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Temporary inter-organisational collaboration as a driver of regional innovation: an evaluation

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Abstract: This paper discusses the results of an ex post evaluation of the Southeast Brabant cluster scheme in the Netherlands. This scheme, which ran from 1994 through 2005, supported new product development of small and medium-sized enterprises and used temporary collaboration between organisations as a means to stimulate product innovation among SMEs and to strengthen the 'industrial tissue' in a region. It is shown that the cluster scheme was very successful with regard to the technological outcomes. However, the economic outcomes were less pronounced. The results of this study are important in several ways. First, it shows that temporary networks are a valuable instrument for regional innovation policy. Second, it stresses that spatial proximity is still a relevant factor in the innovation process. Third, most companies in this cluster scheme have found ways to overcome the drawbacks of temporality.

Keywords: temporary organisation; innovation; product development; regional development; ex post evaluation; cluster analysis.

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1 Introduction

This paper presents and discusses the results of an ex post evaluation of the Dutch Southeast Brabant cluster scheme. This scheme, which ran from 1994 through 2005, supported new product development of small and medium-sized enterprises (SMEs) in the above region, also known as the Eindhoven region. The scheme used temporary collaboration between organisations as a means to stimulate product innovation by SMEs and to strengthen the 'industrial tissue' in a region. In early 2005, an evaluation of the scheme was carried out. Of the 102 clusters, 25 were involved in the evaluation. The paper begins with a theoretical section on temporary inter-organisational collaboration and innovation. It then discusses the framework that was used to evaluate the scheme and information is provided on the region in which the cluster scheme was implemented. Next, the results of the evaluation are presented in three subsections; the outcomes of the product development effort in the various clusters, the process of product development within the clusters and the conditions under which this process took place. Conclusions regarding the effectiveness of the cluster scheme are presented in the final section.

The contributions of this paper are two-fold. According to Tödtling and Trippl (2005, p.1204) 'modern' regional innovation policies consist of a number of elements, which are:

- 1 focus on high-tech, knowledge base sectors
- 2 building on research excellence
- 3 attraction of global companies
- 4 stimulation of spin-off.

In these policies, there is an emphasis on creating and stimulating permanent clusters and networks. This study increases the insight in the effects of a regional innovation policy in which temporary collaboration is used as a policy instrument. Second, ex post evaluations of European Union (EU) regional policy often do not take long-term effects into account and predominantly focus on the socio-economic effects. However, the effects of product development on organisational performance are long-term effects often of a non-economic nature. This study focuses on short and long-term effects and takes non-economic effects (e.g., learning effects) on board.

2 Temporary inter-organisational collaborations and innovation

This paper conceptualises the Eindhoven clusters as temporary organisations. A temporary organisation [Packendorff, (1995), p.327]:

- is an organised (collective) course of action aimed at evoking a non-routine process and/or completing a non-routine product
- has a predetermined point in time or time-related conditional state when the organisation and/or its mission is collectively expected to cease to exist
- has some kind of performance evaluation criteria
- has a level of complexity that it requires conscious organising efforts (i.e., is not spontaneous self-organising).

Further characteristics of temporary organisations are that goals often are more specified, participants are more likely to be included because of task-related competences and the members are often more isolated from their environment.

The literature stresses that the temporary or project-based organisational form is beneficial for innovation (Asheim, 2002; Prencipe and Tell, 2001; Hobday, 2000). The temporary organisation is 'an intrinsically innovative form' because it generates and regenerates new organisational structures related to the demands of each project and customer [Hobday, (2000), p.871]. Moreover, it is able to cope with emerging properties in transformation processes (production and innovation) and react in a flexible way to changing needs. It is also an effective means to integrate different types of knowledge (tacit and codified) and skills and to cope with risks and uncertainties related to complex activities.

Ekstedt et al. (1999, p.192) position the temporary organisation aiming at innovation using two dimensions: the level of routinisation of action and the degree of knowledge renewal. Combining both dimensions results in Figure 1.

The Eindhoven cluster projects qualify as a Project Type IV, as they are organised on a multi-party and multi-disciplinary basis. Innovation is conducted in mixed inter-organisational teams with a diverse range of expertise using combinations of stocks of knowledge in a conscious way as an approach to generate renewal (Lam, 2000).

Another distinct feature of the Eindhoven cluster scheme is that its participants have to be located in the Southeast Brabant Region. That is, temporary collaboration is organised between geographically proximate actors. However, the literature disputes the importance of geographical proximity for innovation in Type IV temporary collaborations. Some scholars (Alderman, 2004) argue that the very nature of such collaborations leads to non-local, thus dispersed, linkages. Due to the low-volume, non-routine tasks that are conducted and the need for specialised knowledge, there is a low probability that suitable partners can be found locally. Put differently, a policy scheme that forces collaboration between local actors runs the risk that lower quality actors are linked. Others, however, argue that organisations involved in production and innovation that depend on tacit-knowledge, face-to-face interaction and trust-based relations tend to be organised in spatially concentrated systems like cluster (Pinch et al., 2003). In the empirical part of the paper we will come back to this issue.

Figure 1 Combining type of action and knowledge process phases

Source: Ekstedt et al. (1999, p.192)

Although temporary collaborations are beneficial for innovation, they have a number of weaknesses [Hobday, (2000), p.871]. They are weak in ‘performing routine tasks, achieving economies of scale, coordinating cross-project resources, facilitating company-wide technical development and promoting organisation-wide learning’. This evaluation pays attention to Hobday’s (2000) last two points, as they are important to knowledge creation.

3 Framework for evaluation

3.1 Regional setting

Southeast Brabant is a small region, even to Dutch standards, yet it ranks among the EU technological top regions. Not only does the region harbour several large research and development (R&D) performing companies, such as Philips and ASML, it also has a technological university, several key private research centres and many SMEs with engineering or even research competences. Today, the gross domestic product (per capita) of the Eindhoven region is at par with that of the Netherlands. This level is well above the EU average but considerably lower than that of Europe’s richest regions.

In the early 1990s, the economic climate in Southeast Brabant was not quite so favourable. Against the background of increased price competition from Eastern Europe and Asia, the manufacturing industry in the region was in sharp decline. Some of the large manufacturing companies, such as Philips and truck manufacturer DAF, laid-off thousands of jobs. Down the supply chain, this led to bankruptcies and further lay-offs among the region’s SMEs. The economic outlook for the region was sufficiently bad for

the EU to give Southeast Brabant the status of Objective 2-region. This allowed substantial funds to be transferred to the region. Objective 2 funding, in particular, supports the promotion of innovation and the strengthening the 'industrial tissue', i.e., linkages between companies and between companies and knowledge centres.

3.2 The cluster scheme

One such policy initiative developed in the Eindhoven region was the cluster scheme (Stimulus, 1999), the object of the present evaluation. The cluster scheme aimed at supporting new product development in SMEs. It has four objectives:

- developing new products in regional SMEs
- strengthening regional SME competitiveness
- strengthening the innovation networks of regional SMEs
- strengthening the regional economy.

A cluster in the sense of the Eindhoven region cluster scheme is a temporary organisation in which several organisations collaborate in order to develop a new product. We will continue to use this definition of clusters. However, we are aware of the fact that 'cluster' is a multi-faced concept that suffers from considerable conceptual ambiguity (Bell, 2005; Cooke and Morgan, 1998). A cluster counted at least one SME, but usually two to three SMEs were involved. Participation of large R&D performing companies and knowledge centres was strongly encouraged. This is to ensure a sufficient flow of technological knowledge to the clusters, as well as to strengthen linkages (the industrial tissue) in the region. Often, but not always, a consultant or engineering bureau was involved to coordinate and manage the clusters activities. On average, it took clusters two years to complete their R&D projects. R&D is expensive and risky, particularly for SMEs; therefore, the EU funded part of the project costs; up to a maximum of 50% but usually less. In principle, any group of companies from the region that wished to perform R&D was eligible under the cluster scheme. However, the program office that coordinated the implementation of the Objective 2-program for Southeast Brabant assessed all applications. Promising proposals were usually accepted provided sufficient funding was available. The program office (named Stimulus) was located in Eindhoven and staffed entirely by people from the region. There was no direct involvement from the EU in Stimulus.

3.3 Developing evaluation criteria

The evaluation of the cluster scheme was aimed at assessing the long-term effects of temporary inter-organisational collaboration. Typically, ex post evaluations of EU regional policy are carried out immediately on completion of the policy program, which does not allow long-term effects to materialise, as this takes more time (Baslé, 2006). The effects of product development on company performance and competences, however, are long-term effects. Evaluating the cluster scheme on these effects is relevant for two reasons. It provides a more complete view of the effectiveness of this policy effort, which may aid regional policy-makers. Second, this is one of the few longitudinal studies on R&D collaboration between companies (Cooke and Morgan, 1998; Grabher, 2002).

Though the data that were gathered in this research project can be used for many things, empirical testing of hypotheses among them, this paper is an evaluation study and, therefore, of a descriptive nature.

The literature on R&D collaboration in temporary networks is extensive, diverse and partially contradictory (Grabher, 2002; Powell, 1998; Sydow et al., 2004). Theoretically, this study chose to keep an open mind to the theoretical diversity that characterises the field. This is possible as comparable concepts appear in different theories. Of course, different theories assume different (causal) relations between the same concepts. But evaluations are assessments based on sets of criteria, they do not study causality. Consequently, this study need not concern itself with the causal relations between variables, except on a high level of abstraction. The key assumption underlying this evaluation study is that R&D collaboration consists of several processes, e.g., knowledge creation, communication and management (Burns and Stalker, 1961; Nonaka and Takeuchi, 1995; Hobday, 2000). These processes, which make up the actual collaboration effort, create individual and collective outcomes. The processes are represented by the process variables in this study. The outcomes can be broken down in economic effects (e.g., firm competitiveness), technological effects (e.g., technological capabilities) and learning effects (e.g., establishing permanent collaboration networks or the implementation of organisational changes) (Rooks and Oerlemans, 2005). The different examples of outcomes are the outcome variables of this study. The assumption is that the more the processes meet certain criteria, the higher the outcomes will be. For example, if the process of knowledge creation functions smoothly, a company is more likely to have developed new technological competences. However, on this level, no causal relations are assumed between the individual variables. It suffices to give definitions and measurements of the variables and specify matching criteria. For example, the variable communication can be measured as the frequency of communication between cluster partners and as the intensity of the communication. For both operationalisations, the criterion is that it should be 'high'. The assumption is that more communication contributes to better outcomes in terms of economic and technological effects.

In addition to 'processes' and 'outcomes', the evaluation framework has a third category of variables, i.e., 'conditions'. This pertains to the characteristics of the organisations participating in the clusters and to the characteristics of the clusters themselves. The assumption is that the conditions impact on how processes unfold. For example, in a cluster that is dominated by a large MNE, communication and management of the cluster is likely to function differently than in a cluster where a dominant MNE is lacking (Larson, 1992). It is important to note that this evaluation only distinguishes between small and large companies, where a small company is considered to employ no more than 50 full time equivalents.

As a detailed theoretical discussion of the framework would be too elaborate for this paper, it is simply presented in Table 1. The method used to develop the framework for evaluation was simple but laborious. After deciding that the key variables be 'conditions', 'process' and 'outcomes', a literature survey was conducted in order to determine what different authors based on different literatures had said about them. For example, 'trust' was identified as an important variable pertaining to the process. In general, the literature argued that the process unfolds better when more trust is present. However, trust can be approached from several perspectives. The transaction cost economics approach, for example, refers to trust as the absence of opportunistic behaviour (Williamson, 1993). In the embeddedness perspective, however, trust refers to the fact that actors may be

mutually dependent on one another (Uzzi, 1997). Both perspectives were included in the framework (see Table 1). On the basis of more than 120 journal articles, books and book chapters, the framework for evaluation was developed (see for the complete overview: Azouz et al., 2005).

Table 1 Framework for evaluation

<i>Variables</i>	<i>Indicators</i>	<i>Criterion</i>
<i>Conditions</i>		
Previous experience with collaboration	Previous experience	Favourable
Motives for collaboration	Kinds of motives	Not purely opportunistic
Composition of the cluster	Supplementary of knowledge bases	Yes
Composition of the cluster	Size of the partners	Mixture of large and small
<i>Process</i>		
Use of external knowledge by companies	Access to knowledge base of partners	High
Use of external knowledge by companies	Absorptive capacity of companies	High
Intensity of communication in cluster	Frequency of communication	High
Structure of communication	Formal and informal communication	Mixture
Management of the cluster	Perceived balance of power	Equal
Management of the cluster	Social and formal control mechanisms	Mixture
Trust	Mutual dependency between partners	High
Trust	Opportunistic behaviour	Low
<i>Outcomes</i>		
Economic effect	Introduction of new product	Yes
Economic effect	Change of competitiveness	Increase
Technological effect	Change of knowledge intensity	Increase
Technological effect	Change of competences	Improved competences
Learning effect	Permanent networks with cluster partners	Yes
Learning effect	More external collaboration with non-cluster partners	Yes
Learning effect	Implementation of organisational changes	Yes

This evaluation is both a process and an outcome evaluation as the focus is on 'outcomes', 'conditions' and 'processes'. A process evaluation assesses to what extent a process (R&D collaboration) meets certain criteria that are derived from theory. This means that the more the clusters meet these criteria, the better the performance of the

clusters will be. The outcome evaluation is primarily used to determine the effectiveness of the cluster scheme. Did it achieve what it intended to do in terms of economic and technological outcomes?

In order to keep the length of this paper within acceptable margins, only the key variables of the evaluation framework are discussed (see Table 1). All variables were measured on the level of individual companies. However, this paper presents an evaluation of the cluster scheme. That is, the level of analysis in this paper is that of the cluster scheme, not that of the individual companies or clusters that participated in the scheme.

4 Data collection

Of the 102 clusters, 25 were selected for this evaluation study. The cluster scheme ran from 1994 through 2005 but was divided in three sub periods: 1994–1996, 1997–1999 and 2000–2005. This corresponds to the three consecutive European regional development programs in the Eindhoven region. Only minor changes were implemented in the cluster scheme during this period. Nevertheless, in order to obtain a representative sample, 25% of the clusters that were started in each period were selected (see Table 2).

Table 2 Sampling by period

	<i>1994–1996</i>	<i>1997–1999</i>	<i>2000–2005</i>	<i>Total</i>
Number of clusters	20	32	50	102
Of which completed	19	29	17	65
Cluster in sample	5	8	12	25
% of clusters in sample	25%	25%	24%	25%

Clusters were further selected on the basis of their financial volume. The distribution of the clusters in the sample accounted for the different financial volumes of the clusters in the population (see Table 3). In other words, our sample of 25 clusters is representative of the population of 102 clusters with regard to the three periods of the Eindhoven regional development program and the financial volume of the projects. The vast majority of the companies in the clusters came from the metal, electronics and information technology sectors, but this was not a selection criterion in our evaluation study.

Table 3 Sampling by financial volume of cluster projects

	<i>< 250 K€</i>	<i>250–500 K€</i>	<i>> 500K€</i>	<i>Total</i>
Number of completed clusters	42	18	5	65
Of which in sample	18	5	2	25
Completed clusters 1994–1996	14	5	–	19
Of which in sample	4	1	–	5
Completed clusters 1997–1999	15	11	3	29
Of which in sample	4	3	1	8
Completed clusters 2000–2005	13	2	2	17
Of which in sample	10	1	1	12

The data were collected in early 2005. For every cluster, at least two companies were interviewed. The interviews were conducted on the basis of a structured questionnaire, with most questions asked in the form of a 5-point Likert scale. Respondents had the opportunity to comment on the position they marked on each scale. General information on the clusters was retrieved from the files at the program office (i.e., Stimulus).

5 The conditions

5.1 Previous experiences with collaboration

The first condition is the previous experience with collaboration of the companies involved. The assumption is that previous positive experiences are a good preparation of and a good basis for successful collaboration in the present clusters (Klein Woolthuis et al., 2004; Gulati, 1995). In general, the previous experiences of the companies involved in the clusters in this study did have favourable experiences. For nearly 70% of the companies, the degree in which previous experiences with collaboration was positive was high to very high (see Figure 2).

5.2 Composition of the cluster

With regard to the composition of the clusters, companies found that their knowledge bases were largely supplementary. According to 84% of the companies, this was the case to a high or very high degree (see Figure 2). A supplementary knowledge base means that the companies are not competitors and, more importantly, that they can learn something from their partners, as the partners possess knowledge that they themselves do not have. According to innovation theory (Nooteboom et al., 2007; Freel, 2003), this is important.

Figure 2 Conditions

The distribution of the size of the companies in the clusters shows a mixed view. In 11 out of the 25 clusters in the sample, a mixture of small and large companies were involved. A further 11 clusters had only small companies, the remaining three clusters had only large companies.

5.3 *Motives for collaboration*

As to the motives of the companies to engage in the collaboration effort, it turned out that ‘individualistic’ motives played a minor role. Less than 10% of the companies had ‘sharing risks’ as their primary motive to collaborate on product development, ‘sharing costs’ was the primary motive for less than 5% of the companies. These two motives can be called ‘individualistic’ because they indicate that the companies that hold them are interested in benefits for themselves first. Many more companies had ‘collectivistic’ motives as their primary motive to collaborate on product development. More than 37% pointed at the ‘opportunity to innovate’, nearly a third of the companies had ‘access to external knowledge’ as primary motive and 14% mentioned ‘specialisation in knowledge and skills’ as primary motive (see Figure 3). These motives are ‘collectivistic’ as they signal that companies are thinking in terms of relationships and collaboration. Even allowing for the fact that the split between ‘individualistic’ and ‘collectivistic’ motives is, to some extent, arbitrary, the data allow the conclusion that the companies that participated in the clusters did not entertain purely self-centred motives because the difference between the two categories is very pronounced.

Figure 3 Primary motives for collaboration

6 The processes

6.1 Accessing and using external knowledge

In order to develop a new product in a cluster, companies have to share the knowledge that each has with their cluster partners. That is, cluster partners need to have access to each other's knowledge bases (Owen-Smith and Powell, 2004). In the case of the Stimulus clusters, this condition was met. In 15 out of the 25 clusters in this evaluation, the level of access to the knowledge base of the partners was very high or high (see Figure 4). Furthermore, it is important to know to what extent companies are able to actually use the knowledge received from their partners. That is, the absorptive capacity of the clusters must have been high in order for them to actually develop new products. This situation, too, was met, as 20 of the 25 clusters reported that their absorptive capacity (Cohen and Levinthal, 1989) was high or very high (see Figure 4).

6.2 Communication: formal or informal

An indicator that tells something about the quality of the communication in the clusters is the degree in which a mixture of formal and informal means of communication was used. Although a certain amount of formal communication is necessary and even helpful, as for example, progress has to be reported formally to superiors, applications for releasing funds have to be submitted formally and (dis)agreements between companies have to go through formal channels, too much emphasis on formal mechanisms of communication indicates a lack of openness and trust within the cluster (Burns and Stalker, 1961; Butler et al., 1998). Moreover, formal channels of communication are not ideal for transmitting tacit knowledge, which is a crucial element in product development (Owen-Smith and Powell, 2004; Nonaka and Takeuchi, 1995).

Figure 4 Process characteristics

A mixture of formal and informal mechanisms of communication, thus, is necessary. The Stimulus clusters met this condition, as nine clusters reported that the degree in which communication followed formal lines was neither high nor low. This suggests that these clusters had a balance between formal and informal means of communication. In the remaining 16 clusters, the degree in which communication followed formal lines was low or very low, which suggest that informal means of communication was most important in these clusters. Taken together, this means that a mixture was used of formal and informal means of communication, with tendency towards the latter, in the Stimulus clusters (see Figure 4).

6.3 Communication: intensity, modes used and spatial proximity

Another communication process indicator is the intensity of the communication between the cluster partners. It should be high, as only through intensive communication can the kind of (tacit) knowledge be exchanged that is necessary for new product development. Furthermore, a variety of modes of communication should be employed; communication should not only depend on electronic forms of communication but also on face-to-face communication. Electronic means of communication provide speed; face-to-face communication provides richness of communication (Johannessen et al., 2001; Nonaka and Takeuchi, 1995). Of course, it is arbitrary to say what is frequent and what is infrequent communication. The respondents in this evaluation had a choice between six different categories to rank the intensity of their communication: daily, weekly, every other week, monthly, less than monthly and never. In this paper, the first three categories are considered examples of frequent communication. Taking also the different modes of communication into account, the following picture emerges.

Figure 5 Modes of communication in implementation phase

Of the 25 clusters, 16 used e-mail frequently as a mode of communication. The telephone was used frequently in 23 clusters, the fax in only 13 clusters. Considering that people had to travel in order to communicate face-to-face, the fact that 20 clusters frequently used this mode of communication is testimony of its importance as a facilitator of knowledge transfer and creation. Group meetings were used frequently in only 12 clusters, which is not surprising given that group meetings require prior organisation (see Figure 5). In summary, the data seem to allow the conclusion that communication within the clusters was, indeed, frequent and that, on the level of the cluster scheme, this condition was met.

In relation to communication, it is relevant to consider the role of spatial proximity. Overwhelmingly respondents argued that spatial proximity was helpful but not necessary. Over 80% of the companies stated their knowledge exchange benefited from spatial proximity but only 27% thought that spatial proximity was necessary. So spatial proximity seems to facilitate face-to-face communication necessary for knowledge exchange, but it seems not to be a necessary condition.

6.4 Management of the cluster: balance of power and control

The next indicator to be discussed here is the balance of power between participants in the clusters. The assumption is that power should be distributed more or less equally among the cluster partners in order to avoid a hierarchical mode of managing the cluster. According to the literature, this is unfavourable for the process of communication and, therefore, knowledge creation in a cluster (Rutten, 2003; Johannessen et al., 1997; Uzzi, 1997).

The balance of power in the 25 clusters shows a mixed view. Six of them reported a low balance of power. A further nine reported a neither-high-nor-low balance of power. The remaining ten reported the balance of power as high or very high. So, on the level of the clusters, the degree in which power was balanced equally was only moderate with a tendency towards high, that is, towards an equal distribution of power.

Another indicator that has to do with the management of the clusters is the use of formal and informal control mechanisms. Parallel to the use of formal and informal means of communication, a mixture of formal and informal control mechanisms should be used to manage a cluster (Davila, 2005). One of the key reasons for this is that professionals, such as the engineers collaborating on product development in the clusters, are managed and motivated best through informal control mechanisms. On the other hand, formal control mechanisms are necessary to give structure to the clusters (Burns and Stalker, 1961; Butler et al., 1998; Johannessen et al., 1997). The evaluation shows that the use of control mechanisms meets the criterion that a mixture of formal and informal mechanisms is necessary. Only two of the clusters used more formal than informal control mechanisms. In 13 clusters, as many formal as informal control mechanisms were used. The remaining ten clusters used more informal than formal control mechanisms. On the level of the cluster scheme, this means that a mixture of formal and informal control mechanisms was used, with a tendency towards more use of informal control mechanisms.

6.5 *Dependency and opportunistic behaviour*

With regard to collaboration in clusters, it is necessary to look at the trust between partners. In this paper, trust is viewed somewhat narrowly in terms of the absence of risk and the absence of opportunistic behaviour. Trust, of course, involves much more than that (Klein Woolthuis et al., 2005). When mutual dependency between partners is high, this is a strong incentive not to behave opportunistically and to assume an open and honest attitude towards ones partners (Uzzi, 1997). Only in that way, it is possible to achieve a constructive and fruitful mode of collaboration, which, in turn, is the best guarantee for a result in terms of new product development.

Of the 25 clusters in the evaluation, 19 indicated that the mutual dependence between the cluster partners was high or very high. This indicates that, on the level of the cluster program, this mutual-dependency-criterion was met (see Figure 4). When looking at actual opportunistic behaviour in the clusters, the evaluation showed that in five clusters the degree of opportunistic behaviour was high. In a further 13 clusters, the degree of opportunistic behaviour was neither high nor low. In the seven remaining clusters, the degree of opportunistic behaviour was low or very low. This means that, on the level of the cluster scheme, the degree of opportunistic behaviour in the clusters was moderate, whereas, according to the evaluation framework, it should have been low (see Figure 4).

7 **Outcomes**

The outcomes give an indication as to how successful the clusters were in achieving their goals. First, the purpose of the cluster scheme was to have clusters of companies develop new products and sell them on the market. The second goal, which directly followed from the first one, was that companies improve their performance on the basis of the new products. The third goal was to raise companies' awareness that implementing organisational changes in their way of working may further their performance.

7.1 *Economic effects*

With regard to the immediate effects of the cluster scheme, 16 clusters reported that they had successfully developed a new product and introduced it on the market. This equals nearly two-thirds of all clusters in this evaluation. Only two clusters did not successfully conclude their project. In the case of the remaining clusters, conflicting answers from various clusters partners denied drawing proper conclusions (see Table 4.)

Another important effect of the cluster scheme was the change in company competitiveness. Eight clusters reported that the competitiveness of the companies in these clusters had increased to a very high degree and a further 12 clusters reported an increase to a high degree. The remaining clusters reported that the increase in competitiveness was neither high nor low (see Figure 6).

Table 4 Selected outcomes of cluster projects

	<i>New product introduced on market</i>	<i>Permanent collaboration with cluster partners</i>	<i>Permanent collaboration with non-cluster partners</i>	<i>Implementation of organisational changes as result of cluster project</i>
<i>(Unit of observation)</i>	<i>(Clusters)</i>	<i>(Companies)</i>	<i>(Companies)</i>	<i>(Companies)</i>
Yes	16	50	42	26
No	2	13	20	37
No answer	6	2	0	0
N valid	24	65	62	63

Figure 6 Competitiveness and competences

With regard to company competences, the cluster scheme aimed at improving them as a result of the collaboration in the cluster. For example, companies should become more skilled in the process of collaborating and in the process of developing new products. The results per cluster show that the cluster scheme was helpful in this respect, though not to the degree as in the case of competitiveness. Still, the majority of the clusters, 16, reported that the competences of the companies in these clusters improved to a high degree. A further eight clusters reported that the improvement of competences was neither high nor low. Only one clusters reported a low increase of competences (see Figure 6).

7.2 Technological effects

Working on product development in the clusters may trigger awareness on the part of companies that sustained investment in knowledge creation is necessary in order to

develop new products in the future as well. An indicator for this awareness is the change in a company's investments in R&D after the temporary collaboration ended. These investments should increase in case companies have become more aware of the need to continuously develop new products. However, looking at the various clusters in this evaluation, no such general awareness seems to have materialised. One year after completion of the project, ten of the clusters reported that the companies participating in them had increased their R&D spending, while nine reported a decrease. In two clusters, no change in R&D spending was observed after one year. On the longer term, after four years, the same pattern can be observed, although the number of reporting clusters is lower as not all clusters had ended four or more years ago. After four years, six clusters reported an increase in R&D spending, five clusters reported a decrease and one cluster reported no change in R&D spending (see Table 5). Consequently, on the level of the cluster program, that is, looking at the average for all clusters, a change in R&D spending cannot be observed. On the whole, the cluster scheme did not contribute to an increase of sustained attention for product development.

Table 5 Change in R&D investments

<i>Change in R&D investment per cluster*</i>	<i>After one year</i>	<i>After two years</i>	<i>After three years</i>	<i>After four years</i>
Increase	10	10	8	6
No change	2	2	1	1
Decrease	9	3	4	5
N valid	21	15	13	12

Note: *Average for all companies in a cluster.

7.3 *Learning effects*

Organisational learning is considered a weakness of temporary collaboration since learning may not materialise in organisations after the collaboration ends (Grabher, 2002). This evaluation looked at several learning effects and organisational changes. One learning effect is the establishment of permanent networks with cluster partners. Establishing more permanent inter-firm relations with its clusters partners signals an organisational change and provides a company with better 'vehicles' for the exchange of tacit knowledge (Uzzi, 1997). Of the 65 companies that reported on this issue, 50 said that they did establish permanent relationships with one or more of their cluster partners, whereas 13 said that they did not establish such links (see Table 4).

Similarly, establishing permanent relationships with non-cluster partners signals an increased awareness of the need for inter-firm collaboration to such a degree that they started looking for partners in a wider field. Of the 62 companies that reported on this issue, 42 confirmed establishing permanent collaborations with non-cluster partners; whereas 20 reported that they did not do that (see Table 4). This means that the cluster scheme did contribute to establishing more durable inter-firm linkages.

A final learning effect concerns the implementation of organisational changes by the participating companies. This indicates that companies reflected on their ways of working as a result of what they learned in the cluster and acted upon it. This proved to be the case among a minority of the companies only. Of the 63 companies that reported on this issue,

26 said that they had implemented organisational changes, whereas, 37 said they had not (see Table 4).

8 Looking for systematic patterns: a multivariate cluster analysis

In the previous sections, a descriptive approach was used to report on the results of the ex post evaluation. In this section, we want to find out whether (un)successful clusters share common features. In order to arrive at this conclusion, a multivariate cluster analysis (k-means clustering) was conducted in which most of the variables discussed in the above were included.

To be able to use cluster analysis, it was necessary to recode some of the variables. The two most important changes are briefly discussed below. Firstly, the outcome variables (see Table 1) have different levels of measurement (nominal and ordinal), which is problematic as ordinary cluster analysis cannot deal with this. To solve this problem, all outcome variable were dummy-coded, each indicating whether or not a specific outcomes was reached. Next, a new variable ('range of outcomes') was computed by adding up all scores. The variable indicates the number of different outcomes (economic, technological and learning) obtained by a cluster with higher scores signalling a broader range of outcomes. Secondly, several items were used to describe the frequency in which different modes of communication were used (see Figure 5). In order to keep a proper balance between the number of cases and variables used in the cluster analysis, a new variable was created by computing an average sum score of the items involved. This new variable describes the intensity of communication within product innovation clusters (PICs). The k-means cluster analysis resulted in three clusters, which are presented in Table 6.

Some interesting results emerged from the analysis. Two clusters consist of PICs with a comparatively high range of outcomes [Clusters 1 (10% of the cases) and 2 (45% of cases)] and one with lower levels (Cluster 3). On the basis of this result, two comparisons will be presented below: one comparing the clusters with high outcome scores with Cluster 3 (low score) and one comparing the two clusters with high scores.

As compared to Clusters 1 and 2, the PICs in Cluster 3 regard sharing costs as the most important motive to engage in the collaborative effort. Moreover, the Cluster 3 PICs were less able to get access to the knowledge of partners and also less able to utilise this externally acquired knowledge. Lastly, in Cluster 3 intra-project communication between partners tends to be primarily informal.

The main differences between the two most successful clusters are:

- Cluster 2 has a lower number of project partners
- Cluster 1 consist of PICs of which the members had negative experiences with collaboration in the past
- as far as motives for collaborations are concerned, the PICs in Cluster 1 put less emphasis on the motives 'opportunities to innovate' and 'specialise in knowledge and skills'
- the PICs in Cluster 1 were less able to utilise externally acquired knowledge (lower absorptive capacity) and had a relatively high communication intensity.

Table 6 Results of cluster analysis

<i>Item</i>	<i>Clusters and cluster centres</i>		
	<i>1 (10%)</i>	<i>2 (45%)</i>	<i>3 (45%)</i>
<i>Number of risk taking partners</i>	4	3	3
<i>Project duration</i>	3	3	3
<i>Previous experience</i>	5	2	2
<i>Motive: sharing risks</i>	0	1	1
<i>Motive: sharing costs</i>	2	2	1
<i>Motive: opportunity to innovate</i>	2	1	1
<i>Motive: access to external knowledge</i>	1	1	1
<i>Motive: specialise in knowledge and skills</i>	2	1	1
<i>Access to knowledge base partners</i>	2	2	3
<i>Absorptive capacity of companies</i>	4	2	3
<i>Formal and informal communication</i>	4	4	3
<i>Perceived balance of power</i>	3	3	3
<i>Opportunistic behaviour</i>	4	3	3
<i>Social and formal control mechanisms</i>	2	3	2
<i>Mutual dependency</i>	2	2	2
<i>Intensity of communication</i>	2.44	3.27	3.10
<i>Outcome range</i>	5.13	5.92	3.24

Note: Italics = statistically significant ($p < 0.10$) differences between clusters.

9 Limitations

This study has several weaknesses. In the first place, the sample of 25 clusters is small and limited to one region only. Although this does probably not affect the evaluation of the cluster scheme as such, since our sample is representative of the cluster scheme as a whole, it does compromise our ability to draw conclusions beyond this particular cluster scheme. In other words, the external validity of this study is low. Secondly, for a number of clusters, the time between the end of the cluster and the evaluation was too short for economic effects to materialise. Third, since it was our goal to evaluate the cluster scheme, we have by necessity, focused on the broad picture. Therefore, many relevant detail findings have been obscured. To explore the wealth of details that our evaluation yielded would require further analyses in the form of surveys and case studies that focus on narrower research questions.

10 Conclusions and discussions

This section presents the actual evaluation of the cluster scheme. That is, it assesses to what extent the empirical observations for each of the indicators from Table 1 meets the criteria that was set for that particular indicator. Both an outcome and a process

evaluation will be presented below. A summary of the results of the above descriptive empirical is presented in Table 7.

Table 7 Results of the evaluation

<i>Indicator</i>	<i>Criterion</i>	<i>Observation</i>
Conditions		
• Previous experience	Favourable	Favourable
• Kinds of motives	Not purely individualistic	Not purely individualistic
• Supplementary knowledge base	Yes	Yes
• Size of partners	Mixture of large and small	Only some clusters mixed
Process		
• Access to knowledge base partners	High	High
• Absorptive capacity of companies	High	High
• Frequency of communication	High	High
• Formal and informal communication	Mixture	Mixture, tends to informal
• Perceived balance of power	Equal	Mixture, tends to equal
• Social and formal control mechanisms	Mixture	Mixture, tends to social
• Mutual dependency between partner	High	High
• Opportunistic behaviour	Low	Moderate
Outcomes		
• Introduction of new product	Yes	Yes
• Change of competitiveness	Increase	Increase
• Change of knowledge intensity	Increase	No change
• Change of competences	Improved competences	Improved competences
• Permanent networks, cluster partners	Yes	Yes
• Permanent networks, non-cluster partners	Yes	Yes
• Implementation of organisational changes	Yes	No

The outcome evaluation looks at the degree in which the results of the cluster scheme correspond to its aims. In Table 7, the aims are summarised in the column marked 'criterion', whereas, the results are in the column 'observations'. The bottom rows of Table 7 concerns the outcome variables. A comparison between the criteria and observations learns that, with the exception of two indicators, the cluster scheme achieved its objectives. This means that the cluster scheme must be considered a success. As the above descriptive empirical part showed, not all clusters and companies in the cluster scheme shared in the scheme's success to an equal degree. However, on nearly every indicator a clear majority of clusters or companies reported favourable results. That, in turn, allows the conclusion that the cluster scheme was a success. The cluster scheme achieved its policy objectives of strengthening the performance of the

participating companies and the economy of the Eindhoven region and thus, may be seen as a good practice example of regional innovation policy. Additionally, it shows that spatial proximity still is an important factor in these kinds of clusters that require intensive and frequent communication between partners.

It is interesting to note that the cluster scheme was very successful with regard to the technological outcomes in that companies did develop new products and acquired new knowledge and skills. However, the economic outcomes were less pronounced. This may have been caused by the fact that the time between the end of some clusters and the evaluation was too short for these effects to materialise. However there is another possibility. As each cluster had to be approved by Stimulus, it is conceivable that clusters of already innovative companies had a higher chance of getting approved. If this is the case, innovative companies would be overrepresented in our sample, i.e., our sample would be biased. That would explain why the results on some outcome indicators were only moderate, as it is difficult to increase a performance that is high already. Whether our sample was indeed biased and how this may have affected the outcomes of our study is a question for further research. This sample bias need not be a problem, though, since the question is not so much 'if' the cluster scheme facilitates innovation but 'how' it does so. As one is not very likely to observe such mechanisms from non-innovative companies, having many innovative companies in one's sample may actually be an advantage.

The second evaluation, the process evaluation, shows a similar result. On all but a few indicators, the cluster scheme met the conditions that were set in the framework for evaluation. This result gives a certain degree of empirical support for the conclusion that the causal relations between 'conditions', 'process' and 'outcomes', as assumed in at the beginning of this paper, were correct.

These descriptive findings were further specified by the results of a multivariate cluster analysis. Three groups of PICs were found: two with high outcome scores and one with low scores. Several conclusions can be derived from this analysis. Firstly, one could look at the extent in which the most successful cluster (in terms of its range of outcomes) meets the pre-defined evaluation criteria. Table 8 presents an overview.

From this comparison, it can be concluded that overall, the PICs in the most successful cluster met most of the evaluation criteria. Interestingly and deviating from the criteria, the PICs in this cluster put more emphasis on non-individualistic (thus, more collectivistic) motives to join inter-organisational collaborations. Moreover, knowledge circulation between project members and the parent organisations and use of this externally acquired knowledge in the PICs is structured by the use of more formal communication channels and of social control mechanisms. These characteristics closely resemble an approach to collaboration to what Miles et al. (2005) call collaborative entrepreneurship, that is, inter-organisational networks that generate wealth-creating innovations in which procedures (social control) and self-organisation are the most important ingredients.

The most eye-catching differences between the most and least successful clusters pertain to items related to the knowledge creation process and communication. The PICs in the least successful cluster were less able to access the knowledge base of the partners and to utilise externally acquired knowledge. Moreover, communication within these PICs is less formalised. One possible explanation of these findings is that less successful PICs lack the capabilities to manage the inter-organisational innovation process, as they are less able to secure access and utilisation of knowledge. Another explanation might be

that the less successful PICs are confronted with one of the downsides of temporary organisations.

Table 8 Results of the evaluation for the most successful cluster

<i>Indicator</i>	<i>Criterion</i>	<i>Most successful cluster</i>
Conditions		
• Previous experience	Favourable	Favourable
• Kinds of motives	Not purely individualistic	Primarily not individualistic
Process		
• Access to knowledge base partners	High	High
• Absorptive capacity of companies	High	High
• Frequency of communication	High	Moderate/high
• Formal and informal communication	Mixture	Mixture, tends to formal
• Perceived balance of power	Equal	Mixture, tends to equal
• Social and formal control mechanisms	Mixture	Mixture, tends to social
• Mutual dependency between partner	High	High
• Opportunistic behaviour	Low	Moderate
Outcomes		
• Introduction of new product	Yes	
• Change of competitiveness	Increase	
• Change of knowledge intensity	Increase	Highest
• Change of competences	Improved competences	Outcome range
• Permanent networks, cluster partners	Yes	(5.92)
• Permanent networks, non-cluster partners	Yes	
• Implementation of organisational changes	Yes	

Lundin and Söderholm (1995, p.446) argue that in order to conduct its activities effectively, the temporary organisation, to some extent, has to decouple its activities from its general surroundings. If this decoupling is too strong, the temporary organisation becomes an isolated island and external signals do not guide its behaviour anymore. The lack of linkage providing access to partners' knowledge and the relative lack of structure in the communication processes might be taken as indications for this isolation. In other words, less successful PICs are too isolated PICs.

On the basis of the literature, the assumption was made that:

- The outcomes are the result of a process of inter-firm knowledge creation. That is, if the process of inter-firm knowledge creation has certain characteristics, as laid down in the criteria, the outcomes of this process should be more favourable.

- The process of inter-firm knowledge creation takes place under certain organisational conditions. The more these conditions meet the criteria as derived from theory, the more productive the process of inter-firm knowledge creation should be.

As it turns out, these theoretical patterns are also observed in the empirical results of this evaluation study. The cluster scheme shows that temporary inter-organisational collaboration can be a driver of regional innovation. The technological outcomes of the cluster scheme were favourable, which indicates that temporary networks may be an important boost for technological innovation in regions. Although this study concerns the level of the cluster scheme, not the participating companies, one may cautiously conclude that some of the drawbacks of temporary collaboration, i.e., company level learning, were not found in this study. The economic and learning outcomes were also favourable and, whereas the technological outcomes were the direct result of network collaboration, the economic and learning outcomes are company level outcomes.

In summary, in spite of its obvious limitations, the results of this study are important in several ways. First, it shows that temporary networks are a valuable instrument for regional innovation policy. Second, it stresses that spatial proximity is still a relevant factor in the innovation process. Third, the companies in this cluster scheme have found ways to overcome the drawbacks of temporality. Part of the explanation for this may lie in the fact that these companies were already innovative companies and experienced in collaboration. This suggests that further research into relation between innovation and different organisational forms seems very relevant.

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