participation



CAs' participation can be classified into a 4-layered "onion" structure with proactive, active, reactive and passive CAs (s. Figure 16).

- ▶ Proactive CAs are the key actors in the CI leading it with own initiatives. They are self-motivated. They are the pearls in the CI.
- ▶ Active CAs may not take on a leading role, but are often partners in these initiatives. As cooperative actors they may be the 'hidden champions'.
- ▶ Reactive CAs are on the look for opportunities and when a project addresses them, they are likely to join. Can be transformed from non-cooperative to cooperative actors. The 'sleeping giants'.
- ▶ Passive CAs do not even react to such initiatives: either they are too picky about projects, are newcomers or are about to "fall off" as the outer layers of an onion.

Figure 15: Responses to question: Which of the following describes your level of involvement in the CI?



Interestingly, managers are not always well-informed about CAs' participation. In CI A many of the respondents declared a lower participation level than indicated by the manager, while none claimed higher. This may be an error of judgement by the manager or simple modesty of the respondents, but the apologetic tone they often used in giving the answers suggests that these CAs see additional potential in participation.

While a higher level of participation is generally better, a successful CI is unlikely to have only core CAs! There must be ways to gradually involve newcomers as well as professional protocols to leave the CI. Newcomers bring new cooperation possibilities increasing the scale and scope of the CI. Newcomers are most likely "brought in" by a CI event or by one of the CAs. Initially their activity is low and will count as passive/reactive members. The absence of such members is often an indicator that they are missing. It is difficult to pinpoint ideal figures, but the ratio of passive members in CI A is a little too high (47%) – the CM should find ways to get them involved, - while in CI B the renewal mechanisms are imperfect so the ratio of passive members is probably a little too low (20%). This suggests that the figure could be 25%-40% of CAs (see also Figure 15). The role of peripheral CAs is discussed further in Section 0.

The structure of the CI

The network of existing connections has much influence on link formation. In a star network the central player is instrumental in forming projects and thereby helping others to connect. In a snowflake this duty is shared. The same holds for a circle network, but there there may be no coordination between the key players. Clearly, CAs at such key positions have a conflict of interest in helping others to connect as this weakens their positions: they may be left out of projects they were needed for. On the other hand they will also benefit from the more extensive cooperation of others are partners. Managers do not have this conflict, but it is not clear what would be their incentive to enhance peer-to-peer cooperation.

Entry and exit

New CAs bring new prospects for cooperation, but at the same time upset the business as usual of the CI. There is a clear conflict between scale and scope: a more focussed, more specialised CI will naturally consist of fewer CAs, in a CI with too many CAs, the focus is lost, the events may become too general or interest only a small part of the CAs. There is no golden rule but facilitating entry and exit helps the renewal of participants and regularly brings the potential of new connections. CAs with many working relations do not leave the CI, so an easier exit is also a cleaning process.

New entrants bring the long-term prospect of new partnerships, but they also enter the circle of trust of the CI as outsiders. It

is not only the new entrant, who has to make a cost-benefit analysis whether to enter the CI, but also the CI allows a new CA into its private sphere. A structure such as the snowflake makes a gradual entry possible, very natural.

The stakes for participation

We have already compared cluster participation to a stag hunt game, where the gains from cooperation exceed the profits without it. This cooperation is, however, risky as its success depends on the participation of other CAs – something we have no control of at all. While we cannot guarantee everyone's participation cooperation is more attractive if the benefits are higher: in this case the expected benefit from the (risky) stag hunt goes up, while the benefits of the rabbit do not change. Then the stag hunt becomes more attractive making it more likely that CAs choose a high level of participation. This, in turn, further increases the value of participation so a chain reaction starts. Igniting the process is more difficult, but patient CAs, who, realising the process, are willing to lend high level participation in the hope of high returns, or a risk-neutral investor, such as a government can intervene at that point.

The role of the sub-clusters

When the stag-hunt does not require full cooperation and a smaller group can get the same prey, the prospect of having to share it with unnecessary CAs may make this group consider severing cooperation with these CAs. Ex ante, that is, before the projects are realised there seems to be no reason for assuming that additional CAs bring no benefit, but ex post, when a particular project shapes up, and we do not only theorise about profits, but these are about to be realised there may be CAs who are suddenly superfluous.

We found little evidence of such destabilising groups in CI A, which is hardly surprising. In CI B there are some denser areas in the network where such conflicts may arise in the future.

Size

When the number of participating firms is high the fixed costs of organising a workshop or a training divide making things that would be too expensive for a single firm or even a small CI affordable. Such benefits would be available for any group of firms. While we do not want to downplay the importance of such savings, the added value of CIs is cooperation, so in the following we look at size from a cooperation point of view.

There is a trade-off between size and search costs. In large CIs there is a large selection of potential partners, so there is no need to start bonding at the first chance: quite possibly there will be better matches. On the other hand, good cooperation is built on a high level of trust, that is developed over several encounters and in a large CI the number of encounters with a

particular firm are too few. Among the many companies one meets at meetings it is difficult to remember a single one – this is at least the experience from CI A.

When few firms are “locked up” in a small CI trust develops much more easily and joint projects emerge more often despite the smaller choice of perfect partners. The difference was striking at our question regarding the ideal team (question 21) very few (10%) of the large CI could actually name multiple partners, one respondent explicitly mentioned contacting the CM for advice. CAs of CI B had no problem thinking up a good team, since, with one exception they already have such co-operation partners

A good manager can work magic in a large CI by an appropriate “matching service”, in a small CI it is easy to reach a dead end.

Focus

An CI is of course a concentration of firms working in similar industries. On the other hand it is often a little difficult to draw firm lines and there may be reasons to include firms with more remote profiles and competences. CI B has been a bit more closed in the past, but is now slowly opening up for new ideas. Clearly, for them this brings in new CAs, although some are sceptical about cooperation among firms with such different profiles.

On the other hand, in CI A we have received some rather surprising suggestions. A design firm suggested that they would like to work with artists and more artists should be brought into the CI, while a firm active in circular economy missed garbage collection and transportation competences. These are clearly CAs with ideas and allowing them to explore them might result in a peripheral player becoming a local hub, possibly a key player in the future. What will artists have in common with garbage collectors is another story.

Geographical distance

One might think that in the 21st century technology crosses distances and makes the classical definition of clusters where geographical proximity is stressed outdated. Perhaps this is true for general communication, but travelling time has been mentioned in both CIs as a serious problem inhibiting cooperation. People find travelling expensive and inconvenient and prefer activities near their own location. In CI B distance – we are talking about a 30 mins ride – is the main risk, or at least serious obstacle for cooperation. In CI A distances can be even larger and some CAs mentioned travel as the main cost of participation. The findings of Gaspar & Glaeser (1998) confirm this point.

7 Conclusions

In the following we interpret our results, compare it to similar findings in the academic literature, characterise the “ideal” CI from the point of view of cooperation. We close with a summary of the main findings and with a set of open questions/hypotheses.

7.1 Literature

While we believe that ours is the first work to investigate CIs from a game theoretic perspective, several studies have been published that explored the cooperation network of CIs. While this is only part of our story it is interesting to see the conclusions.

Iammarino & McCann (2006) present an excellent recent survey of results, moreover they use a similar classification system to the one we use to describe successful CIs. Their purpose is to overview the literature and based on the documented case present a classification that explains why are there so many different CIs. They also explicitly address the dynamics of change in CIs. One must note that the discussed studies use various means to describe CIs often using tools that were not available to us. For instance, while our notion of “contact” depended on self-reporting, Gaspar & Glaeser (1998) looked at patterns of telephone usage to conclude that face-to-face and telephone contacts are complements, not substitutes, that is we call those people more who we also meet. Technology, it seems, cannot replace personal communication and therefore geographical proximity plays an important role. Discussing the geography-firm-industry relationship they identified three main types: in pure agglomeration the benefits of participation come from the size of the CI – to some extent CI A meets this description. In an industrial complex the characteristics of certain industries forces companies to make long-term commitments for cooperation by locating themselves near to each other. The third type is social networks, like CI B, where the CI is built on existing cooperation and the driving force is trust. They treat the old and the new social networks separately as the old ones usually operate in traditional industries, the new ones (CI B is an example) in high-tech sectors.

7.2 The nature of cooperation in CIs

Cooperation in CIs has three aspects, when discussed from a game theoretic perspective. The first is intensity: value generation, structure and balance: value distribution. The following lessons can be learned about good practices for cooperation.

7.2.1 Value generation

The interviews have revealed that participation in the knowledge flow, such as sharing information on market trends is ranked high among sought benefits of cluster participation. After joining a CI each actor is free to decide its level of participation, such as, its level of sharing. Considering this as a non-cooperative game, we look for the Nash equilibrium of this game: this technical concept describes a possible strategy for each CA with the property that no CA would benefit from choosing a different strategy assuming that the rest stick to their old one. In our example this would mean describe a level of sharing such that no CA gains by sharing more or by sharing less. There may be more Nash equilibria and one of these is where the CI is completely dysfunctional, where no-one shares. If one of the CAs would change its mind and started to share information, all the benefits would go to other CAs. Obviously the question is whether there are more cooperative forms of cooperation that can be sustained as equilibria.

This problem goes well beyond the scope of CIs and is generally termed as the voluntary provision of public goods: how to make free parties make efforts to the benefit of others? Well, there are at least two aspects of CIs that can help cooperation: one is long term cooperation and the second is, what we may call a **multiplicator effect**.

It is a well known result that long term cooperation can sustain virtually any strategy profile: As long as the initial effort levels are maintained, cooperation continues, but as soon as there are cheaters, cooperation breaks down. When CAs are sufficiently foresighted, the future gains of cooperation outweigh the one-time benefits of cheating.

This is especially true when the gains of cooperation are high, when cooperation is rewarded by, for instance, external funding, but especially when the joint efforts “multiply”, **The ideal CI will consist of stag-hunters, who trust each other, spare no time and money and go for intensive cooperation, which is then reinforced by the prospect of long-term cooperation.**

7.2.2 Balance: value distribution

The fundamental distributional problem of public goods is that those who provide the good may be different from those who benefit from it. As long as the imbalance is temporary, the reversal of the roles releases the associated tension, but if it is

lasting, some CAs may feel that others are free-riding on their efforts. With a substantial multiplication effect they benefit from even a very small input from the less committed CAs, but there may be a point where the CI is more effective without some free-riders. One solution to this problem is to implement compensation mechanisms, such as a higher participation fees for free-riding CAs, which can also act as incentives for more intensive cooperation. Such mechanisms are currently in consideration in Cluster B. Note that one tends to think that we must seek free riders among the less active CAs, while this is typically not so: passive CAs are less likely to benefit from their (loose) participation. One must also deal with new CAs separately, as they will often be temporary free riders, but here high charges would not be very welcoming.

Another solution is to create mechanisms to sanction lack of cooperation with discontinued or second-rate membership. Unfortunately current policies encourage CIs to widen cooperation disregarding the optimal CI size and the depth of cooperation. With stricter participation rules CAs would be forced to elevate their level of involvement.

Services provided by the CM add to the prize of cooperation, but if services are non-differentiated and so also free-riders benefit, these services do not increase the incentives for cooperation.

The ideal CI should reward cooperators and disincentivise free-riders.

7.2.3 Structure

There are many ways for CAs to connect: R&D cooperation, joint business projects, joint applications for funding, they may simply be trading partners, provide services to each other, or simply know each other: future projects are built over these, often looser forms of cooperation. The importance of the CM as a matchmaker to foster the formation of such links cannot be overestimated. We assume that projects can only be built over connected sets of firms: if the participants of a project is split into two groups, there must be at least one CA of each group who know each other. Without this the two groups do not trust each other or cannot even communicate.

The two CIs studied are based on two distinct models of cooperation. CI A is a managed cooperation network, where the CM has strong ties to each CA and as part of its services it can set up project teams on demand. CI B is a peer-to-peer cooperation network, where the CM has more of an administrative role, cooperation is decentralised, links are formed directly between the CAs.

If a CA seeks a partner with a particular competence (that is available in the CI), it can get this very easily in a **managed cooperation network**: it needs only to ask the CM since all available competences are 2 links away. In a **peer-to-peer cooperation network** there are no such guarantees, and the search costs depend highly on the network structure. Here the flight network between airports is a good reference: by having a group of well-connected hubs it does not usually take more than 3 or 4 flights to reach even the most remote destination. The snowflake structure has this feature: when the key CAs are well connected, CAs connected to them have good access to each other. The network structure of CI B is just slightly worse than that: the network's graph has a diameter of 5, so it takes at most 5 connections to contact the most remote actors. The ideal CI must therefore have several of the most active players well connected to each other to build up redundancies. The ideal CI is also open for new CAs, who are typically less connected initially.

A CA is critical to a project if connectivity breaks with its exit. CAs who are often critical in projects are critical to the success of the entire CI, too. Critical CAs create risks for the CI: their departure drastically reduces the scope for cooperation and may result in the CI falling apart. CIs with a star structure, with a firm or possibly the CM in the centre would fall apart after the departure of the central firm. Risks of this type negatively affect the cooperation effort of CAs, by reducing long-term benefits. The risk can be mitigated if the centre of the star is a professional CM firm with contractual agreements that guarantee long-term reliability. Such risks apart the star structure could be more efficient as the central actor can efficiently link other CAs and generate much peer-to-peer collaboration. Evidence, however shows that it cannot, or at least so far the number of peer-to-peer connections is almost negligible. Such a network seems very efficient in one sense, but apparently difficult to manage in another. Two more networks have been considered: The circle network, which has local cooperation centres, but these do not directly know each other - probably only via the CM; and the haystack, which is the random benchmark.

The snowflake-structure is therefore a good compromise between risk and distance between CAs, with a densely connected inner core and additional CAs connected according to their level of participation.

7.3 Implications for funding and managing cluster initiatives

Targeting an ideal CI there are a number of lessons learned based in the finding of this study, targeting the funding (policy) as well as the operational (cluster management) level.

7.3.1 Cooperation and funding

First of all, recall that a CI is a large number of cooperating companies in geographical proximity. Thus: a large number of firms, in particular: cooperating firms. But it seems neither of these – otherwise successful – CIs has fully explored both aspects of being a CI. So far we have been looking mostly at the first one: having a large number of firms and successful CIs were thought to be characterised by a large and increasing participation. This puts a lot of pressure on small CIs to keep CAs practically at all

costs, stopping the natural in- and outflow of CAs. Focussing on and evaluating CIs by their key actors and on overall statistics only would remove this constraint.

Enhancing cooperation is a lot more difficult. An initial ring of firms grows in a busy criss-cross of contacts and cooperation like a tiny crystal grows in a concentrated solution. How to support growth? One of our findings was that the more firms put into a CI, the more they can get out. External funding currently tends to replace cooperation effort resulting in CIs that lack peer-to-

Table 7: The ideal CI

Aspect	Ideal CI	Alternatives and their risks
Goal of participation	Cooperation benefits	Free (public funded) services – these attract free-riders and disincentivise cooperation
Costs	Substantial time/money contributions	Free membership - low commitment
		High cooperation costs – barrier to cooperation
Funding	No long-term reliance on only external funds	Top-down CI with publicly funded CM – risk of addiction to free services
Trust	Elevated trust level in CI	CI brings on trust benefits – cooperation is risky
Cooperation strategy	Stag hunt	Rabbit hunt – why to have a CI?
Initiatives	From various CAs	From CM – likely shortage of variety
Time-span	Long term, open-ended projects	Few, fixed term projects – reduces cooperation effort, increases free-riding
Cooperation intensity	Many direct links	Indirect connections – ideas “lost in transmission”
Access to knowledge	Managed cooperation or dense snowflake network	Decentralised cooperation – required competence may be too far.
Vulnerability	Low, due to peer-to-peer cooperation	Managed cooperation – CM is a very critical actor in the network of cooperation
Centre vs. periphery	Periphery has connection to multiple “hubs”	Unique access points – too much centrality power leads to biased allocation of resources
Competences	Balanced competences	Short competences – unequal cooperation benefits, imbalanced allocation of resources

peer contacts. Growth is supported by funding that is complementary to cooperation efforts and not a substitute. This is especially problematic with “top-down” CIs that do not have the existing core of cooperation, the “crystal” to start the process.

In terms of the stag hunt game model, cooperation is more likely if the rewards of cooperation (with respect to the rewards of noncooperation) are higher or if others’ claims of hunting the stag are credible, trustable. The first is precisely where external funding can help. External funding can add to the benefits be won in the form of subsidies, free workshops or trainings or other services, but beware that the general support of CIs benefits cooperators and non-cooperators alike, actually reducing the cooperation benefits in relative terms.

External funds are helpful and in the case of top-down clusters even essential in the initial stage of a cluster. Funding lowers the barrier to join the CI and thereby facilitates a high growth in size. This growth, however is a mere growth in quantity and not necessarily in quality as well. Funding attracts free riders and invites passive actors to step in adversely affecting the composition of the CI. With free riders present, also active CAs will be reluctant to make cooperation investment due to the higher risk of losing that investment. In the absence of trust CAs will act more noncooperatively inhibiting a growth of peer-to-peer connections. Mature CI should therefore not rely on (substantial) external funding for their daily business, although it is clear that in the absence of a cooperative attitude, when CAs are not ready to make investment in the CI, a sudden change in the funding regime – a drop in funding can lead to the termination of cluster activities.

7.3.2 Managing cluster initiatives

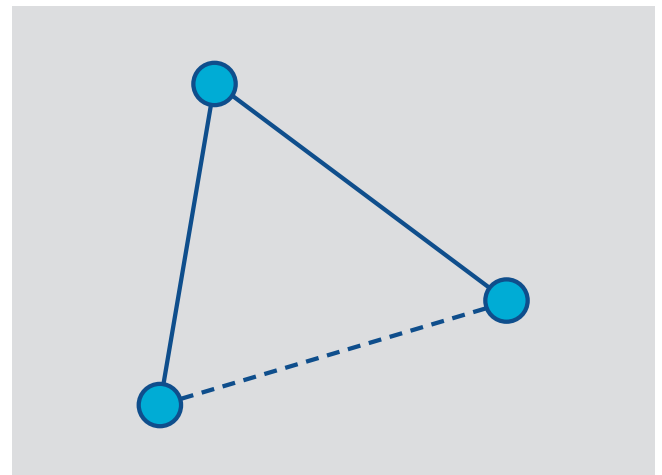
Trust must be earned, but with frequent contact and communication CAs get to know each other and one can “trust” another firm better if its behaviour is predictable. We must not fully ignore cultural aspects, but in the CI where the network of cooperation was denser, more respondents (80% vs. 33%) trusted fellow CAs more than firms in general.

CMs have, of course, an instrumental role in link formation. Links form when a CA of the manager brings together unconnected CAs in a project or at an event (as in Figure 17). While CAs face a trade-off between weakening their position in the network and increasing the overall value of the CI, that is, the choice between a larger slice of a small, or a smaller slice of the larger cake, CMs have the sole incentive to increase the cake. They should, by knowing the CAs well, keep track of the offered and sought competences and offer a kind of a matching service between these.

CMs must understand the different positions or types of CAs.

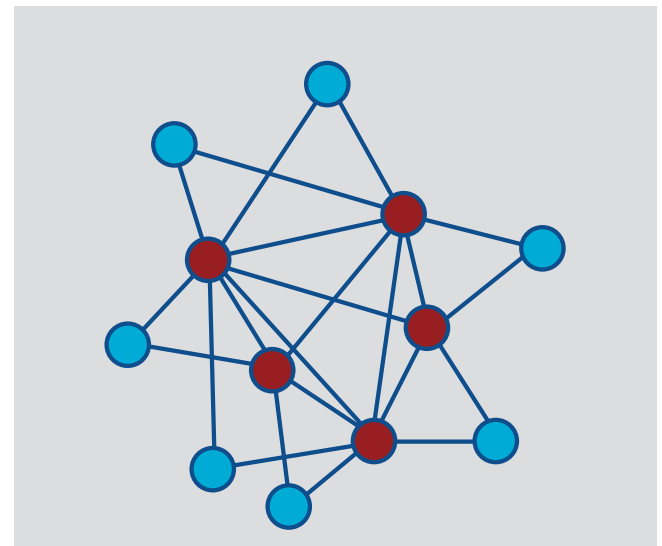
Active actors (Figure 18, highlighted in red) are the pearls of the CI. These actors are fundamentally cooperative and – in the right circumstances – they are the actors who go for the stag. They are key to the strategy and service development. Since they are the most active and they are the ones responding to initiatives they are also the core target group for the CM; their wishes must be respected and requests satisfied. Active actors are also the key to turn passive, non-cooperative CAs into active, cooperative ones.

Figure 17: Link formation among two unconnected firms in a project



Reactive actors (Figure 18, highlighted in blue) are the reserves of the CI. As sleeping giants they bring growth potential – as soon as they can be converted into active actors. They should be involved in the strategy development, but without high expectations in terms of input. Such actors are currently focussing more on private, rather than public benefits, rather than the

Figure 18: Different roles in the CI: highlighted CAs are the key actors



well-being of the CI, they are interested in hunting rabbits, but may perhaps be tempted to go stag hunting. One can tempt them with profitable project opportunities, but transparency, getting to understand their positions, interests and providing them with information may help to overcome barriers of trust and cooperation.

7.3.3 Services offered by CM

How to translate this into practical terms? What does it mean for cluster managements developing and implementing business support services? The key lessons learned is that the type of services or added-value created and implemented by the cluster managements can not be seen disconnected from trust and openness for cooperation. In most cases, business support services offered by cluster managements depend on the competence of the cluster management, the strategy of the CI or of the interest of the CAs. The study has shown that this is not really the most promising way. Services offered by the cluster management has to be actively absorbed by the CAs. If services are offered which require strong trust and mutual openness among the targeted CA (Figure 19), but the CAs are not ready or willing to behave properly, all related actions will fail (CM offers to go for stag hunting but nobody of CA joins). For instance, joint product development or joint R&D is the most risky undertaking within a CI. It is risky (failure possible), but can great big profit (if successful). No public funding can lower this risk (it is similar like the stag hunting). Only those CAs will

participate which are ready to take the risk. Trust, willingness for cooperation and readiness to invest are mandatory preconditions. If the cluster management offers support in this direction, but there are no or not enough CAs to join, nothing will happen. Meaning, the service might be good and the demand exists, but nobody dares to take risk and trusts each other.

Based on this assumption, the spectrum of services offered or designed for CAs has to be appropriate to the real intension of the majority of CAs and the trust and openness among them. Figure 20 displays the dependency of services offered by CM of trust and openness among the CAs. When having a closer look why so many (young) CI focus on services with a grouped in the left bottom area of Figure 20. These services will always be absorbed by CAs since low trust is needed. Free-riders do like it, since they don't need to open and can easily gains small benefits (rabbit hunting). It also becomes clear why many CI fail to design a (real) common strategy. Because CAs have to be open minded, sharing ideas and needs among each other. This is only possible with a minimum of trust and openness. Free riders will benefit but not contribute. If CAs do have the feeling that there is no common base of contribution and trust, the CI strategy remains a fake or is done by a small group who trust (or done by CM himself).

The cluster activities will therefore depend on the composition of the CI and the general cooperation attitude. Figure 19 groups typical services offered by CM intended for active, trustful CAs (upper right area) and reactive CAs (lower left area).

Figure 19: Services offered by CM vs. level of trust required among CA

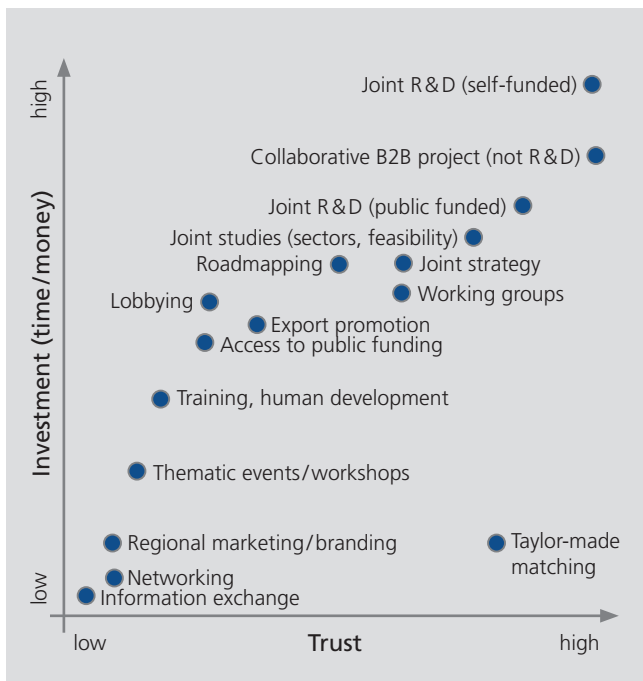
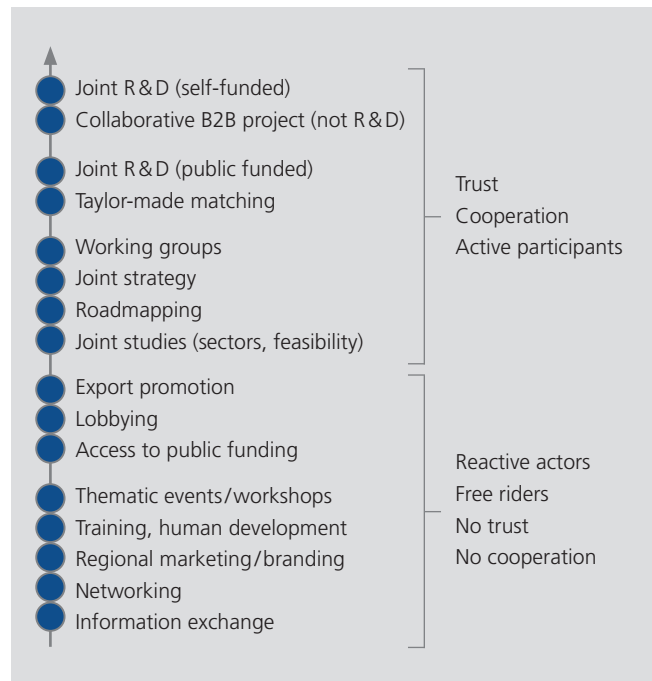


Figure 20: Activities among CA dependent on the level of cooperation



There is no good and bad. Even CI can be considered to be a success when most CAs are reluctant and not really open minded to share trust. Provided they will for "served" by proper services offered by the CM. The benefits are quite low (rabbit hunting), but also the investments (and no need to trust and open itself). But such a CI will fail if the CM strives for more and trying to implement services and common actions that requires more (trust and investments like stag-hunting).

On the other side, if there is a trustful cooperation attitude within a CI, CAs will be disappointed and dissatisfied, if the services offered by the CM are mostly those mentioned in the bottom area of Figure 19. It is like if the CAs want to hunt stag, but the CM supports them in hunting rabbits.

7.4 Robustness

While some of our conclusions seem rather clear and crisp we must note that our work is based on less than 40 interviews in only 2 CIs. Previous work does not seem to contradict our findings but a large number of interviews would help to make the conclusions robust.

Taking this into account, an additional round of interviews among CAs of the CI A has been just been conducted. About 50 responds have been collected. Based on the previous findings and lessons learned, some questions have been sharpened or slightly modified. Thus the results are not one to one comparable with those of the first round. The main outcomes of the second round are given in the appendix.

The findings of the second round clearly back the robustness of the methodology of the study and are well in line with the outcomes of the first round. However, additional activities shall be implemented to further test the robustness of applied methodology.

Acknowledgements

We thank the cooperation of the managers and actors of the two anonymous CIs. We also thank the Steering Committee consisting of Professor Thomas Rønde (Copenhagen Business School), Betina Simonsen, Sara Tvile M. Sørensen and Henrik Barslund Fosse (both Danish Agency for Science Technology and Innovation), for invaluable feedback on earlier versions of our model and findings. We also thank the Danish Agency for Science Technology and Innovation for funding this study.

Bibliography

- Borm, P., Owen, G., & Tijs, S. (1992).** On the Position Value for Communication Situations. *SIAM Journal on Discrete Mathematics*, 5(3), 305. doi:10.1137/0405023
- Copic, J., Jackson, M. O., & Kirman, A. (2009).** Identifying Community Structures from Network Data via Maximum Likelihood Methods. *B. E. J. Journal of Theoretical Economics*, 9(1).
- Gaspar, J., & Glaeser, E. L. (1998).** Information Technology and the Future of Cities. *Journal of Urban Economics*, 43(1), 136–156. doi:10.1006/juec.1996.2031
- Gedai, E., Kóczy, L. Á., & Zombori, Z. (2012).** Cluster Games (p. 37). Copenhagen-Berlin. Retrieved from http://files.conferencemanager.dk/medialibrary/04d6301d-b532-4d77-9d6f-90a7e38fc1db/images/Cluster_Game_theory.pdf
- Gillies, D. B. (1959).** Solutions to general non-zero-sum games. In A. W. Tucker & R. D. Luce (Eds.), *Contributions to the Theory of Games* (Vol. IV, pp. 47–85). Princeton: Princeton University Press.
- Herings, P. J.-J., van der Laan, G., & Talman, D. (2005).** The positional power of nodes in digraphs. *Social Choice and Welfare*, 24(3), 439–454. Retrieved from <http://www.springerlink.com/index/G18873X86K423L53.pdf>
- Iammarino, S., & McCann, P. (2006).** The structure and evolution of industrial clusters: Transactions, technology and knowledge spillovers. *Research Policy*, 35(7), 1018–1036. doi:10.1016/j.respol.2006.05.004
- Kind, S., & Meier zu Köcker, G. (2013).** Cluster Impact Analysis: The real cluster case (p. 36). Berlin.
- Kóczy, L. Á. (2007).** A recursive core for partition function form games. *Theory and Decision*, 63(1), 41–51. doi:10.1007/s11238-007-9030-x
- Porter, M. (1998).** Clusters and the new economics of competition. *Harvard Business Review* (pp. 77–90).
- Shen, Y., Nguyen, N., Xuan, Y., & Thai, M. (2013).** On the discovery of critical links and nodes for assessing network vulnerability. *IEEE/ACM Transactions on Networking*. Retrieved from <http://dl.acm.org/citation.cfm?id=2525564>
- Sölvell, O., Lindquist, G., & Ketels, C. H. M. (2003).** The Cluster Initiative Greenbook.
- Von Neumann, J., & Morgenstern, O. (1944).** *Theory of Games and Economic Behavior*. Princeton: Princeton University Press. Retrieved from <http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Theory+of+Games+and+Economic+Behavior#0>

Appendix A: Questionnaire for cluster managers

1. What is the main profile of the cluster?

2. What are the prevailing markets the cluster members are active in?

3. Who are the main (cluster) actors operating in the respective markets?

4. What the key factors to succeed in these markets (activities, competences, features)?

a) _____ b) _____ c) _____ d) _____

5. Do the cluster actors have any specialisation in these markets?

yes: _____ no

6. What is the role of the entire cluster in these markets?

key players influential players market participant/followers

7. When was the cluster (initiative) founded?

8. What was the initial goal to form the cluster?

9. What was the original number of founding members/what is it now?

10. How many cluster actors stepped out since then / how many joined?

11. What are the main rights and duties of members (committed actors)?

rights: _____

duties: _____

12. Describe the cluster's mechanisms for governance, decision making process, sharing tasks etc.

13. What links cluster actors? What are the common competences?

14. Are competences well balanced within the cluster?

yes no, we have ...

... too much of _____ ... too little of _____

15. What is the usual form of cooperation within the cluster?

regular projects at the cluster level

regular projects for smaller teams

ad-hoc projects at the cluster level

ad-hoc projects for smaller teams

16. What is the content of cooperative projects successfully implemented in the cluster? Give examples.

17. How many members are involved...

...in each project _____ ...in most projects _____ ...occasionally _____ ...never _____

18. Have cluster projects ever failed?

yes no

19. If yes, how many cluster actors were involved

... in each failed project _____ ... in most projects _____ ... occasionally _____ ... never _____

20. If yes, were the members involved in the successful and the failed projects different?

- no, the same yes, some are more successful yes, incidentally

21. What are the plans of the cluster in a nutshell (short-, medium-, and long-term)?

22. Which of the following thematic priorities are most important for the cluster and why?

- collaborative technology development, R&D, technologie transfer _____
- information exchange and matchmaking (within the cluster) _____
- development of human resources or training of cluster actors _____
- development of entrepreneurship _____
- matchmaking and networking with externals _____
- acquisition and distribution of funding _____
- business activities _____

23. Do you have a set target date to realise cluster goals? Do you plan beyond?

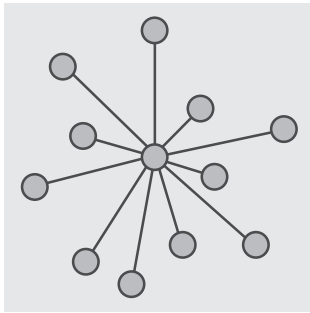
24. Who are the main actors in the cluster?

25. Are there companies who are important for the cluster but are not members?

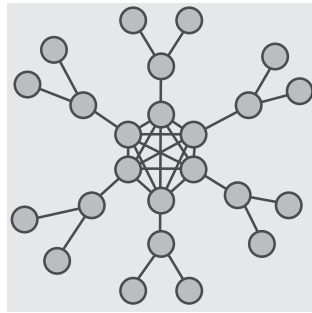
Company:	Its role and the reason for not being a member:
_____	_____
_____	_____
_____	_____
_____	_____

26. How are conflicts managed within the cluster?

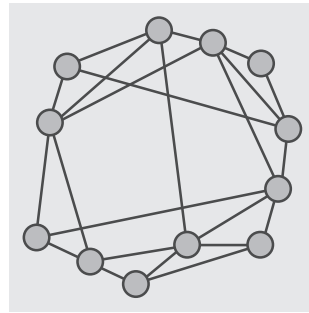
27. Which of the following structures describe your cluster best?



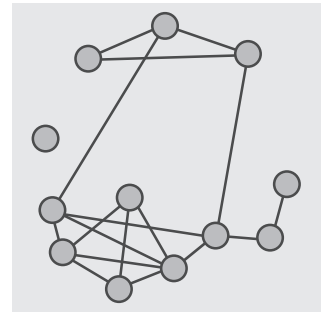
centralised



"snowflake"

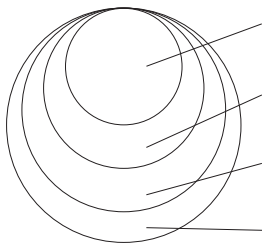


decentralised



random

28. The distribution of cluster members according to their level of involvement (number)



Proactive members taking own initiatives

Active members supporting cooperation

Passive members, but receptive to others' initiatives

Passive members irresponsive to initiatives

Appendix B: Questionnaire for members

1. Please name your firm.

2. Number of employees _____ Annual revenue _____

3. When did you join the cluster?

4. Why did you join the cluster?

5. What is your business profile and how does it fit the cluster's activities?

6. What competences you have that are valuable for the other cluster actors?

a) _____ b) _____ c) _____ d) _____

7. Have any of these become important within the cluster?

yes: _____ no

8. Please rank your expectations connected with your cluster membership? (1 = low – 5 = high)

Access to
knowledge

Human develop-
ment/training

Joint R&D, product
development

Networking/match-
making

Business generation
(without R&D)

Access to public
funding

Improved image and
reputation

Others: _____

9. Rank to what extent your expectation have been fulfilled (1 = low – 5 = high)

- | | | | |
|--|---|---|--|
| <input type="checkbox"/> Access to knowledge | <input type="checkbox"/> Human development/training | <input type="checkbox"/> Joint R&D, product development | <input type="checkbox"/> Networking/match-making |
| <input type="checkbox"/> Business generation (without R&D) | <input type="checkbox"/> Access to public funding | <input type="checkbox"/> Improved image and reputation | <input type="checkbox"/> Others: _____ |

10. If you would have to invest into one of the following projects, which one would you choose?

- | | |
|---|---|
| <input type="checkbox"/> Guaranteed € 100k or | <input type="checkbox"/> 25% chance for € 500k, otherwise no profit |
| <input type="checkbox"/> 10% chance of € 1.25 M, else none, or | <input type="checkbox"/> 40% chance of € 250k, otherwise none. |

11. Would you pay for an airport service that allows you to use the fast line at airport security?

- no yes, about this much: _____ EUR

12. How much would you pay for a taxi to cut travel time by half an hour?

_____ EUR

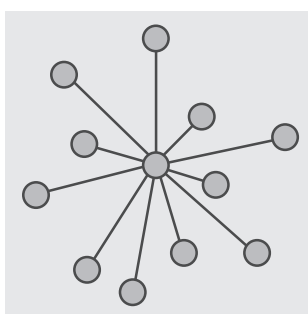
13. Have you made a cost-benefit analysis before joining the cluster?

- no yes, our expected revenue growth is: _____

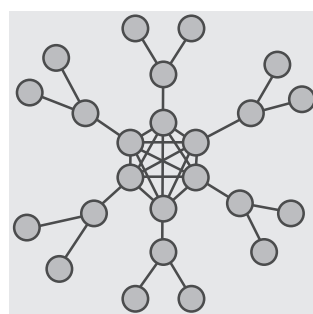
14. What are your investments associated with membership or involvement in the cluster work?

- Monetary investments (membership fees...) _____ EUR
- Investment of time (person hours / days) _____ hours

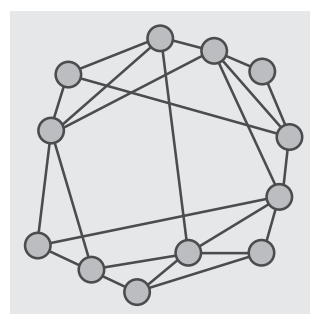
15. Which of the following structures describe your cluster best? Circle your firm on the „map“.



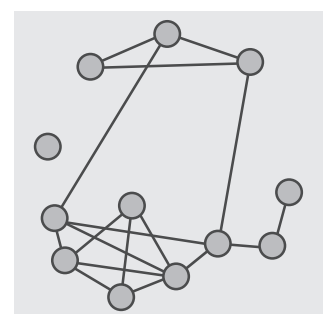
centralised



"snowflake"

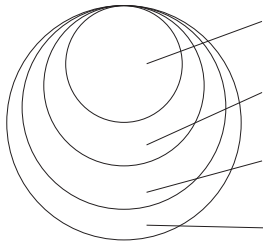


decentralised



random

16. Which of the following describes your level of involvement in the cluster?



- Proactive members taking own initiatives
- Active members supporting cooperation
- Passive members, but receptive to others' initiatives
- Passive members irresponsible to initiatives

17. Who are the key actors within the cluster?

18. Would you like to see additional firms in the cluster?

no yes, these: _____

19. Which cluster actors do you expect or plan to cooperate with – perhaps you already do?

20. Which additional members is cooperation most likely with?

21. Suppose there is a very valuable project for teams of 5–10 cluster actors. Who would you like to, ideally, team up with?

22. Who would you share sensitive information with for potential benefits? Check all that apply.

- Our company pre-screens all its partners. Actors of the cluster are more trustworthy.
- We only trust firms we personally know. We feel no discomfort sharing our information.
- We generally trust firms, cluster membership has nothing to do with this.

23. Which cluster actors would you share sensitive information with?

24. What is your strategy for cooperation?

- We actively seek opportunities, and so actively share and participate in knowledge flow.
- We look for competences that are useful for us.
- We present our competences and hope to raise the interest of other members.
- Other: _____

25. How far do you plan to maintain your membership and current strategy?

_____ years

26. Overall, is cluster membership / involvement beneficial for you?

- yes no

Appendix C: Main Results from second survey

After the main part of the study was done, an additional round of interviews among CA of the CI A has been conducted. About 50 additional responds have been collected. Based on the previous findings and lessons learned, some questions had been sharpened or slightly modified before the second round. Thus the results are not one to one comparable with those of

the first round. The findings of the second round clearly back the robustness of the methodology of the study and are well in line with the outcomes of the first round.

Figure 22: Prevailing reasons to join the CI A

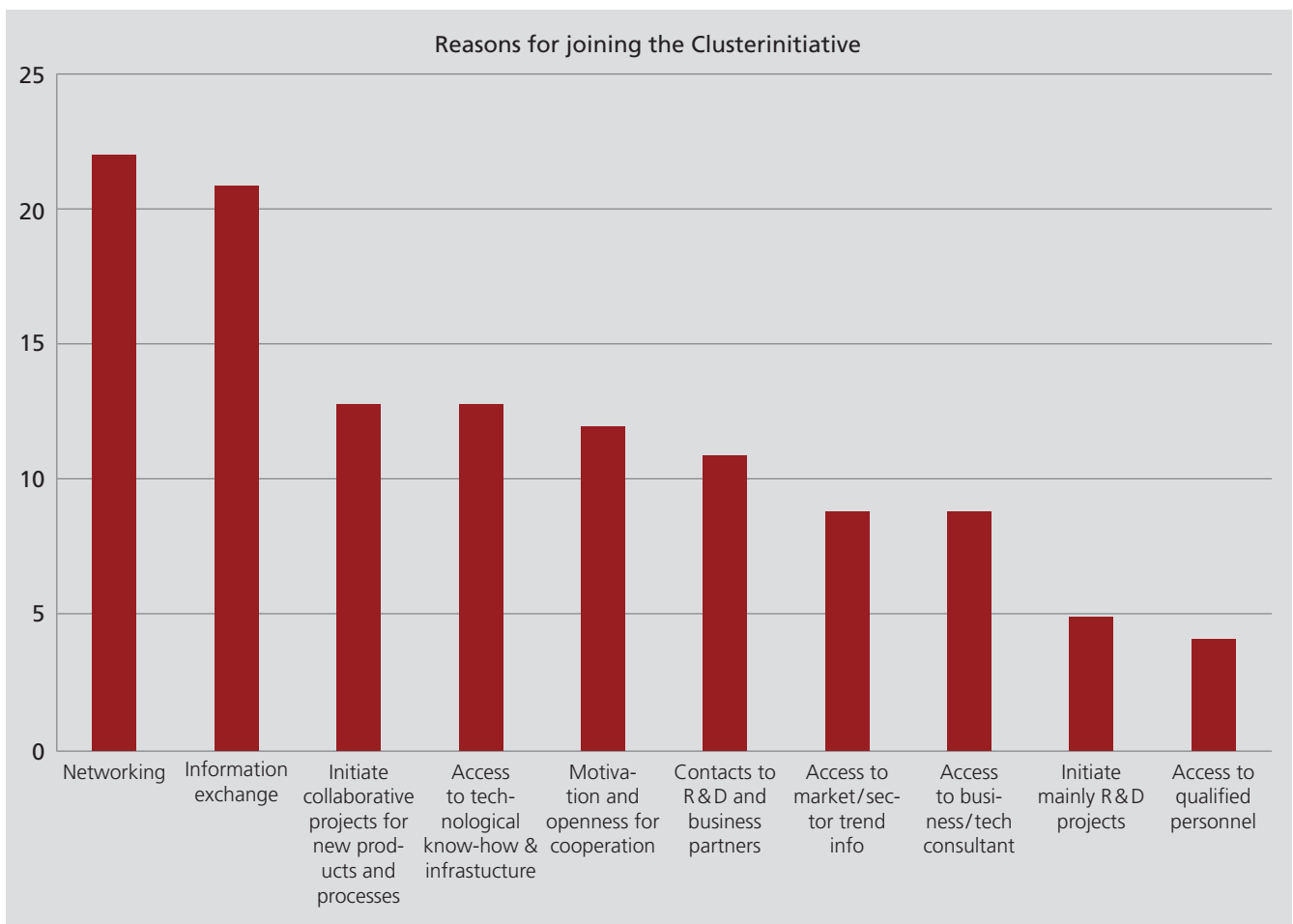


Figure 23: Distribution of active and passive actors within CI A

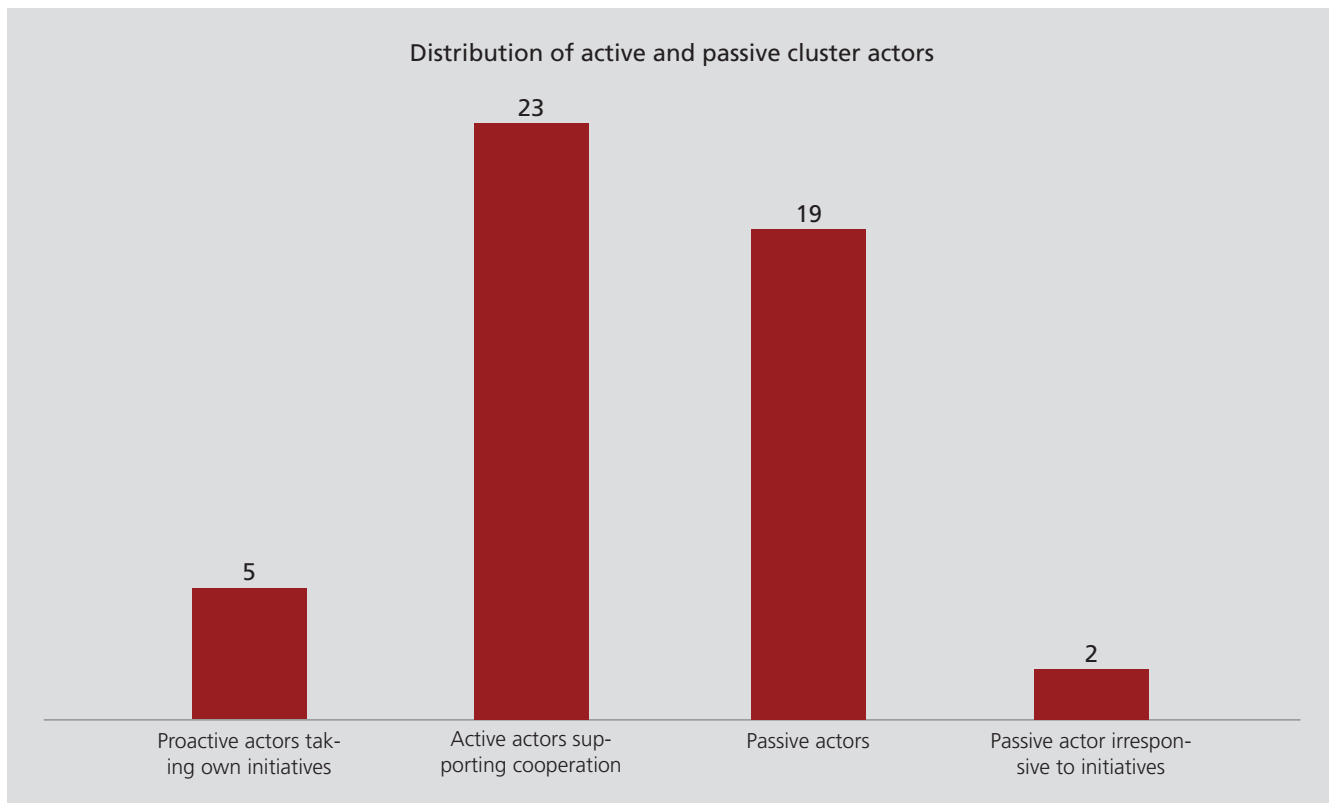


Figure 24: Cost-benefit analysis as tool for decision making

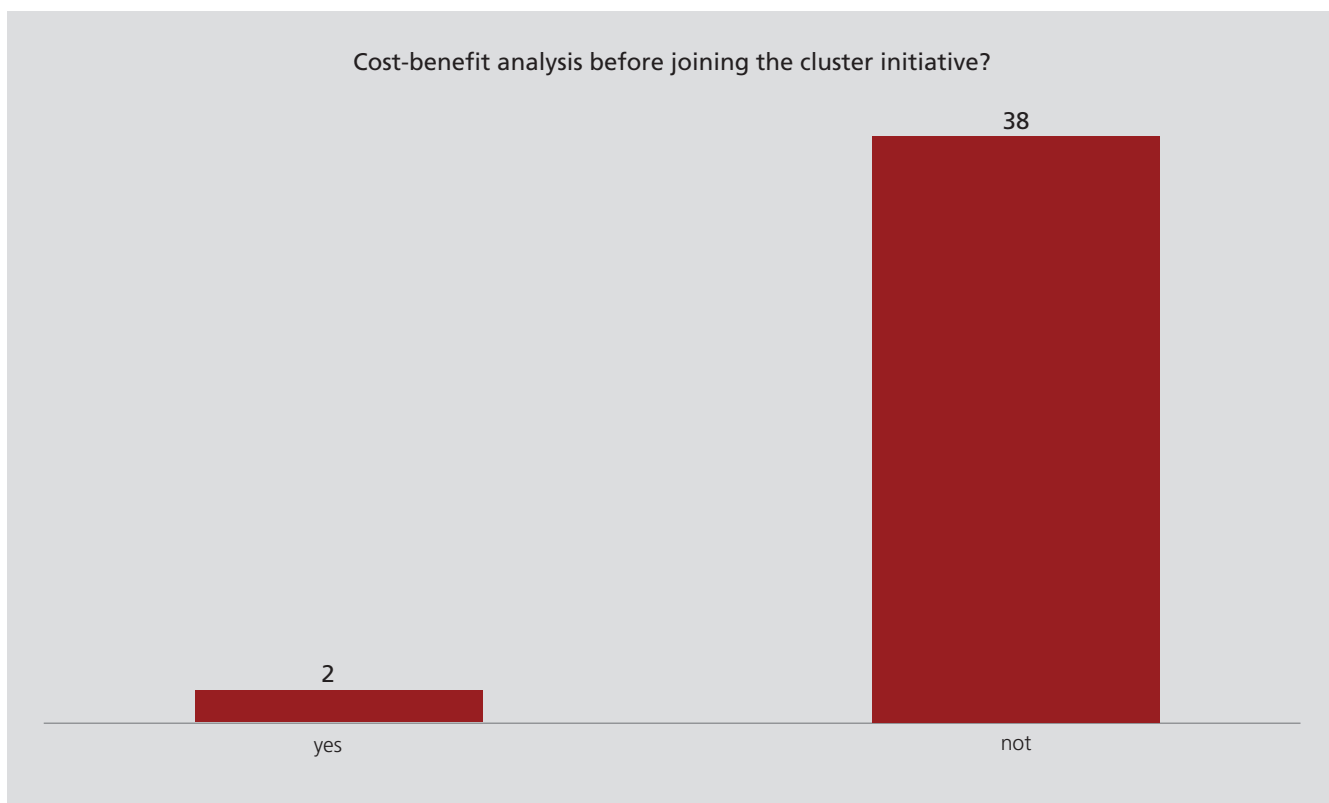


Figure 25: Monthly costs (personal efforts, membership fees etc.) connected with the involvement in cluster based-cooperation

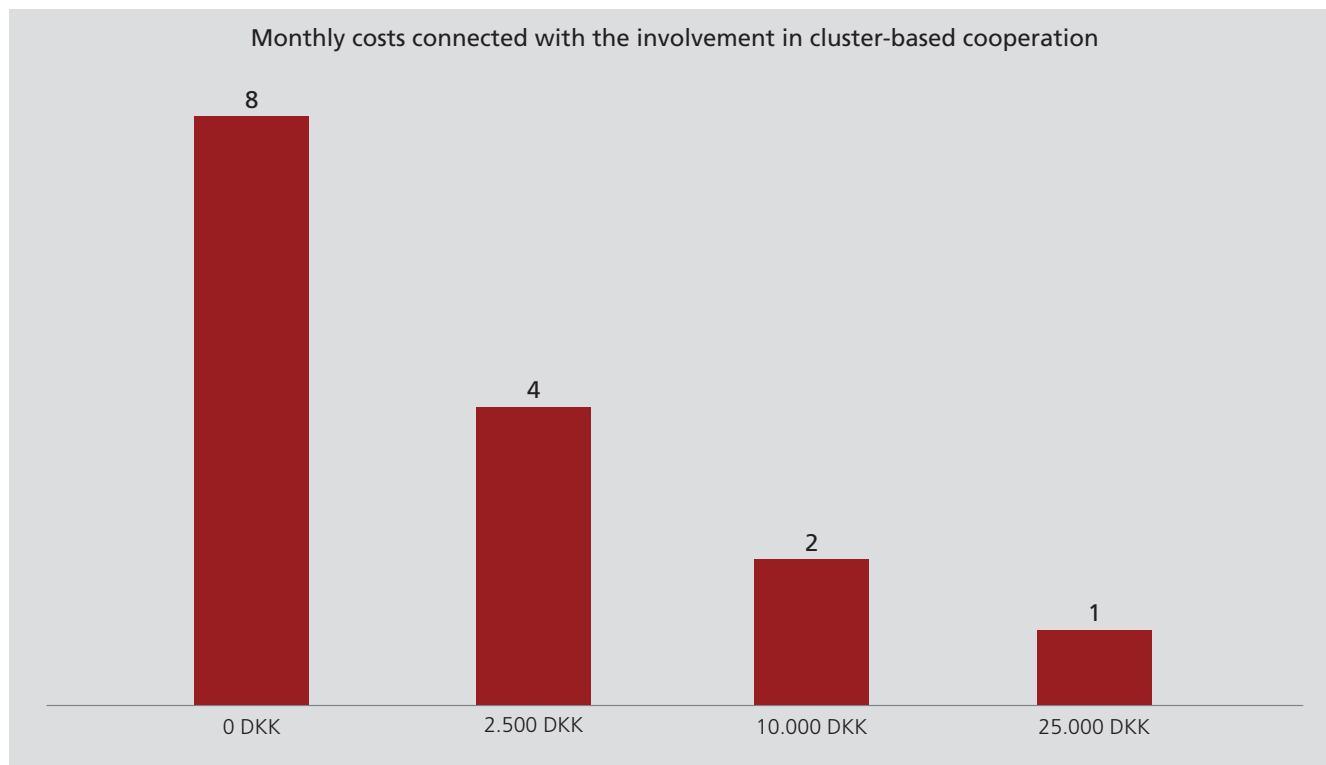


Figure 26: Distribution of time devoted to cluster work (per month)

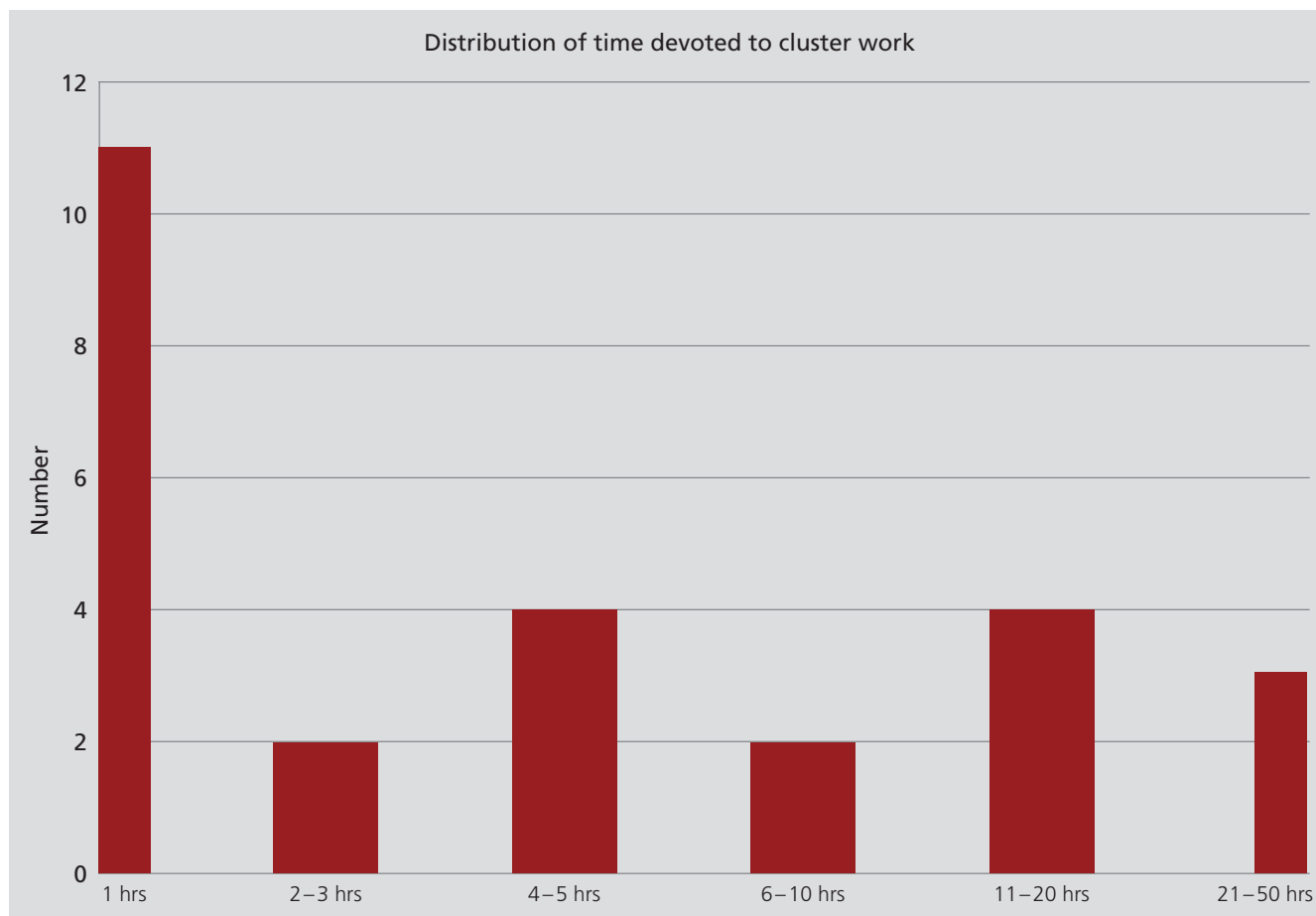


Figure 27: Number of different contacts (with other actors of CI A) in certain time periods

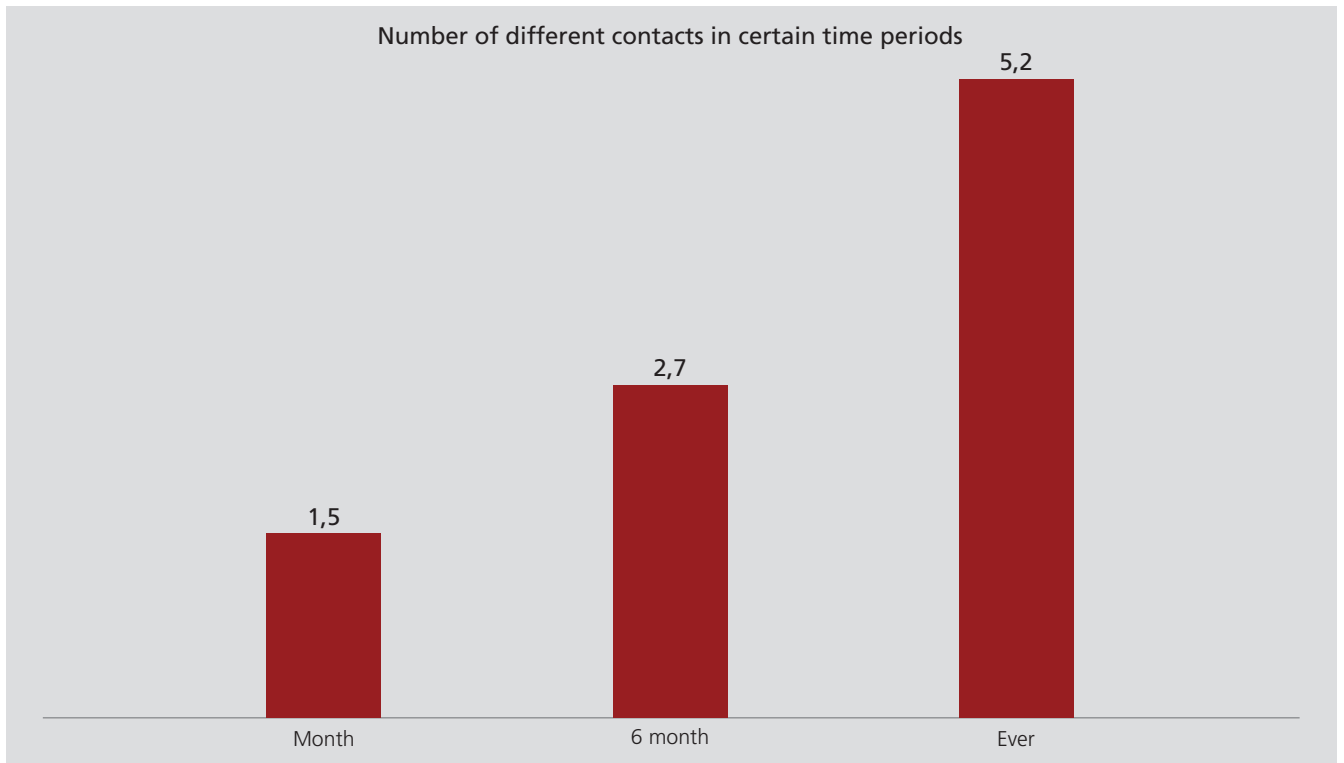


Figure 28: Trust among CA and non CA (First round: red, second round: blue)

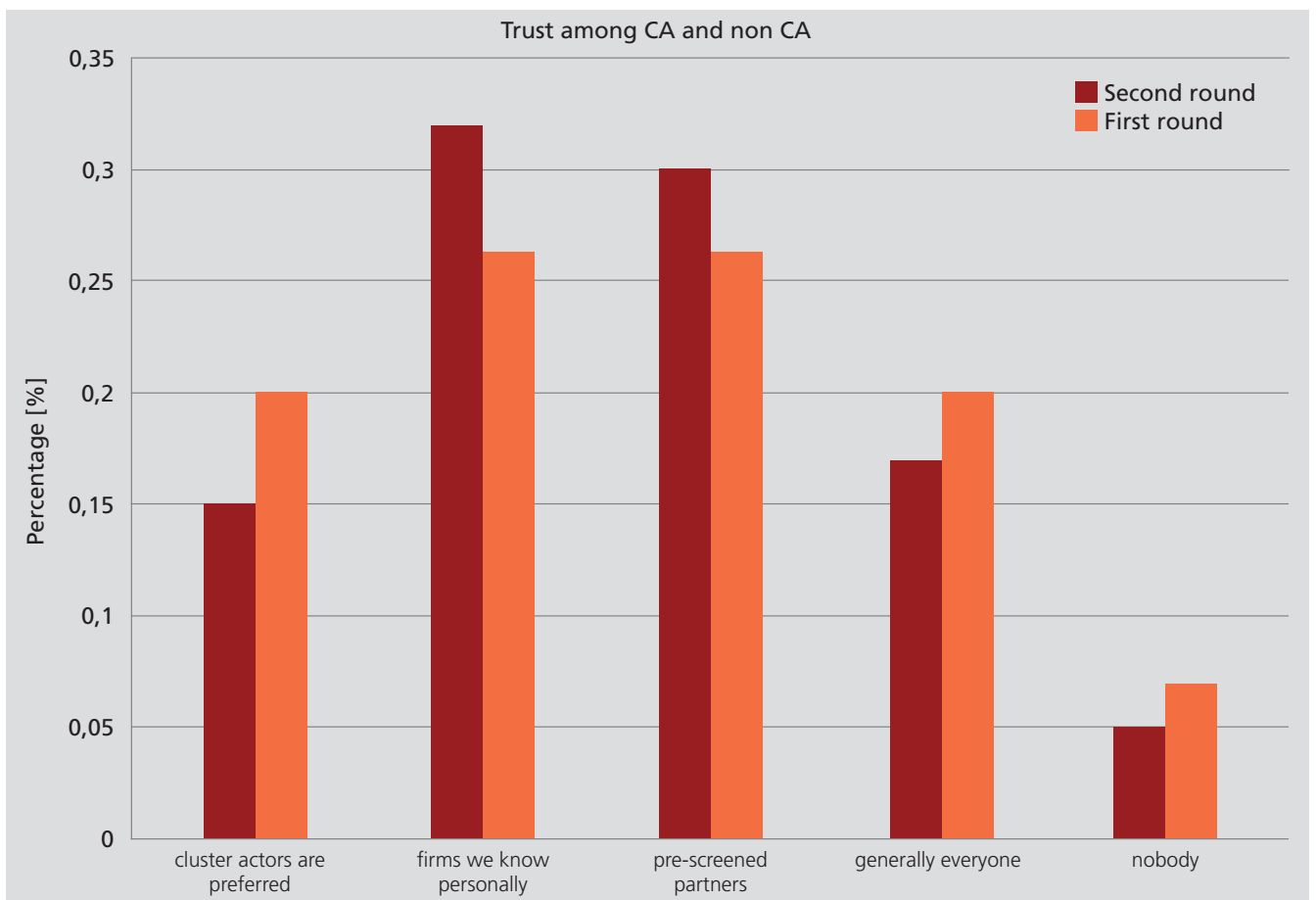


Figure 29: Plans for future participation strategy

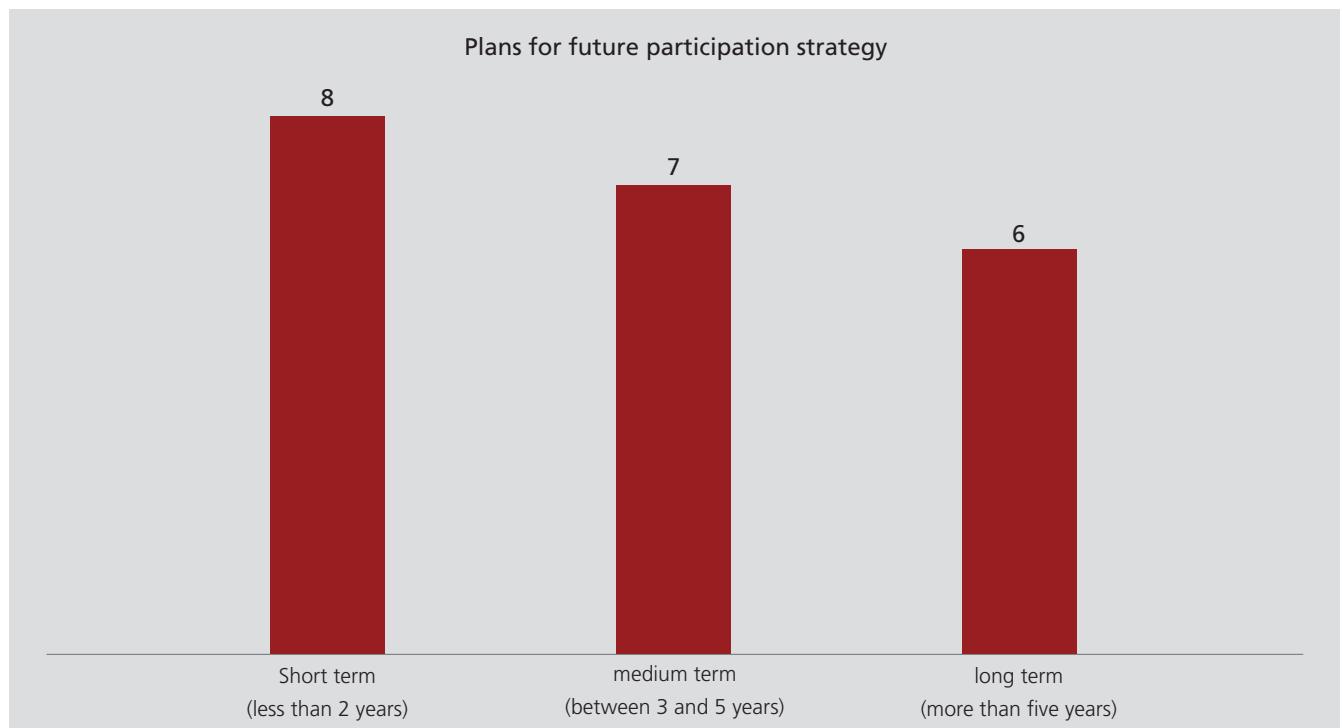


Figure 30: Satisfaction rate with cluster management

