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KompetenznetzeDeutschland
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Clusters in Germany

An Empirical Based Insight View on Emergence, Financing, Management and Competitiveness of the Most Innovative Clusters in Germany

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The document presents updated outcomes of the work done in the framework of the Initiative Competence Networks Germany (www.kompetenznetze.de). This Initiative was initiated by the Federal Ministry for Economy and Technology (BMWi) and comprises about 100 of the most innovative German competence networks with a particular focus on technology. The Initiative offers a common platform to the highest-performing networks in technology, and provides various benefits to its members. Members of the initiative stand out due to innovative partners, intensive co-operation and the goals they share. Particular qualities that characterize the initiative's members also include outstanding proximity to markets and industry, regional integration, dynamic development and flexibility.

The experts from Institute for Innovation and Technology (iit, Berlin) also contributed by providing the methodology and scientific approach used to this cluster paper. The aim of the IIT is to leverage the complementary expertise of academia, industry and government to facilitate new systems for innovation and novel collaborative processes on behalf of its clients. The work of the IIT is based on a broader understanding of innovation, which also regards, besides the core technological development itself, the economic and social preconditions and impacts of technological innovations. Cluster and regional innovation policy plays an important role for the work of the Institute (www.iit-berlin.de).

The Initiative Competence Networks Germany has commissioned the statistical analysis of a data set collected by the Initiative Competence Networks Germany containing data of 77 German competence networks to N R C Network Research & Consulting UG (haftungsbeschränkt). N R C Network Research & Consulting is a spin-off company from the Chair for Inter-firm Cooperation at the Institute for Management, School of Business & Economics at Freie Universität Berlin. It is therefore scientifically embedded as well as transfer and business oriented. The company focuses on the analysis of network structures within and between organizations and applies scientific analysis methods and software. The work was co-ordinated by Dr. Frank Lerch and Prof. Dr. Stephan Duschek, both CEOs of N R C (frank.lerch@fu-berlin.de).

The contents of this publication are responsibility of the author on behalf of the Institute for Innovation and Technology, Berlin, as well as members of the chair for Inter-firm Cooperation and Corporate Management of the Institute for Management at the School of Business & Economics at Freie Universität Berlin.

Table of Content

1. Introduction

Economic policy can be considered as being one of the major tasks of a national approach to increase the wealth of a domestic economy. It aims at different objectives, like economic growth, full employment, stable prices or positive balance of payments from international trade. In this connection, insufficient innovation was recently considered a major cause of Europe's disappointing growth performance[1]. European regions need more innovation and economic growth to face new global challenges, making the facilitation of favourable innovation conditions a chief objective for economic policy makers. National and regional governments have recognised the potential of regional networks and clusters as a major driver in regional development policy. Many of them have introduced significant measures to strengthening local economies, creating new jobs and attracting new investors. In this attempt many cluster initiatives have been launched. Some countries include cluster policies in national development plans, others pursue regional policy models.

The cluster concept builds upon earlier work on industrial complexes by Alfred Marshall[2] and later studies of industrial districts by Brusco[3] and others, propagated by Piore and Sabel[4] and further developed in industrial and regional economics[5] and other regional sciences[6]. Porter defines clusters as "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated industries in a particular field that compete but also co-operate."[7] This established conceptualization has received some criticism, because of the inadequate specification of central concepts used like regional proximity or collaborative and competitive linkages.[8] However the very ambiguity offers conceptual flexibility in the implementation of cluster policies[9], which might explain the widespread application[10].
Despite the confusion around the notion of clusters, 'soft factors' like a trusting atmosphere, free information flow, and a collaborative milieu seem to be important for clusters.[11] In addition, innovation related programmes and clusters appear to have a positive impact on the development of a targeted industrial sector. First, clusters are important because they allow companies to be more productive and innovative than they could be in isolation. And second, clusters are important because they can reduce barriers to entry and foster new business creation relative to other more dispersed locations.[12] As a consequence, clusters and regionally based networks (in the following consequently named clusters for simplicity reasons) have increasingly become the focus of public debates, national supporting initiatives, and academic research. Many studies have been published, analysing different aspects of governance, structure, growth poles, competitiveness, internationalisation issues and so forth. A number of comprehensive literature reviews on clusters have been published in the past.[13]

[1] See European Commission (2006). The Aho report is available at http://ec.europa.eu/invest-in-research/action/2006_ahogroup_en.htm

[2] Marshall, A. (1890): Principles of economics: An introductory volume. London: Macmillan.

[3] Brusco, S. (1982): The Emilian model: Productive decentralisation and social integration. In: Cambridge Journal of Economics 6(2), 167-184.

[4] Piore, M.J./Sabel, C.F. (1984): The second industrial divide: Possibilities for prosperity, New York: Basic Books.

[5] Porter, M.E. (1990): The competitive advantage of nations. London: Macmillan.; Krugman, P. (1991): Geography and trade. Cambridge, Mass.: Harvard University Press

[6] E.g. Asheim, B.J., Cooke, P. & Martin, R. (2006) (Eds.): Clusters and regional development. London: Routledge.

[7] Porter, M.E. (1998): On competition. Boston, Mass.: Harvard Business School Press.

[8] Martin, R. & Sunley, P. (2003): Deconstructing clusters: Chaotic concept or policy panacea? In: Journal of Economic Geography, 3(1), 5-35.

[9] Jacobs, D. & de Man, A.-P. (1996): Clusters, industrial policy and firm strategy: A menu approach. In: Technology Analysis and Strategic Management, 8(4), 425-437.

[10] Sölvell, Ö., Linqvist, G. & Ketels, C. (2003): The cluster initiative greenbook. Stockholm: Ivory Tower.

[11] e.g. Maillat, D. (1991): The innovation process and the role of the milieu. In: Bergman, E.M., Maier, G. & Tödtling, F. (Eds.): Regions reconsidered. London, New York: Mansell, 103-117; Rosenfeld, S.A. (1996): Overachievers: Business clusters that work. Prospects for regional development. Chapel Hill, NC: Regional Technology Strategy, Inc.

[12] Porter, M.E. (2000a): Location, competition, and economic development: Local clusters in a global economy. In: Economic Development Quarterly 14(1), 15-34.

[13] E.g. Porter, M.E. (1998): On Competition, Boston: HBS Press.

The emergence of clusters is often a specific result of a certain initiative, based on a national or regional cluster policy, especially if the emergence is based on a top-down approach. Cluster or network administrative organisations[14] often play an important role as service providers to cluster members and in the coordinated development of clusters. The set-up of such cluster administrative organisations is often supported by a clear mandate and public funding from authorities on a regional and/or national level. During the initiation and emergence phase of cluster development many parameters are constituted, that may have a long-term impact on the development, governance and performance of the clusters. One crucial parameter is the cluster organisation or management itself, since it plays an important role in providing specialised services and added-values to cluster members and is to a large extend 'making the cluster happen'[15]. Therefore, the quality and professionalism of a cluster's management, matters. However, this is often underestimated in discussions related to clusters.

For a better understanding of the findings, it seems to be important to clearly distinguish between clusters, clusters policies and respective clusters initiatives. We consider clusters as a real economic phenomenon that can be economically measured[16]. In addition, the clusters we have regarded in this paper all fulfil high requirements, which are mandatory to become members of the Initiative Kompetenznetze Deutschland[17] (Initiative Competence Networks Germany). All of them, 107 clusters in total[18], have passed an evaluation procedure by an external scientific board of experts, and thus can be considered as the most competitive and innovative clusters in Germany (League of the best innovation clusters).

This cluster portfolio can be considered as an excellent source for this investigation, for it avoids methodological issues other publications have faced, when analysing a greater number of clusters, which differed very much in terms of structure and quality. Altogether, the clusters represent more than 6.500 member organizations, coming from different areas, as described in Figure 1.

In the following we will present and discuss our explorative findings related to the emergence, structure and governance of the clusters, the financing, the management, as well as the current main tasks and future challenges of the clusters we have analysed.

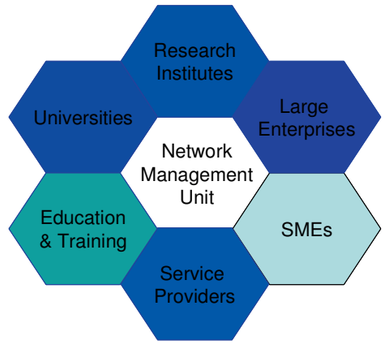

Figure 1: Main types of partners gathered in a cluster

[14] Human, S.E. & Provan, K.G. (2000): Legitimacy building in the evolution of small-firm multilateral networks: A comparative study of success and demise. In: Administrative Science Quarterly, 45(2), 327-365.

[15] Cf. in a related vein: Huxham, C., & Vangen, S. (2000): Ambi guity, complexity and dynamics in the membership of collaboration. In: Human Relations, 53(6), 771-806.

[16] See for example www.europeanclusterobservatory.eu

[17] This initiative is funded by the Federal Ministry of Economics and Technology (BMWi), gathering the most innovative, mainly industrial driven regional networks in Germany and supports them in different areas. The membership to the initiative is a quality label only for the best networks. Members must fulfil mandatory requirements, e. g. a dedicated thematic focus, strongly industrial driven, high regional concentration, clear organisation and high identification of the network, complete gathering of the representatives of the value chain, minimum size and number of members, strong collaborative development of technology, providence of added value for the members, good sustainability of the network, high innovation potential and strong international orientation

[18] Status at June 2008

2. Aims and Objectives

Previous investigations by van der Linde revealed, that based on the diamond approach of Porter[12], not only factor and demand conditions were the most common cause of cluster establishment. Other determinants, like related and supporting industries, context for strategy and rivalry as well as other reasons, were also reported of having a certain impact on the competitiveness of clusters and companies within such clusters. The determinants "other reasons", like type of cluster emergence, management, financing and funding, and others, are of special interest in this report, because they can be influenced, to a certain extent, by cluster actors themselves or by setting up appropriate framework conditions within cluster initiatives.

Clusters practitioners, policy makers, economic development agencies, as well as clusters managers themselves, are concerned with the reason of the initial establishment of clusters. Why do certain clusters develop better than others? How do the perfect framework conditions look like for clusters development? Is it only a financial question? Is it usually due to favourable local factor conditions, demand conditions, or the presence of other related or supporting industries close by (when the Porter diamond approach is applied)[5]? What kind of impact could public activities have? Can policy makers trigger the emergence of clusters? Are clusters comparable and can they be benchmarked in order to learn from the best?

The main objective of this cluster paper is to investigate the most competitive clusters in Germany in more detail, and to discuss the main findings of this first empirical evaluation. Last but not least, it is the intension to gain a better understanding of the causal relationships involved by conducting multiple regression analyses. All the information we gained so far were collected and stored in an internal cluster database. In addition, we turned these data into quantitative indicators in order to make them comparable. By means of this approach, we set up a benchmarking approach for clusters/cluster organisation, based on about 60 indicators we have defined. So far more than 70 clusters all over Europe has been benchmarked. The experiences we made so far by this benchmarking approach are very promising.
Before we proceed to the details of the empirical study, we revert to extensive review of research related to management/ leadership related aspects of networks and clusters. As already indicated above, we argue that a cluster can – at least to some extent – be understood as a diffuse form of a network. Furthermore, most research that deals with clusters on an empirical basis – including this study – concentrates upon 'manageable chunks' of information, usually focusing upon network administrative organizations or other empirical units that can be operationalized. Summa summarum, we argue therefore that by means of analyzing the literature on managing/leading networks and clusters, we can infer from these results intriguing insights for the management of clusters. This holds particularly true insofar, as there is almost no research on cluster leadership. Accepting this notion, it becomes evident that policy makers have a genuine interest in comprehending how clusters can be led or managed. As a result, the insights from the literature review are supposed to supply individuals interested in economic policy with information from previous research.

Our literature review concentrates upon double-blind reviewed articles in English and German language top-tier. We utilized the search terms 'govern', 'lead', 'manage', 'control', and 'orchestrate' in connection with the termini 'network' and related English and German phrases or synonyms. Subsequently, we checked the articles (approximately 500) for consistency against the background of our research interests and neglected those studies that matched the predefined search criteria but were, nevertheless, irrelevant for our purposes with regards to their content. For instance, we disregarded articles that deal with dyadic relations (due to the fact that a network – and a cluster by nature as well) need to be comprised of at least three or more actors), illegal interorganizational constellations or intra-organizational arrangements. In order to assure consistency, we surveyed previous reviews and related publications (e.g., special issues) that dispose of similar foci in order to present an analysis that is as thorough as possible. Thereupon, we identified 35 journal articles that matched our predefined search criteria and that constitute the core of our review (the data is available on request from the authors). These articles were read in depth and classified with regards to a number of different criteria.

Some central characteristics can be summarized as follows (the numbers in parentheses indicate the number of studies that match the respective aspects):

- First, the discourse has gained *increasing attention in recent years:* only three sources were published before 1995, whereas 19 stem from after 2000. Furthermore, the majority of publications concentrate on for-profit oriented networks (18), rather seldom on those where public sector companies are involved (seven).

[19] van der Linde, C. (2003): Demography of clusters – findings from the Clusters Meta-Study, In: Dohse &Soltwedel (Eds.), Innovation Clusters and Interregional Competition. Berlin etc.: Springer, 130-149.

- Second, most of the contributions are based *upon empirical data* (27 empirically based vs. six conceptually/theoretically oriented articles). Most of these studies revert to qualitative approaches (21), whereby 16 of them make explicit use of the case study design, and three times action research is applied. Only three times were the studies predominantly based upon quantitative methods, two used multivariate measurements and one a structural network analysis. In the remaining studies, either no details were given or mixed methods were applied.

- Third, when management or leadership oriented *issues are addressed, strategic and structural aspects dominate* (23; understood in this context as studies that analyze the ties between the various actors, e.g. in the form of juridicial connections). Rather seldom, these aspects are ascertained from a processual and operative perspective (4).

Apart from these 'structural' characteristics of the literature review, we were able to confirm the overall research gap, i.e. the lack of research with regards to strategic management and leadership in network/cluster constellations. More specific, a rather holistic picture is seldom conveyed, e.g. comprising the life cycle of networks/clusters as well as their management. In addition, due to reasons of confidentiality, only scarce empirical evidence exists that was able to obtain information about critical issues like the financing of the clusters – this holds particularly true with regards to their performance.

Bearing these observations in mind, the subsequent analysis (4) incorporates both, the analysis of the development of clusters, its financing, management, as well as a comparison of these data in relation to the cluster performance.

3. Methodology

Our cluster portfolio offers an excellent starting point for analysis, because the clusters have broadly comparable structures and qualities in terms of innovation capability and competitiveness. Many previous studies suffered from incomparable data bases for meta-analyses or meta-studies. Moreover, in many studies there is no definition of a cluster. As a result, many cluster studies are confined to individual clusters or have a very narrow focus[20].

Our analysis is based on empirical of 77 of the 107 cluster members (not all members were regarded due to reasons e.g. quality of primary data, missing data, etc.). Members were visited in 2007 or early 2008 by experts from the Agency of the Initiative Competence Networks. Interviewers were also key contact partners for the cluster since May 2007. All of the experts have appropriate technical knowledge of the respective innovation fields the clusters are operating in, as well as of cluster operation. Such knowledge is important in order to get an improved comprehension of the development of the numerous clusters as compared to others. In addition, expert knowledge is needed to validate the information provided by the cluster managers.
During the data collection procedure, interviewers aimed at understanding the development of the clusters, the key success factors, current cluster status, and future challenges and needs. The overall aim was to better understand why certain clusters had developed better than others, and how environmental conditions should be structured to create a viable surrounding for the development of clusters.
The presentation of our findings follows the main aspects we were interested in:

- The impact of cluster emergence on cluster development (chapter 4.1),
- the financing of cluster organisation (chapter 4.2),
- cluster management (chapter 4.3), and
- cluster competitiveness (chapter 4.4).

We begin with some descriptive and correlational evidence about how the clusters are structured, and about key indicators such as number of members, financing, benchmarks, etc. Then, in order to get a more thorough and robust understanding of the causal relationships involved, we conducted multiple regression analyses using OLS (ordinary least squares) estimators. The OLS model follows the general approach: $yi = a + bXi + ei$, where i indicates the unit (cluster), y is the dependent (or endogenous) variable, a and b are (vectors of) the population parameters to be estimated, X is a vector of explanatory (or exogenous) variables, and e is the idiosyncratic error term which captures any unexplained or unmeasured factors in y.
The (unstandardized) b-coefficients can easily be interpreted as slopes, and thus indicate the unit change in y given a one unit change in the respective x. Regression analysis allows us to rule out third variables effects, and thus helps us to uncover the true drivers of cluster performance. More information are given in appendix I.

[20] Potter, K. (2006): Methods of Presenting Statistical Information – The Box Plot Method

4. Findings

The clusters in the sample vary considerably in terms of age, size, structure, governance, services provided, etc. Therefore, the average values need to be considered cautiously. Figures 2a – c show the data of some variables analysed in the cluster portfolio to give a rough impression. We used the box plot, which has become the standard technique for presenting the 5-number summary. It consists of the minimum and maximum range values, the upper and lower quartiles, and the median. This collection of values is a quick way to summarize the distribution of our dataset. The typical construction of the box plot, which can be seen in Figure 2a, partitions a data distribution into quartiles, that is, four subsets with equal size. The box is used to indicate the positions of the upper and lower quartiles; the interior of this box indicates the innerquartile range, which is the area between the upper and lower quartiles and consists of 50% of the distribution. 25 % of all value lie above the upper quartiles, 25 % of all value lie below the lower quartile. Lines are extended to the extrema of the distribution, either minimum and maximum values in the dataset[20].

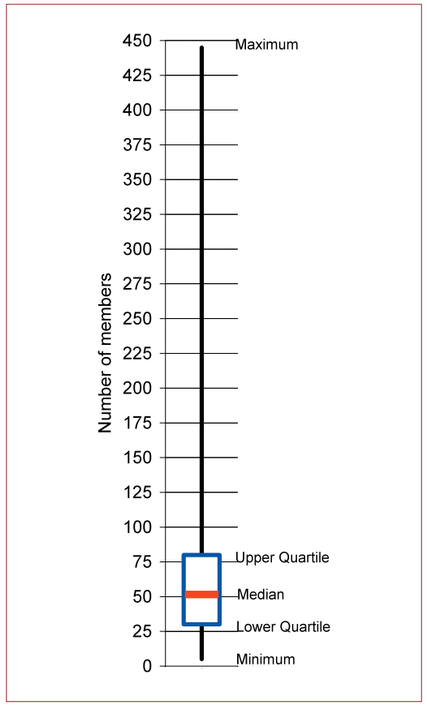

Figure 2a: Number of committed members of the analysed cluster portfolio according to the box plot method

The share of private financing of the cluster organisations varies, drastically, as showed in Figure 2b, whereas the median is 48 %. We come back to this phenomenon in chapter 4.2

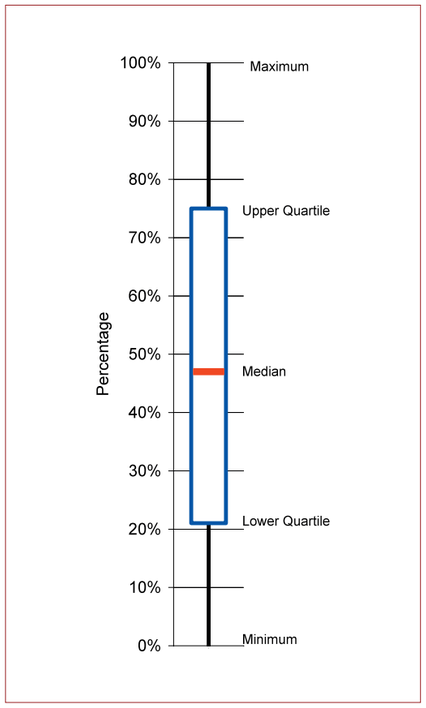

Figure 2b: Share of private financing of the analysed cluster organisations according to the box plot method

Figure 2c reveals that the share of committed SME members. The median can be calculated with 56 %, but 50 % of all cluster investigated contain a share between 45 – 69 % SME. It is worth to mention that biotech cluster tend to have a higher share of SME, whereas Energy cluster show the opposite trend. This, of course, is not a surprise when taking industrial structure of these technological domains into account.

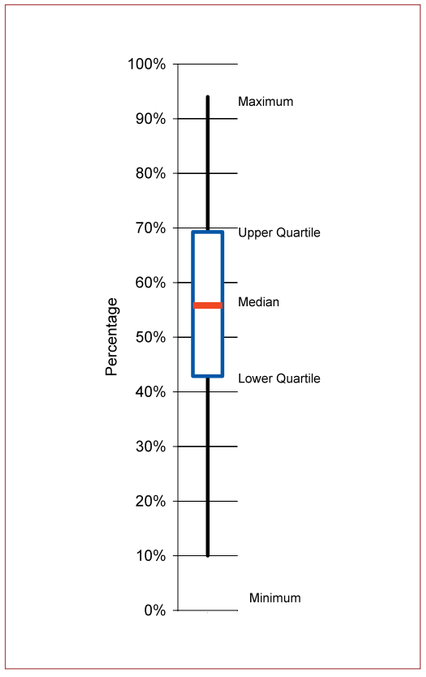

Figure 2c: Share of committed SME cluster members of the analysed cluster portfolio (based on EU definition) according to the box plot method

In the following we will have a more specific look on aspects like type of cluster emergence, financing of clusters and cluster management.

4.1 Type of cluster emergence

Cluster policies[21] often result in specific cluster initiatives. In consequence, cluster initiatives can be understood as "organised efforts to increase growth and competitiveness of clusters within a region, involving clusters firms, government and/or the research community"[22,23]. In Germany cluster funding targets predominantly two levels, the federal level (mainly provided by the Federal Ministry for Economy and Technology, BMWi, and the Federal Ministry for Research and Education, BMBF), as well as the federal state level (Bundesländer), where many different regional ministries are conducting cluster initiatives. As a consequence, Germany displays a dual system of cluster funding.

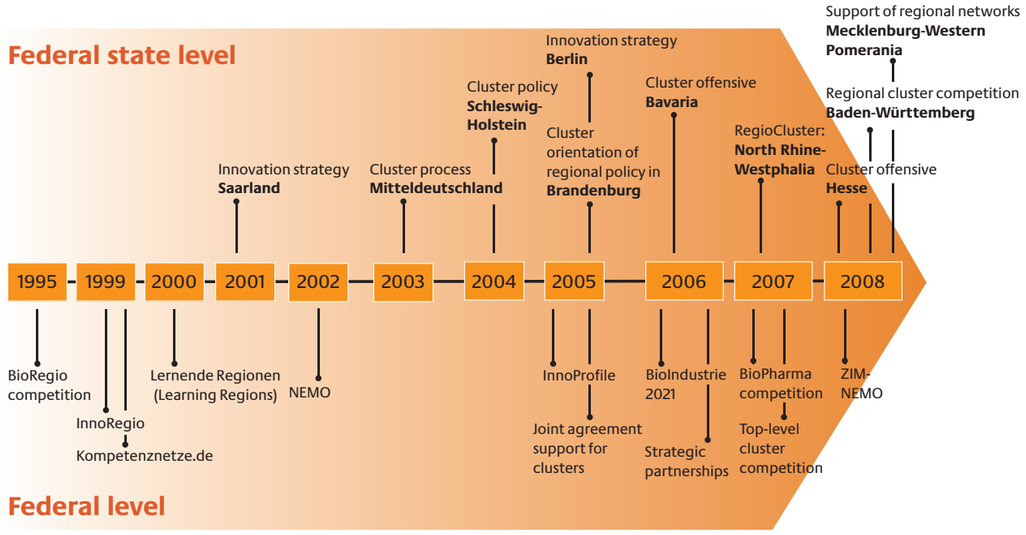

Figure 3 presents some of the most relevant cluster initiatives in Germany in the recent past (on federal as well as on federal state level), which resulted in many successful clusters that are members of the Initiative Kompetenznetze Deutschland.

Clusters which have been set up and were initiated by means of such clusters initiatives, can be considered as top-down, externally initiated clusters (cf. also Figure 4). Other approaches of cluster emergence outside of a cluster initiative or significant support of regional or federal policy makers, are bottom-up clusters as well as top-down, internally initiated clusters. Of course, in reality there are mixtures of these three scenarios, but in most cases, one of these is predominating. In the following we summarise the main characteristic features of clusters according to the three types of cluster emergence. In all three types of cluster emergence, different driving forces can be identified.[24]

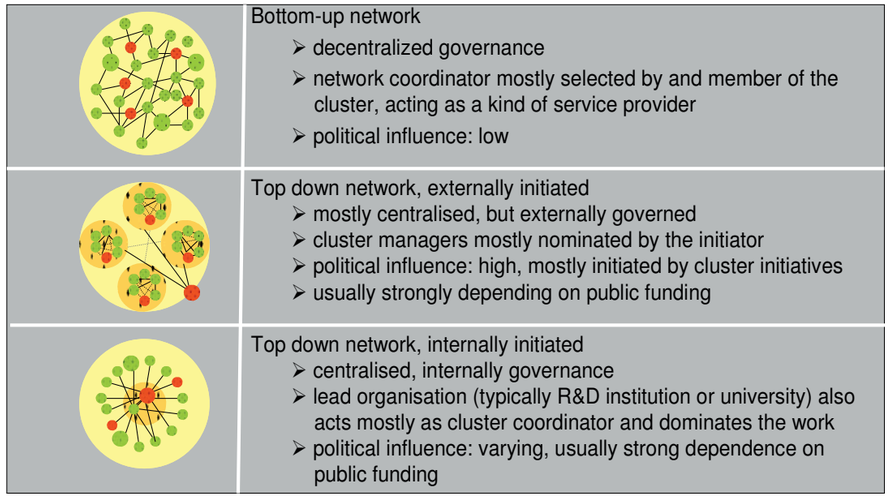

Figure 4: Prevailing types of cluster emergence[25]

[21] Hospers, G.-J. & Beugelsdijk, S. (2002): Regional cluster policies: Learning by comparing? In: Kyklos, 55(3), 381-402.

[22] Sölvell, Lindqvist & Ketels (2003): The Cluster Initiative Greenbook, http://www.cluster-research.org/greenbook.htm.

[23] Andersson et al. (2004) define clusters initiatives as "conscious actions taken by various actors to create or strengthen clusters".

[24] For a comprehensive overview of types of competence development in networks see Sydow, J., Duschek S., Möllering G. & Rometsch M. (2003): Kompetenzentwicklung in Netzwerken – Eine typologische Studie. Wiesbaden: VS. (in German only)

[25] See also Fromhold-Eisebith, M. & Eisebith, G. (2005): How to institutionalize innovative clusters? Comparing explicit top-down and implicit bottom-up approaches. In: Research Policy, 34(8), 1250-1268.

Bottom-up clusters

Bottom-up clusters are typically characterised in that they emerged by a gathering of industrial and scientific partners to intensify mutual co-operation in order to gain competitive advantages for their daily business. Of course, there may be other reasons for setting up such kind of clusters. The governance is typically decentralised, and the cluster organisation in charge has been selected by the cluster members themselves. The political influence is low since the setting-up was typically realised without considerable involvement of regional or federal policy makers. This does not necessarily imply a lack of governmental involvement or of direct members, but they do not have a leading role, and can be considered as ordinary members.

The cluster organisations raise the majority of their operating costs themselves by membership and service fees, participation fees for conferences, sponsoring etc. The financing model might differ considerably. Fee based financing models urge the cluster organisations from the very beginning to provide demandoriented services and added values to cluster members.

Top-down, externally initiated clusters

The installation of this type of cluster is typically supported by a clear mandate, and publicly funded by authorities on federal or federal state level (sometimes by both in parallel). Often cluster initiatives facilitated or stimulated the emergence of such type of clusters (cf. Figure 3). Sometimes it is spontaneously initiated within the triple helix[26] of industry, university and government, in order to overcome obstacles of cooperation and allow trust building between partners. In the beginning, such clusters receive public funding, at least during the embryonic phase (stretching over a period of approximately 3 – 5 years), whereas the funding concepts and funding rates differ substantially. When mature and successful, clusters or their respective management organisations tend to raise the majority of their operating costs themselves by membership and service fees, participation fees for training and conferences, sponsoring and so forth. As far as the analysed clusters are concerned, in chapter 4.3 the change of funding sources over time is described more detailed. The amount of fees is often lower than those of bottom-up clusters, since these fees are intended to co-finance the cluster organisation, since the other (significant) financial part is provided by public sources.

Political influence in these clusters is typically quite high, since policy makers consider these clusters as appropriate tools to successfully increase the innovation capability and competitiveness of a certain region.

Top-down, internally initiated clusters

In this type of cluster, the main driving force is typically a specific organization, most likely a research institution or university but possibly also a company. This leading organization inherits the governance and management of the whole cluster, and also provides resources for cluster organisation. The initiator often follows objectives that are supposed to be pursued by means of cluster activities. In a later stage of cluster development the initiator is likely to dominate the activities and themes of the whole cluster.. Analysing our cluster portfolio, in such cluster types, in more than 70 % of the cases the activities and topics the clusters are dealing with are dominated and set by the clusters organisation (which is in fact in all cases the original initiator of the clusters). The initiator often uses the cluster approach as a tool to increase its reputation and to gather members to acquire funds for joint R&D activities.

As shown in the review of the academic literature on clusters (managed or led in the form of networks), prominent themes comprise typologies[27], life cycle models[28] and categories of cluster structure/governance[29]. However, there is only little discussion on how the history of cluster emergence and governance issues relate to one another. In the data we found three main scenarios of how clusters typically emerge in Germany. As far as our investigated clusters are concerned, the majority are top-down, externally initiated (about 70 %, s. Figure 5). Many of them are a result of clusters initiatives on federal or federal state level, as described in Figure 2. Only about one quarter of the clusters have been initiated in a bottom-up manner, and never have been influenced by any public cluster initiative.

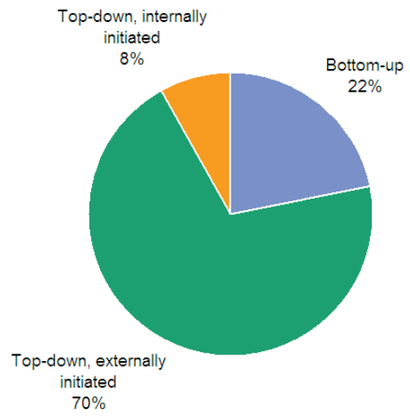

Figure 5: Distribution of the three prevailing types of cluster emergence

[26] Etzkowitz, H. & Leydesdorff, L. (2000): The dynamics of innovation: From national systems and `Mode 2' to a triple helix. In: Research Policy, 29(2), 109-123.

[27] Markusen, A. (1996): Sticky places in slippery spaces: A typology of industrial districts. In: Economic Geography 72(3), 239-313.

[28] Menzel, M.-P. & Fornahl, D. (2007): Cluster life cycles: Dimensions and rationales of cluster development. Jena Economic Research Papers #2007-076.

[29] Provan, K.G. & Kenis, P. (2008): Modes of network governance: Structure, management, and effectiveness. In: Journal of Public Administration Research and Theory 18(2), 229-252.

The type of cluster emergence seems to have a certain impact on structural items related to clusters. One important topic is the financing of the cluster organisation and management, which we will discuss in the upcoming chapter. We found distinctive evidence of cluster emergence and a lasting commitment of the clusters members in terms of a corresponding legal constitution of the clusters. The results displayed in figure 5 indicate that it can be assumed that those cluster members who are strongly committed to a cluster, select legal constitutions like an association, which appears to be beneficiary for their work and the overall objectives of the cluster. By choosing a certain legal constitution, a cluster gains higher liability, predictability and legitimacy[4] for its members. Tasks and duties of all members, as well as of the management, become more transparent. The selection of a specific type of legal constitution firstly depends on the level of cooperation among the members, secondly on who dominates the cluster, and thirdly on the issue whether there is a certain (commercial) interest or not. Those cluster organizations that are only slightly committed or intend to be only loosely involved in cluster-based co-operation will most likely only spend little efforts on implementing a certain legal constitution within the cluster. Figure 6 indicates that bottom-up and externally initiated top-down clusters more often selected a certain legal constitution than those, which are top-down, but internally initiated.

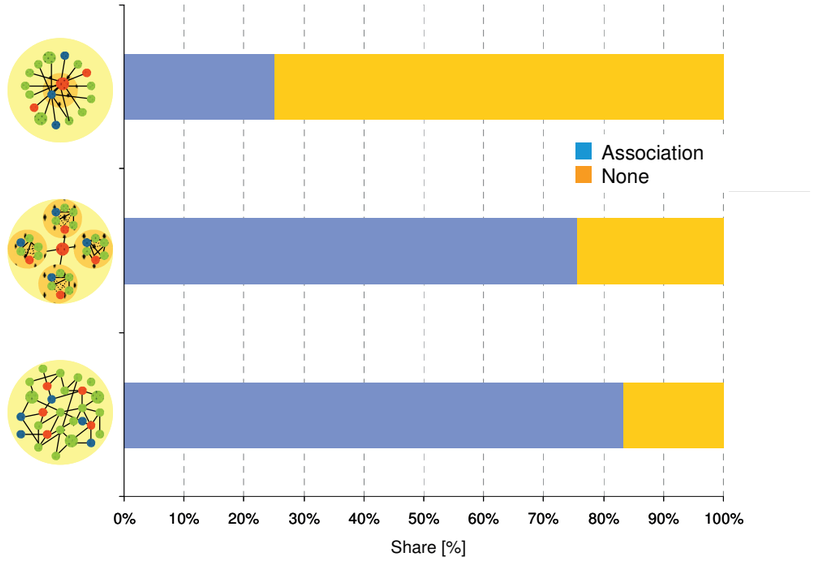

Figure 6: Percentage of clusters that have chosen the legal status of an association compared to those that did not select any legal constitution (depending on their history of emergence, data source: 60 out of 77; 15 selected another type of legal constitution, like GmbH/Ltd. or Inc.)

Our analyses also illustrates that the kind of cluster emergence seems to have an impact on the scope of the clusters future internationalisation. Internally we rated the clusters according to certain levels of internationalisation[14]. In Figure 7a the different levels of internationalisation of clusters operating in the technological domain "Micro/Nano/Opto" are presented, separated according to cluster emergence. The results clearly indicate that bottom-up clusters are much more internationalised (level 6 out of 7, levels are explained in the appendix) than both other types of cluster emergence. Figure 7b reveals the same effect for the technological domain "Manufacturing". The same tendency can be found in other innovation fields, whereas the absolute values slightly differ[30].

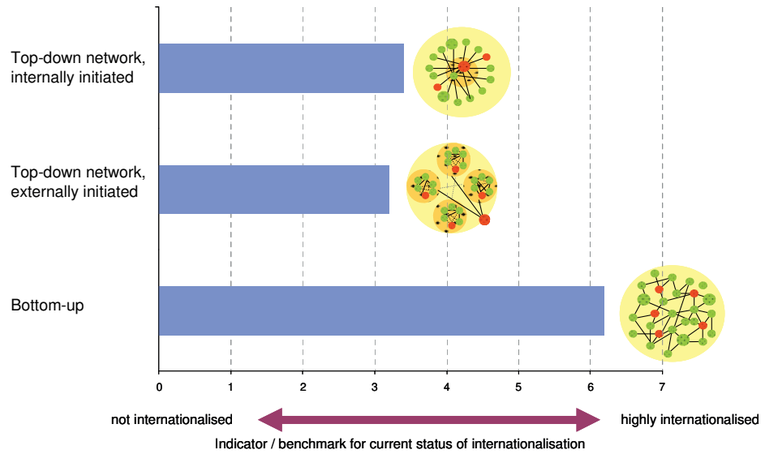

Figure 7a: Dependence of the internationalisation of clusters on their type of emergence (technological domain: Micro/Nano/Opto, indicators are explained in the appendix)

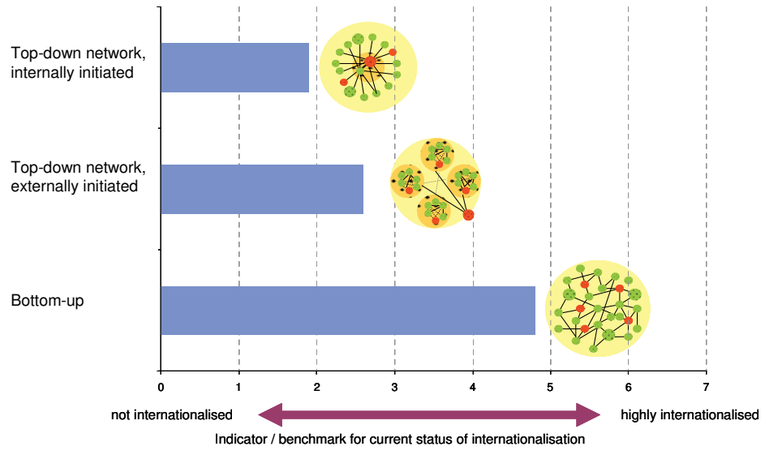

Figure 7b: Dependence of the level of internationalisation of clusters on their

[30] Meier zu Köcker, G. (2007): The Development of Clusters in Europe, INTERCLUSTERS Conference, December 6th, 2007, http://www.intercluster.eu/images/Programmes/InterCluster2007/MEIERzuKOCKER_RT1.pdf

4.2 Financing of the clusters

Setting up cluster organisations is often supported by a clear mandate and public funding from authorities on the federal or federal state level. In particular, cluster organisations often play an important role as service providers and support institutions for the clusters members. Cluster administrative organisations can be defined as the legal entity engineering, steering, motivating, involving, empowering, supporting, sensemaking, mobilizing, controlling, manipulating, legitimizing and representing[31] (in) the clusters, usually including the participation and access to the clusters' premises, facilities and activities as well as services.

Considering the European level, many clusters that have been set-up in the recent past received or are still receiving public funding that is provided for the installation of the cluster's administrative organisation and management. Especially during the embryonic phase of a cluster, it often gets considerable public funding, typically in the framework of certain cluster initiatives. In the ideal case, matured and successful cluster organisations tend to raise the majority of their operating costs themselves by membership and royalties, participation fees for training and conferences, sponsoring etc. In practice, private based financing is still a big challenge for many clusters world-wide. As a consequence, sustainable financing of (matured) clusters, preferably combined with a low share of public funding, is a key topic in Germany. Although most clusters have been set up in the framework of certain cluster initiatives, policy makers are generally interested in reducing the amount of public funding as soon and as much as possible.

In contrast, cluster organisations have to provide as much added value and demand-oriented services to their members as possible, in order to make participation in the respective cluster attractive for its (potential) members. However, the provision of services and men power requires a considerable amount of various resources. Analysing the data from the Kompetenznetze cluster portfolio, the financial status was of particular interest (especially for the most successful clusters), in order to understand how are clusters currently financed, and shared financing (private or public) changed over time. Figure 8a reveals the development of the financial sources of the clusters at the time of emergence compared to that in the year 2007[32]. In the course of emerging (as a cluster), on average 78 % of cluster financing came from public sources, whereas 22 % were based on private sources. The main sources are federal and federal state funding. This average value of public funding decreases to 57 % in 2007 for all respective analysed clusters. When looking closer at Figure 8a, it becomes obvious that the share of federal-based funding of the clusters considerably changes over time. It decreases on average from 27 % at the time of cluster emergence to 9 % in 2007.[33]On the contrary, the share of EC-based funding, as well as federal state funding, remains almost the same over time. The latter one remains on quite a high level of about 30%.

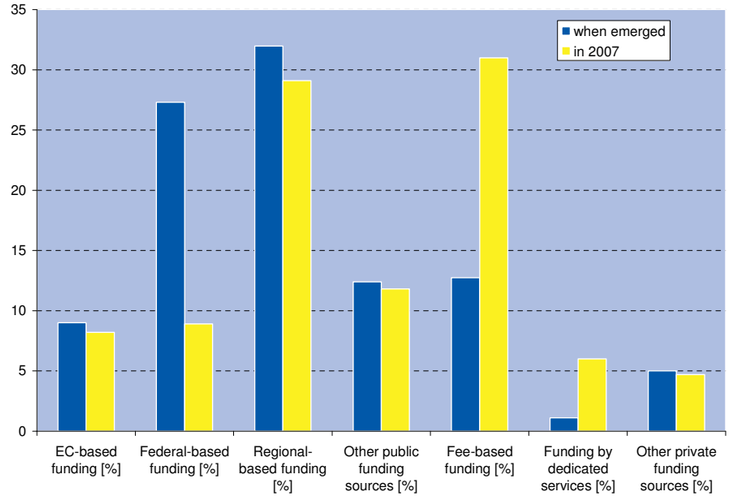

Figure 8a: Development of the average financing source of clusters over time (figures given in %)

[31] Huxham, C. & Vangen, S. (2005): Managing to collaborate. London: Sage.

[32] Financial data from 2008 confirm this findings

[33] The findings in the Cluster Initiative Greenbook study point in a similar direction.

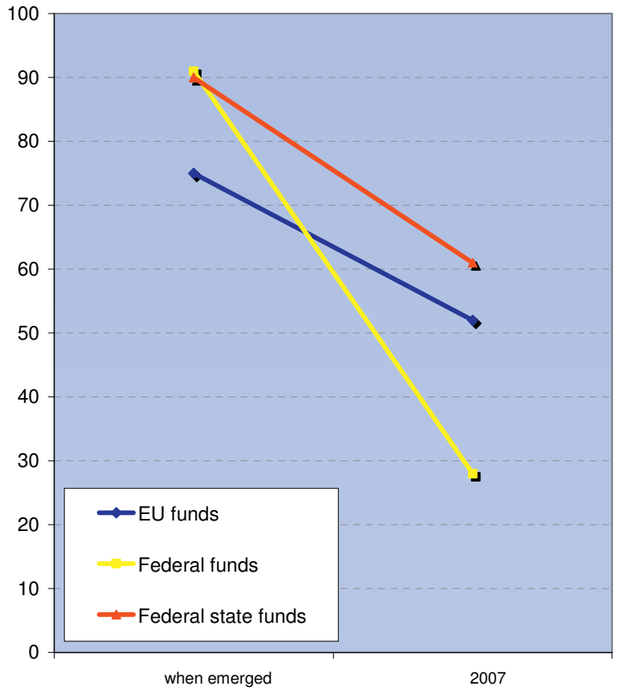

Figure 8b: Development of different prevailing funding sources of clusters over time

Figure 8b reveals that federal state cluster funding seems to have a more institutional character (long-term funding) than federal funding, which is usually comparatively more short-term oriented. In the respective figure the development of funding rates of the prevailing funding sources (EU, federal and federal state) over time, is shown. When they were emerging, clusters funded by federal, as well as by federal state level, receive comparable high funding rates (85 – 90 %). But in 2007, the funding rates of federal funded clusters are considerably lower than those of federal state funded clusters. The rationale behind this finding is that in most cases in Germany, the funding schemes of federal cluster initiatives significantly reduce the funding rates over time by imposing pressure upon the cluster organisations and management from the very beginning, in order to find other private funding sources. This approach is rather uncommon for in federal state cluster initiatives, where the funding rates often remain quite high over a long period of time, or the degree of the digressive funding is rather low.

Another interesting finding is shown in Figure 8c, where we grouped the number of clusters according to their share of private financing. There are two extrema prevailing, one group having a share of private financing below 20 % (about 30 % of all clusters regarded), the other having a share of private financing of more than 80 % (also about 30 %). Only about 15 % of all corresponding cluster organisation are privately financed between 40 – 80 %,

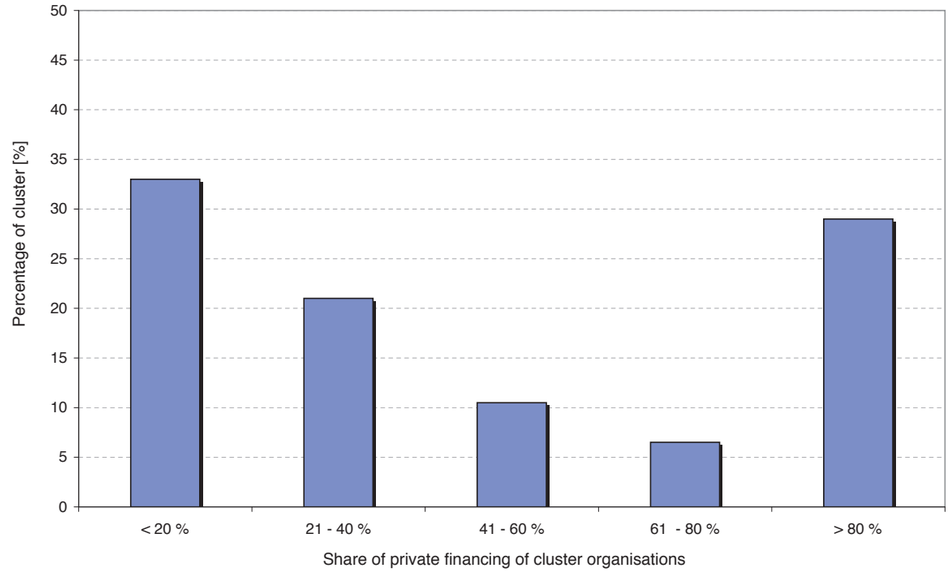

Figure 8c: Clusters grouped according to their share of private financing in 2007 (figures given in %)

In chapter 4.2 we have seen that three main types of cluster emergence prevail in Germany. The share of public or private financing also strongly depends on the type of cluster emergence (definition s. Figure 4). As shown in Figure 9, bottom-up initiated clusters have a much higher share of private financing (66 %) than top-down clusters (37 %). As far as bottom-up clusters are concerned, the main financial sources for the cluster organisations mainly consist of membership fees (73 %) and fee-based services (17 %). The rest stems from other sources. The internally initiated top-down clusters in particular, considerably depend on public funding (with a public funding rate of over 90 % on average). The data indicates that cluster organisation acting for this type of cluster are mainly operated and managed by universities or R&D institutions in Germany, which often follow their own R&D strategy. The services and added values are more directed to attract public funds for initiating collaborative R&D projects.

Such activities are much more vital for the clusters' activities than providing demand-oriented services for the industrial members. The cluster administrative organisations are typically located in the universities or other research organizations themselves, and either paid by these organizations or in the framework of public funded R&D projects. We learned from those cluster managers that member fees or private financing sources are not on top of the list of priorities of such types of clusters. Since demand-oriented services or other added values (besides potentially joint R&D programmes) are often missing in these clusters, industrial cluster members are often not willing to pay membership fees. Since cluster or network membership is mainly free of charge in these cases, and the access to public R&D funds is fostered by being a member of such a cluster, industrial members appreciate to be part of a cluster (since there are no costs or disadvantages). However, industrial cluster members in these cases are found to be rather inactive in the cluster development process itself.

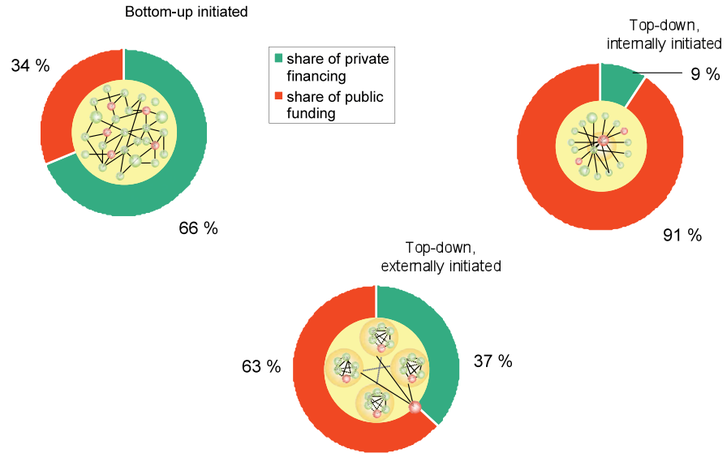

Figure 9: Share of public funding of the cluster organisations against the type of cluster emerge

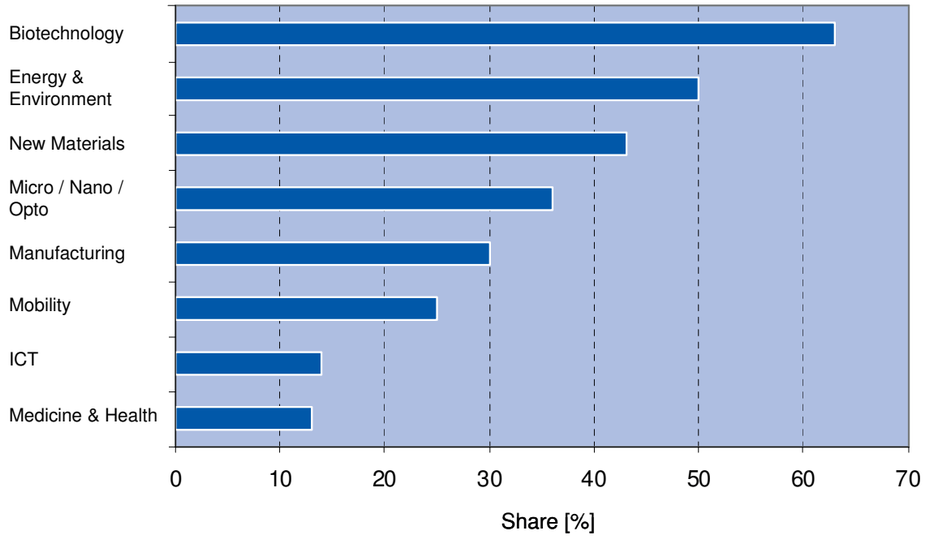

Figure 10: Share of clusters receiving at least 75 % public funding (in 2007), depending on the innovation field they are operating in

As seen in Figure 10, the amount of funding of cluster organisations does not only depend on the type of cluster emergence, but also on the technological domain, in which the clusters are operating in. More than 60 % of all biotechnology cluster organisations received at least 75 % of public funding in 2007. This is mainly caused of the fact that many excellent biotechnology clusters have been established in the framework of public funded cluster initiatives or public competitions in the field of biotechnology in Germany (e. g. BioRegio). On the contrary, clusters organisations in the fields of manufacturing, mobility and ICT seem not to depend as strongly on public funding since less than 30 % of them receive a higher share than 75 % of their budget out of public funding sources. Thus, it can be concluded that federal and federal state funding schemes considerably shaped the cluster landscape in Germany.

Although all clusters regarded in our analysis belong to the most successful and competitive ones in Germany, the sustainability of the resources available to the clusters' organisations differs considerably. We selected four different categories of sustainable financing of the clusters organisations (cf. Figure 11 for more details) and rated the clusters in the portfolio accordingly. Most of the cluster organisations, in total 89 %, reported of having a very sustainable financing, regardless which type of clusters emergence they belong to. About 21 % assessed their own financial situation at least to be critical.

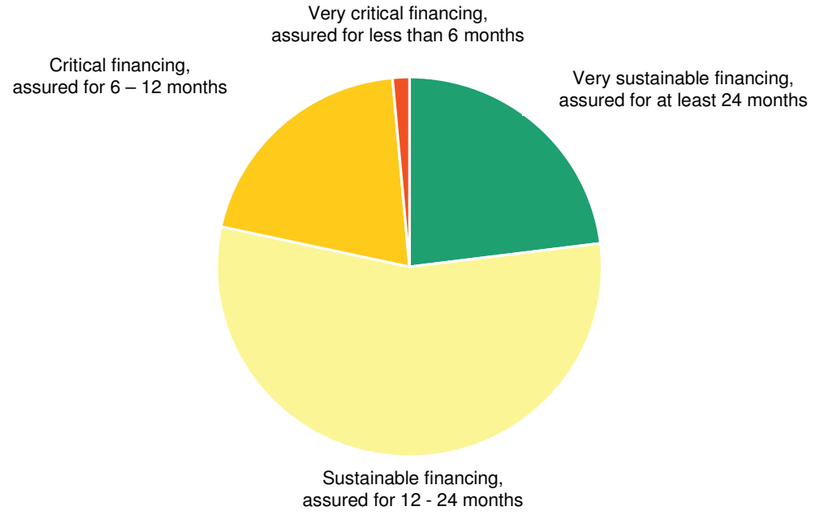

Figure 11: Sustainability of financing of cluster organisations in 2007

When comparing the growth of the clusters in terms of size, those that have a cluster organisation with assured financing tend to grow and develop better than those having financial issues. According to Figure 12, about 70 % of all clusters having an assured financial situation for the cluster organisations grew up significantly (at least 20 % per year) and only 10 % did not grow during the last two years. In contrast, almost 30 % of those cluster organisations not having gained a well assured sustainable financing did not grow in the recent past and only around 20 % grew significantly.

Figure 12: Growth of clusters in the past (two groups are compared: those cluster organisations with sustainably financial and those not having a financing assurance situation)

When assessing the future growth potential of the clusters[34], we also identified that those clusters with a good financial situation are considered to have an improved growth potential on average in comparison to those suffering from an unreliable financial base (Figure 13).

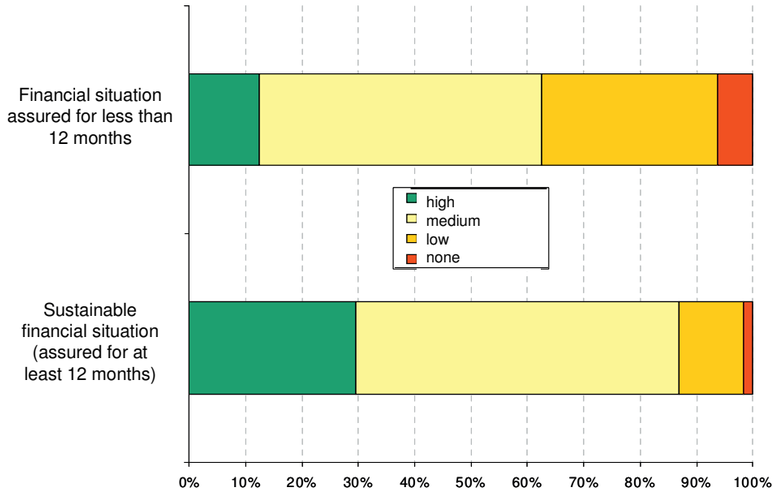

Figure 13: Expected future growth in terms of size (two groups are compared: those cluster organisations with sustainably financial situation and those whose financial situation is not assured)

Those cluster organisations having a solid financial base expect in almost 90 % a medium or high growth rate of their clusters in terms of size over the next two years. On the contrary, only 60 % of those with financial issues expect a comparable growth rate in the future. Almost 40 % expect a low growth rate or no growth at all.

[34] The assessments have mostly been conducted by the cluster managers themselves and were verified by our experts subsequently. However, in some cases the assessments were solely made by our experts. In this connection, high values imply a growth rate of at least 20 % growth per annum in terms of size (for a period of two years time), 'medium' indicates 10 %, 'low' signifies below 10 %, 'none' represents stagnation.

4.3 Management of clusters

According to our experience, the management of clusters plays a decisive role for the success of the respective cluster. The cluster management serves a functional purpose to provide a range of specialised and demand oriented services to its members. Cluster organisations help to channel, facilitate or provide access to facilities and services, which may include specialised research and test centres, consultancy, training etc. Due to the importance of the clusters management for the overall performance of the clusters and in turn for the competitiveness of regional actors, we discuss some of the related results we infer from our statistical analyses.

The communication among cluster members, among others, depends to a large extent on the cluster manager or coordinator, and how s/he is linked to and how s/he is accepted by the clusters members. There are several entirely different approaches to this phenomenon throughout Europe. One approach consists of the cluster manager or the cluster organisation itself as being a member of the cluster. In another approach the cluster manager or organisation is no direct member of the clusters itself, but is entrusted with this responsibility by the cluster members. A third approach is that of an external serviceprovider (or business development or funding agency), which takes the lead being appointed by a third party that often funds or initiates the cluster set-up. Figure 14 shows how these three options are distributed in our clusters portfolio.

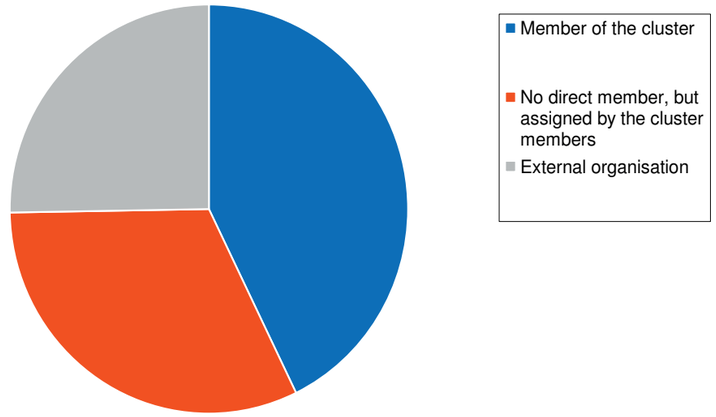

Figure 14: Relation between cluster managers and clusters

Based on the assumption that the cluster management plays an important role in identifying and implementing demand oriented-services and added values for the members, the corresponding cluster organisation should have sufficient staff to do so. Nevertheless, the question remains what seems to be the optimal number for an efficient cluster organisation? A small amount of staff implies that the number and spectrum of services performed may be low(er) or the cluster organisation cannot take sufficient care of the demands of the individual cluster members. In turn, too much staff within the cluster organization may unnecessarily increase the overhead costs of the cluster organisation.

An analysis of our cluster portfolio reveals that 73 % of the cluster organisations have between one and three employees. Capacities based on voluntary support of certain individuals within a cluster, e.g. by a member of the board, chairmen of working groups, are not covered by the analysis displayed in Figure 15. Further investigations have shown that the number of staff working for cluster organisations slightly varies between the different types of cluster emergence.

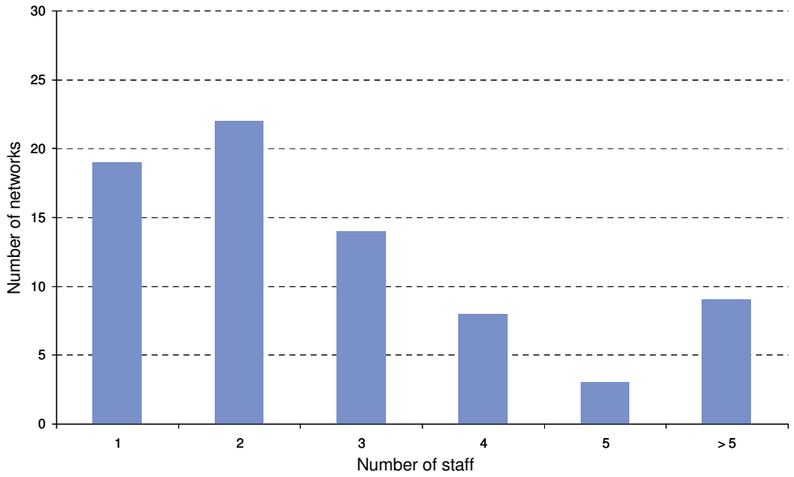

Figure 15: Distribution of staff number of the clusters organisation

It has been mentioned before that the management of a cluster and the services provided are very important for the value added a cluster can offer to its members. Therefore, it can be assumed that cluster managers have identified certain tasks that have priority. The respective services and added values provided by the clusters management/organisation should, in turn, be the result of the main tasks identified. We asked the cluster managers to select the two most relevant tasks they consider relevant for their clusters out of several different options we offered. In total, the acquisition of public funds, internationalisation issues, stimulating information and experience exchange among the members, as well as training and qualification (incl. recruiting) were mentioned most frequently (cf. Fig. 16).

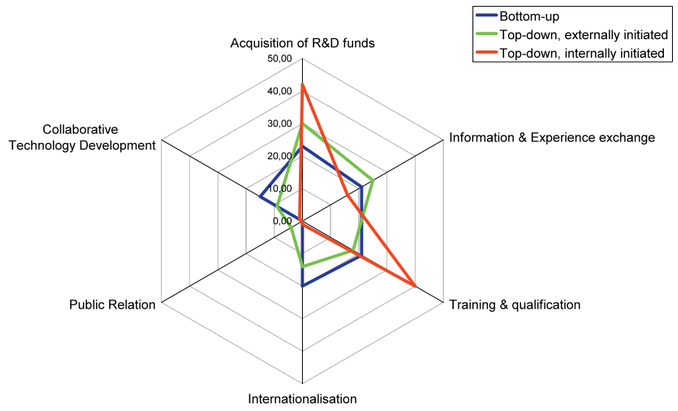

Figure 16: Main current tasks of the clusters according to their category of emergence (cluster managers were allowed to vote for the two most relevant tasks, figures in percentage)

Once again it is worth noting that we identified that the type of cluster emergence does exert an impact upon the main tasks that dominate the clusters' works. As shown in Figure 16, bottom-up clusters tend to concentrate on different tasks than top-down internally initiate clusters. The latter mentioned the acquisition of R&D funds and training as well as qualification as their main task they have to follow. This is not surprising, given the fact that most initiators and cluster organisations are universities and R&D institutions and these tasks are those that they can execute very well. They tend not to pay much attention to issues like internationalisation of their industrial members. In turn, bottom-up clusters named a rather balanced spectrum of main tasks (approx. 20 % for each item) they have to complete, like to support their members in internationalisation issues, training and qualification, acquisition of public funds as well as to stimulate the information and experience exchange among the members. Top-down externally initiated clusters tend to have a similar spectrum of main tasks like bottom-up clusters.

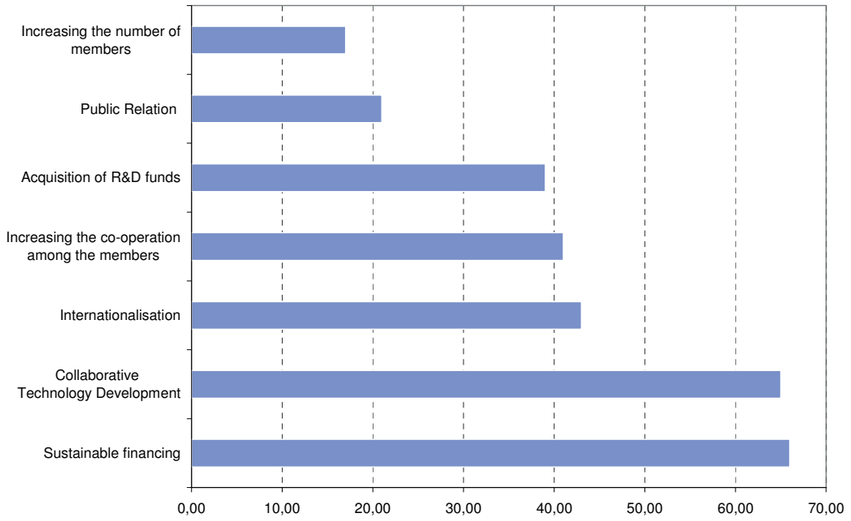

Figure 17: Relative importance of future challenges by cluster managers point of view (up to two opinions per cluster allowed, figures given in percentage)

We are aware that even successful clusters will face diverse challenges in the foreseeable future, depending upon their specific situation. Nevertheless, we asked the cluster managers for the main challenges they will face over the next two years and offered them 12 different options to choose from. We were surprised that the majority of answers concentrated upon only 7 options. Figure 17 reveals the overall results, pointing out that "sustainable financing" and "collaborative technology development" were considered to be the main challenges. Followed by "internationalisation issues", "increasing the cooperation between the members" and "acquisition of public R&D funds".

Reverting to clusters with a similar type of emergence we observed that these clusters tend to face similar priorities concerning future challenges, as can be seen in Figure 18. Top down internally initiated clusters mainly consider "sustainable financing", as well as "acquisition of R&D funds", whereas bottom-up clusters assess an "increase in co-operation among its members" as a main challenge, apart from the strengthening of "collaborative technology development", as well as "internationalisation" issues. Financing issues do not seem to be pressing. One reason for this might be the fact that these clusters already have established a fee-based financing. Top-down externally initiated clusters also consider "collaborative technology development" and "sustainable financing" as the main future challenges.

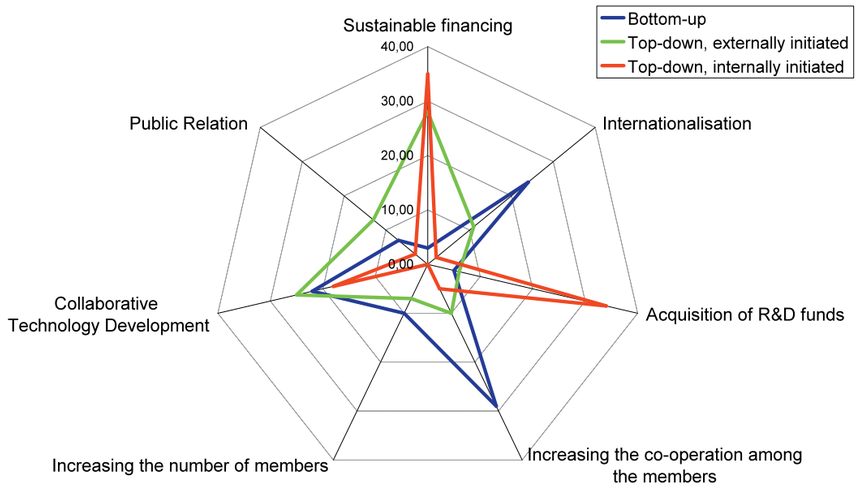

Figure 18:Future challenges of the clusters according to their category of emergence (clusters managers were allowed to vote for the two most relevant challenges; figures in percentage)

In the previous section, we elaborated upon the issue of sustainable financing and its potential innate impact on the cluster development. We investigated a potential tendency between the skills and experiences of cluster management and the financial situation of the clusters organisation. Our suggestion is that the financial situation of a cluster (especially when it does not receive sufficient public funding and it depends on fee-based membership) may also depend on the performance and capability of clusters management itself. Cluster organisations which are able to offer added values and demand-oriented services that are of some value for their members, may ascertain it to be easier to receive sustainable fee based financing than those that are not able to provide appropriate services.

Based on the findings revealed in Figure 19, cluster managers working for cluster organisations with assured financing more often have experiences as professional networkers that do not dispose of additional experiences in the corresponding technical area the cluster is operating in. In those clusters, which are suffering sustainable financing, more often cluster managers are employed having good technical experiences, but not so much as professional networkers. We are aware that the results presented in Figure 19 are forcing us to treat them with caution, since there may be other rationales involved. But the findings are in line with investigations, conducted by experts of ZENIT a couple of years ago[35].

[35] Iking, 2004, Erfolgreiche Netzwerkarbeit – Vorbedingungen und Erfolgsfaktoren-, published by ZENIT GmbH (in German only)

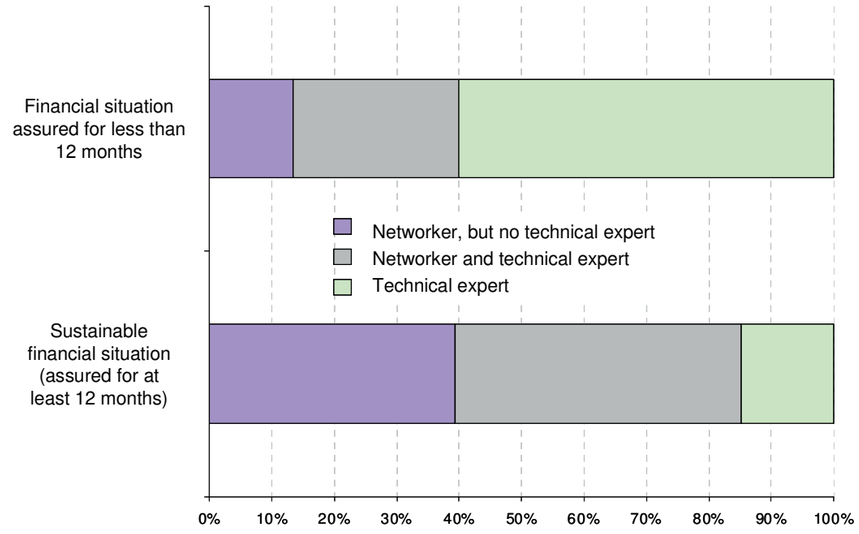

Figure 19: Skills and experiences of cluster managers of clusters with sustainable as well as without sustainable financing

In line with previous research[36] we argue that the effective management, or rather the effectiveness of the way the network administrative organization (that presides over the management of the cluster, that is, those interviewees that took part as informants in our research) of the whole cluster principally depends upon the form of governance. Prior findings suggest[37] that trust among the cluster partners – at least in those cases where the size of the cluster appears to be manageable and the diverse partners are reciprocally aware of each other and know each other on a face-to-face basis – represents an essential element of successful clusters.

In addition, the number of participants in the administrative organization is decisive. Although generalizeable conclusions are difficult to draw, we cautiously claim for preventing the cluster (members) from becoming 'unmanageable', i.e., the number of partners should not increase unhampered in order to prevent the cluster from simply being something abstract that is not deemed to be valuable for (potential) cluster members / participants.

A practical solution to tackle this issue might be the installation of several layers of management exerting entities. For instance, instead of a single lead organization or cluster administrative organization as in our case, subdividing these entities might help to create a form of 'shared' or 'empowered' leadership that is possibly better capable of delivering the desired benefits of a cluster administrative organization than a single, isolated entity.

Moreover, in line with the findings from our study, but also prior results from other researchers we suggest that homophily is another important aspect, understood in the present context as similarity with regards to the arena the organizations operate in, as well as the way the organizations act within the cluster. However, this aspect ought to be critically reflected upon in every single case insofar– bearing the notions of Brandenburger and Nalebuff[38] in mind –, as the diverse partners should not be too similar, as this might impede cooperation due to repercussions from the same markets the partners are competing in.

[36] Kenis, P., & Provan, K. G. (2006): The Control of Public Networks. In: International Public Management Journal, 9(3): 227-247, as well as Provan, K. G., & Kenis, P. (2008): Modes of Network Governance: Structure, Management, and Effectiveness. In: Journal of Public Administration Research and Theory 18(2): 229-252.

[37] Cf. also Müller-Seitz, G., Sydow, J., Windeler, A., & Lange, K. (2009): Strategic Leadership in Heterarchical Networks? A Structuration Perspective on Leadership Practices in the Semiconductor Industry, Academy of Management Annual Meeting 2009, Chicago 10.-11.08.2009.

[38] Brandenburger, A. M., & Nalebuff, B. J. (1998): Co-opetition. New York: Doubleday.

4.4 Cluster performance

In this chapter we are dealing with one of the main questions: does any of the three parameters 'kind of emergence', 'financing' and 'management' may have any significant impact on the output performance of the clusters themselves. If this assumption holds true, how strong might the effect actually be? For policy makers and cluster practitioners this aspect is of considerable interest in order to gain an improved understanding, why certain clusters developed better than others, and how a cluster can be designed from the very beginning, subject to maximising its economic impact afterwards.

Cluster performance can be measured both in terms of outputs, as well as economic outcomes. Clusterspecific outputs can include reduced costs (from labour-pooling or technology-sharing), and innovation (from knowledge-sharing and networking). Cluster-specific outcomes comprise general economic measures, such as employment, wages and exports. Outcome measures illustrate the cluster's impact on the regional or national economy.

In our approach, we concentrated upon the cluster output performance and rated our clusters according to four different categories ('very good', 'good', 'acceptable' and 'some weaknesses'), depending upon the degree the membership criteria of the Initiative Kompetenznetze Deutschland were fulfilled, as well as upon other output related indicators (e.g., the quality and intensity of cluster management, collaborative projects initiated within the cluster, the reputation of a cluster in the region or within the scientific community). All of the clusters fulfil these mandatory membership criteria, but it is quite obvious that the respective criteria can be fulfilled to a different extent, which becomes visible when using benchmarking indicators (cf. Figure 20).

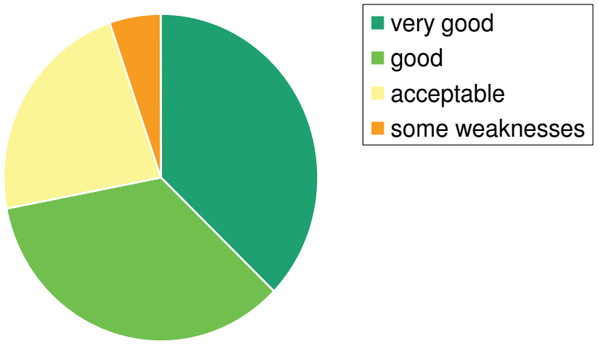

Figure 20: Assessment of the overall performance of the analysed clusters

Most clusters can be assessed to have shown a very good or good output performance over the past (almost three quarter). About 20 % have shown an acceptable performance, but did not perform as well as clusters of the both other categories did. Only few clusters have shown some weaknesses in the past.

In the former chapters we have seen that the type of cluster emergence seems to exert an impact upon the legal constitution, internationalisation, financing, etc. Taking these aspects into consideration, it could be assumed that the type of cluster emergence may also have some impact upon the overall cluster performance too. This assumption is confirmed by the results shown in Figure 21, where we separated the cluster performance according to the type of cluster emergence.

Figure 21: Cluster performance according to the type of cluster emergence

Our analysis reveals that slightly over 75 % of all bottom-up and top-down externally initiated clusters have a very good or good performance, whereas the share of clusters rated with "very good" is much higher for bottom-up clusters. In contrast, top-down internally initiated clusters show a complete different picture: most of them have shown an acceptable performance and more than 25 % have shown some weaknesses in the past. Only about 10 % were labelled "good".

In a second step, we analysed whether the sustainability of financing performance exert an impact upon the output performance of clusters. According to our analysis, clusters that dispose of a very sustainable or at least sustainable financial situation show an improved overall performance in comparison to those without any sustainable financing (see Figure 22 for details).

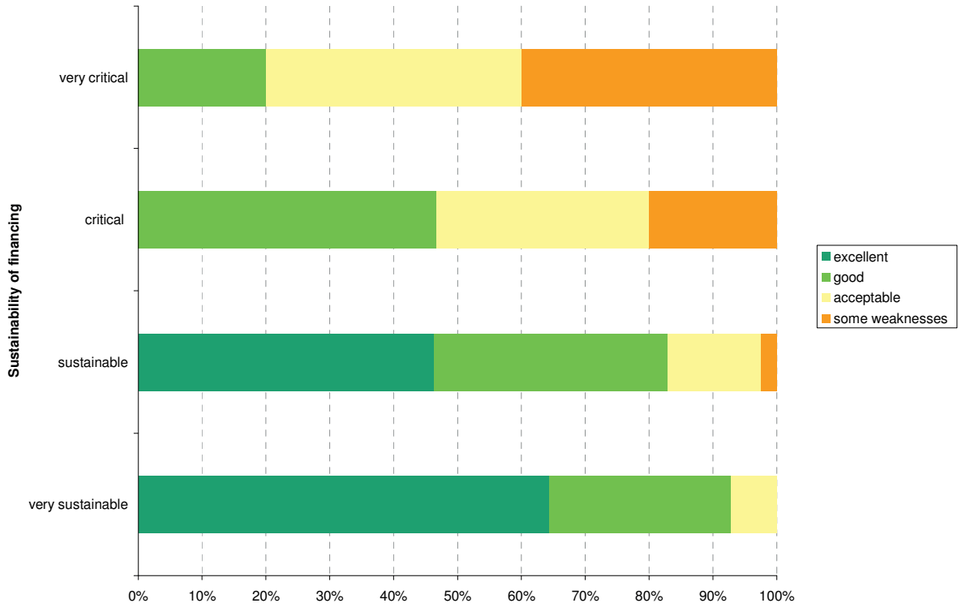

Figure 22: Distribution of output performance of clusters according to the financial situation of the cluster organisation

More than 80 % of the clusters revealed a very good or good performance when the financing of the clusters organisation is at least sustainable, which means assured for at least 12 months. If in case of a critical financial situation or where finances are only assured on a short-term basis (that is, less than 12 months), fewer than 50 % achieved the grade 'good', and none a very good performance. In those cases when financing is considered to be very critical, the distribution of the four performance categories is even worse. Thus, a relationship between the clusters performance and financial situation is graspable, whereas the reasons are not fully clear and there is a need for further investigations.

5. Regression results

Duschek, St.; Lerch, F.; Müller-Seitz, G.; Okute, A.*

As indicated above in order to get a more thorough and robust understanding of the causal relationships involved, we conducted multiple regression analyses. We first created an index of cluster performance. The index consists of three variables: overall cluster performance (rated on a 4-point answer scale), cluster financial situation, and cluster growth (both rated on 3-point scales). The original variables were first transformed to the same metrics (0-1), and then aggregated to a single index with range 0 through 1, where all index variables were assigned identical weights. This index has a mean of .62 (sd = .25), and was then used as the dependent variable for the multivariate models. The full model contained the following sets of variables:

- cluster size (number of permanent members, number of temporary members, number of administrative staff);
- legal form (e.V., GmbH, other legal form, no legal form; coded as dummy variables with no legal form as the reference category);
- funding (EU, federal, regional, other public, fees, services, other private sources; dummy coding, EU-funding serves as the reference category);
- cluster type (bottom-up, top-down externally initiated, top-down internally initiated; dummies, top-down externally initiated clusters are the reference category).

Further explanations related to the methodology we have applied are given in appendix II. The full regression model explained about 35% of variance, which is a moderate but satisfactory amount, and was significant with $p < .001$. In sum, the series of regression models we ran showed a consistent and robust pattern of results:

(1) Cluster performance was positively influenced by cluster size; that is, the number of permanent cluster members predicted cluster performance. A reasonable explanation is that member firms contribute resources to the clusters, and thus bigger clusters provide better chances for the generation of synergies and positive network effects.

(2) Contrary to #1, we observed a negative effect of temporary cluster members on cluster performance. While the effect was only marginally significant ($p = .10$), it still aims at freeriding problems. Very likely, temporary members do not provide as many tangible and intangible resources and commitment as compared to permanent members. Worse, they will try to benefit from the cluster, thus lowering overall cluster performance.

(3) Bottom-up initiated clusters performed better than top-down externally initiated clusters; top-down internally initiated clusters performed worse than both externally and bottom-up initiated clusters. Interestingly, these results hold regardless of the set of controls accounted for.

(4) We did not find significant effects of the legal forms of the clusters. Controlling for clusters of the following forms: e.V., GmbH, others, against clusters which did not have any legal form did not show significant deviations.

(5) There were hardly any funding effects. As compared to clusters with EU-funding, only clusters that offered services on the market showed higher performance indications. All other kinds of funding did not differ from EU-funding.

6. Conclusion

This paper represents work in progress and its findings are preliminary results. While we have assembled a considerable sample of clusters, many variables and their relationship are not finally evaluated. Further investigations together with the Free University of Berlin (FU Berlin) in progress, and likely to be published in 2009.

In the following section, the most relevant findings of our empirical analysis will be summarized and discussed. It is important to note that these findings are based on a cluster portfolio analysis with regard to the 75 most innovative clusters in Germany. By nature, these findings are predominantly valid for the clusters we have analysed, but we are convinced that some general conclusions for clusters facing similar situations can be drawn.

Top down, externally initiated clusters are the prevailing type of cluster emergence in Germany

As described in chapter 4.1, we identified three dominating types of cluster emergence.[39] Nevertheless, the most dominant type of cluster emergence in Germany relates to those clusters that are top-down, externally initiated. These clusters were oftentimes set up in the framework of cluster initiatives on federal state, as well as on federal level as mentioned in Figure 3. These different cluster initiatives have shaped a specific cluster landscape in Germany. Many federal and federal state cluster initiatives, which were realised in the recent past, led to the foundation of many excellent top-down, externally initiated clusters. The fact that around three quarter of Germany's most innovative clusters are originally politically initiated, reveals that this kind of cluster emergence, stimulated on federal, as well as on federal state level, appears to be in many cases a promising approach. Nonetheless, it is worth noting that almost one quarter of the most innovative clusters in Germany were initiated regardless of any cluster initiatives, i.e. they belong to the category of the so called bottom-up clusters'. This indicates that there are many excellent examples that clusters can also be set-up by the interested community itself without benefiting from any political influence or funding. Bottom-up and top-down externally initiated clusters tend to chose a legal constitution for the clusters, mostly that of an association (cf. Figure 6). Discussion with cluster managers revealed that cluster members who are strongly committed to a cluster, tend to select an association as a legal cluster constitution, which is beneficiary for their work and rules the tasks and duties of all the members.

In contrast, top-down internally initiated clusters often do not chose a certain legal constitution, which we understand as a lack of commitment of the partners involved, as in many cases there is also no formal membership and commitment mandatory in place.

Bottom-up clusters tend to be more internationalised

In addition, we discovered that bottom-up clusters tend to be more internationalised on average than other top-down clusters. This analysis was done specifically for certain innovation fields since we also observed in previous investigations that the innovation field the clusters operate in may exert an impact upon the level of internationalisation of the respective clusters. Figures 7a and 7b show that bottom-up clusters are more internationalised than top down clusters. The reason for this finding might be that in bottom-up clusters firms interested first and foremost in internationalisation (rather than other members) are dominating. Thus, the cluster management puts tremendous efforts in internationalisation activities for the benefits of the industrial members. Such services are considered to be an added value for which the industrial members are willing to pay membership fees. Oftentimes, this results in an increased level of internationalization of the whole cluster. These findings confirm the related observation that internationalisation of the members is one of the top four priorities bottom-up clusters have defined for their current activities.

Federal state based funding of clusters lasts longer than federal funding

We devoted a lot of attention to the issue of funding of cluster administrative organisations, which are in charge of managing the clusters. Figures 8a and 8b clearly show that public funding of clusters based on federal funds is faster reduced than in case of federal state funding. We found out that the public funding rate of those clusters which receive a share of federal state funding of at least 50 % is extremely high when they emerged, and was only slightly lower in 2007. As far as clusters are concerned, financed to at least 50 % by federal funds, the funding rate decreased significantly over time. Clusters funded by federal funds mostly substituted the reduced amount of public funds by acquiring private, fee-based funds. Top-down internally initiated clusters depend predominantly on public funding, whereas bottom-up clusters dispose of lower shares of public funding (cf. Figure 9) .

[39] It should be noted that a mixture of two types is also common in some cases. However, in those cases one of the categories is dominating.

Sustainable financing seems to exert a significant impact upon the development and performance of a cluster

Regardless of the sources of financial budgets, the issue of sustainable financing is of high priority for most cluster managers. Although most of the clusters were the result of a cluster initiative and, therefore, mainly publicly funded when they were installed and emerged, the majority reported to have gained a sustainable financing; in line with our categorization this implies that the financing is secured for at least 12 months. Most of the bottom-up clusters confirmed this. Moreover, the majority of the top-down initiated clusters reported that their financing is currently assured.

In the cases in which sustainable financing was not assured in the past nor at present, we found out that the growth in terms of size so far, as well as the growth perspectives are considerably lower than for those gaining a sustainable financing (cf. Figures 12 – 13). Even more, we found out that clusters tend to perform much better when they have a good financial record compared to those facing financial difficulties (cf. Figure 22). As a consequence, financial issues are ascertained to be top priorities in terms of future challenges for cluster managers, especially for top-down initiated clusters (cf. Figure 18).

Five main future challenges can be identified

Five central future challenges were identified by the cluster managers: Sustainable financing ranked top (cf. Figure 17), chiefly aired by top-down cluster managers. Intensifying the joint collaborative technology development (also interdisciplinary co-operations) ranked second. Internationalisation of the clusters and their members, increasing the co-operation among the members as well as the acquisition of additional public R&D funds constitute further challenges that the cluster managers deemed to be top priorities.

It is interesting to notice that clusters with a similar type of emergence tend to identify challenges with similar priorities. As far as bottom-up clusters are concerned, their managers mainly consider the increase of mutual co-operation among their members, internationalisation issues, as well as collaborative technology development (also interdisciplinary co-operations) to be among the main challenges. The latter ones are also one of the two main concerns for top-down externally initiated clusters, the other ones concern sustainable financing of the clusters work.

Financing future activities is also considered to be a challenge for top-down internally initiated clusters. Moreover, they will also concentrate upon the acquisition of sufficient public R&D funds (Figure 18).

Size of clusters and type of clusters emergence seem to have a significant impact on the cluster performance

Although the analysed clusters are all members of the initiative Kompetenznetze Deutschland and, therefore, can be considered to be among the most competitive networks/clusters in Germany, there are some clusters, which show superior output performance (cf. our performance categories in chapter 4.4). It is worth noting that the performance differs according to the types of clusters emergence (Figure 21). Bot-tom-up initiated clusters performed better than top-down externally initiated clusters; top-down internally initiated clusters performed worse than both externally and bottom-up initiated clusters. This finding was clearly backed by regression models (chapter 5). Such models also revealed that bigger clusters tend to perform better than smaller ones. We also we observed a negative effect of temporary cluster members on cluster performance, based on the same regression models. Sustainability of financing of cluster organisations may have also show a clear impact, but this finding was not analysed by means of the regression models.

Appendix I Categories of Cluster Internationalization

In this appendix we attempt to offer an approach on how to categorize a clusters' degree of internationalisation. These categories are deemed to represent a basic distinction that reveals the differences concerning the level of internationalization of clusters. There is no direct link between these categories and the information we obtained from cluster managers in this study.

7 Noticeably internationally acting cluster:
both the cluster itself, as well as its members act successful on an international level and are recognized for doing so. Moreover, foreign partners are members of the cluster. A large number of examples for successful international co-operations exist resulting in improved innovative dynamics, a strengthened market position and improved financial figures of the cluster and its members.

6 Intense cross linking / partnership with one or more foreign clusters.
A lot of measures and activities both on behalf of the management and of most of the cluster's members point out the international orientation of the cluster. A large number of examples for successful international co-operations exist resulting in improved innovative dynamics, a strengthened market position and the financial figures of the clus-ter and its members.

5 Active, regular and intense participation of the cluster and its members in European projects and other events,
partially also initiated by the cluster itself. The cluster is present on an international level and accepted by similar foreign partner clusters. There is a basic strategy / implementation plan. Members and management can report on first successes in international co-operations. However, there exists a potential to adjust to a more international orientation.

4 Punctual co-operations with international partners
exist (that is, the cluster manager, an institution or a company), but the co-operations are rather unspecific and sporadic. Single members of the cluster are already internationally active and linked, but the cluster itself is not recognized as acting internationally. In spite of first successes, there is still a high potential for further internationalization that is yet to be implemented in specific strategic measures.

3 First participation in and/or organization of international events by the cluster's management are visible.
The management and most companies have the intention to internationalize, but there are no strategies or solid options for action in place. Internationalization is less relevant to date, even if singular companies already engage in internationally oriented measurements .

2 No international activities
by the cluster's management are visible, but are basically intended. Tangible measures or plans do not exist, because other priorities prevail. Nevertheless, some of the cluster members might already dispose of international contacts that might be utilized subsequently.

1 No international activities
by the cluster's management are visible or intended. There are no intents, concrete measures or plans to do so in the foreseeable future. However, individual cluster members might already dispose of international contacts that might be utilized in the foreseeable future.

Appendix II Statistical Analysis of Competence Networks Germany

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Before conducting the multiple regression analysis, correlations between the potential dependent variables were computed and, based on these results, a dependency index of cluster performance variables was designed. Potential dependent variables were: overall cluster performance, the financial situation of the cluster, cluster growth, future cluster growth potential, and internationalization of the cluster.

		1	2	3	4
1	Overall cluster performance				
2	Financial situation of the cluster	0.36**			
3	Cluster growth	0.50***	0.24*		
4	Future growth potential	0.39***	0.01	0.52***	
5	Internationalization	-0.39***	-0.20+	-0.10	-0.28**

*** p<0.001; ** p<0.01; * p<0.05; + p<0.10

Because of their significant correlation coefficients, the cluster performance index is based on the following variables (table 1):

- Overall cluster performance (perf1)
- Financial situation of the cluster (perf2)
- Cluster growth (perf3)

To create the index, the three variables were transformed (single categories with only few observations were aggregated) and recoded, with high index values indicating high performance.

For example, the first variable, overall cluster performance, was initially rated on a 6-category answer scale. The number of categories was then reduced to four: (4) very good, (3) good, (2) acceptable, and (1) weaknesses in cluster performance. Recoding the categories means that higher cluster performance contributes to a higher index level as compared to lower performance (table 2).

Table 2: Overall cluster performance (perf1)

	Frequency	Percent			Frequency	Percent
1 = Very Good	28	36.36	→	4 = Very good	28	36.36
2 = Good	28	36.36	→	3 = Good	28	36.36
3 = Acceptable	16	20.78	→	2 = Acceptable	16	20.78
4 = Some weaknesses	2	2.60	→			
5 = Critical weaknesses	2	2.60	→	1 = Some weaknesses	5	6.49
6 = Exotic cluster	1	1.30	→			

The second variable, financial situation of the cluster, was previously measured with four categories, which were then reduced to three. The new categories were (3) very sustainable, (2) sustainable, and (1) critical financial cluster situation (table 3). The coding was adjusted as described above.

Table 3: Financial cluster situation (perf2)

	Frequency	Percent			Frequency	Percent
1 = Very sustainable	17	22.08	→	3 = Very sustainable	17	22.08
2 = Sustainable	43	55.84	→	2 = Sustainable	43	55.84
3 = Critical	16	20.78	→	1 = Critical	17	22.08
4 = Very critical	1	1.30	→			

The third variable, growth of the cluster, was treated as described above. The last two categories (low for different reasons) were aggregated to a new class low cluster performance.

The categories significant and moderate cluster growth remained the same, but were also recoded such as to express that high values contribute positively to cluster performance (table 4).

Table 4: Cluster growth (perf3)

	Frequency	Percent			Frequency	Percent
1 = Significant	41	53.25	→	3 = Significant	41	53.25
2 = Moderate	25	32.47	→	2 = Moderate	25	32.47
3 = Low, because not aspired	7	9.09	→	1 = Low	11	14.29
4 = Low, though aspired	4	5.19	→			

The cluster performance index, "perform", was generated according to the following formula, where all index variables were assigned the identical weights.

$$\text{perform} = \frac{1}{3}\left[\left(\frac{1}{3}(\text{perf}1-1)\right)+\left(\frac{1}{2}(\text{perf}2-1)\right)+\left(\frac{1}{2}(\text{perf}3-1)\right)\right]$$

This index is bound between 0 and 1. The index has a mean of 0.62 and a standard deviation of 0.25. 50% of the index observations are in the section from 0.39 to 0.83, which is a range of 0.44. The minimum is at 0.00 and the maximum is an index value of 1.00 (table 5).

Table 5: Index of cluster performance

Index Value of "perform"	Frequency	Percent	Cumulative Percent
0	1	1.30	1.30
0.11	2	2.60	3.90
0.22	1	1.30	5.19
0.28	8	10.39	15.58
0.33	4	5.19	20.78
0.39	5	6.49	27.27
0.44	3	3.90	31.17
0.50	1	1.30	32.47
0.56	7	9.09	41.56
0.61	1	1.30	42.86
0.67	3	3.90	46.75
0.72	14	18.18	64.94
0.78	2	2.60	67.53
0.83	17	22.08	89.61
0.89	1	1.30	90.91
1	7	9.09	100.00
Total	77	100.00	

N	77
Missing	0
Mean	0.62
Median	0.72
Modus	0.83
Std Devidation	0.25
Variance	0.06
Minimum	0.00
Maximum	1.00
Interquartile Range	0.44
100% Quantile	1.00
75% Quantile	0.83
50% Quantile	0.72
25% Quantile	0.39
0% Quantile	0.00

Using multiple regression analysis techniques, the impact of the control variables (number of permanent cluster members, number of temporary members and number of administrative staff) and the impact of the explanatory variables (legal form, funding in 2007 in percent and cluster type) on the index of cluster performance were tested.

A dummy coding was used for the variables legal form, funding and cluster type. Legal form can take the values e.V., GmbH, other legal form, or no legal form, with no legal form serving as the reference category. Funding 2007 could be EC-based funding (reference category), federal-based, regional-based funding, municipality-based funding, other public funding sources, fee-based funding, funding by dedicated services and other private funding sources. The cluster emergence variable can take the forms bottom-up, top-down externally initiated (reference category), and top-down internally initiated.

Table 6: Refression models

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	0.501***	0.382***	0.420**	0.483***	0.384**
Permanent members	0.001***	0.001***	0.001**	0.001**	0.001**
Administrative staff	0.017	0.016	0.019	0.019+	0.016
Temporary members	-0.002+	-0.002	-0.002	-0.003*	-0.002
Legal form					
■ e.V.		0.161*			0.76
■ GmbH		0.085			-0.018
■ Other legal form		0.105			0.112
Funding in 2007 (in %)					
■ Federal-based			0.000		0.000
■ Regional-based			-0.000		0.001
■ Municipality-based			0.001		0.000
■ Other public funding sources			0.000		0.000
■ Fee-based			0.002		0.001
■ Funding by dedicated services			0.003		0.005*
■ Other private funding sources			0.001		0.000
Cluster type					
■ Bottom-up				0.132*	0.104
■ Top-down internally indicated				-0.134*	-0.159*
Model-Fit	$F_{(3.37)} = 8.29$***	$F_{(6.70)} = 5.45$***	$F_{(10.66)} = 3.66$**	$F_{(5.71)} = 9.01$***	$F_{(15.61)} = 3.70$***
Goodness of Fit	Adj. $R^2 = 0.224$	Adj. $R^2 = 0.260$	Adj. $R^2 = 0.259$	Adj. $R^2 = 0.345$	Adj. $R^2 = 0.347$

*** p<0.001; ** p<0.01; * p<0.05; + p<0.10

The first regression model explained about 22% of the variance of the dependent variable (cluster performance as expressed by the index), and was significant with $p < 0.001$. The estimated parameters of the significant variables were 0.001 ($p < 0.01$) for the permanent cluster members, and -0.002 ($p < 0.10$) for the temporary cluster members. Ten more permanent cluster members would increase the cluster performance index by about 0.01 points, while five more temporary cluster members would lead to a decrease of 0.01 cluster performance index points. A reasonable explanation for the positive effect of an increase in permanent members is that member firms contribute resources to the clusters, and thus bigger clusters provide better chances for the generation of synergies and positive network effects. But we observed a negative effect of temporary cluster members on cluster performance. While the effect was only marginally significant, it still indicates the possibility of free riding problems. Very likely, temporary members do not provide as many tangible and intangible resources and commitment as compared to permanent members. Worse, they will try to benefit from the cluster, thus lowering overall cluster performance.

The second model explained about 26% of variance and was significant with $p < 0.001$. Significant predictors were the number of permanent cluster members with an estimated parameter of 0.001 ($p < 0.001$), and the category “legal form e.V.”. The number of permanent cluster members had the same influence on cluster performance as in the first model; clusters with the legal form e.V. have, on average, a performance index which is 0.16 ($p < 0.05$) points higher as compared to a cluster with no legal form. Clusters of the forms GmbH, other legal forms and clusters without legal form did not differ significantly. The pattern appeared rather unsystematic, because the dummy coefficients for e.V. and other forms were positive, and the GmbH coefficient was negative.

The third model explained about 26% of variance ($p < 0.01$). The effects of the control variables remained similar as compared to model two: permanent cluster members contributed positively to performance (coefficient of 0.001, $p < 0.01$), whereas administrative staff and temporary cluster members failed to reach acceptable significance levels. There were no significant differences among the different ways of funding.

The fourth model explained about 35% of variance and was significant with $p < 0.001$. The estimated parameter of the permanent cluster members was 0.001 ($p < 0.01$), the coefficient for administrative staff was 0.019 ($p < 0.10$), whereas the negative influence of temporary cluster members was -0.003 ($p < 0.05$). Cluster emergence impacts with an increase of 0.13 index points, if the cluster emerged as a bottom-up-cluster (0.132, $p < 0.05$), or a decrease of 0.13 if the cluster was a top-down internally initiated cluster (0.134, $p < 0.05$) (in reference to the category top-down externally initiated cluster).

Integrating all control and explanatory variables, the full regression model five explained about 35% of variance, which is a moderate but satisfactory amount. The model was significant with $p < 0.001$. Significant effects were those of permanent members (0.001, $p < 0.01$), funding by dedicated services (0.005 $p < 0.05$), and top-down internally initiated cluster emergence (as compared to top-down externally initiated) (-0.159, $p < 0.05$).

As a concluding remark, whereas the results reveal some interesting insights, the validity of the dataset needs to be established with future data collection efforts.

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