Organising R&D in a global environment,

Increasing dispersed co-operation versus continuos centralisation.

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Abstract

Theories on R&D organisation draw on globalisation literature as well as on communication theories. This mixed discourse is a problem, since mixing levels of logic sometimes cause faulty conclusions. How is this double logic handled in organisations, and what is the effect on R&D organisation? This study investigates R&D activities in multinational companies with several production sites and markets, focusing what reasons and forces are mentioned in relation to the geographical structure of the R&D activities. We assume that there are opposing forces, both dispersing and contracting the R&D activities geographically. The purpose of the paper is to investigate perceived geographically dispersing and contracting forces on R&D activities, and how a possible conflict between these is handled. This is done by studying how the level of dispersion has come to be, what events or decision has caused the dispersion of R&D. We show that trends in R&D dispersion are active in two directions, one dispersing and one contracting, and that these are partly working at separate organisational levels. The dispersing forces are more prevalent at strategic levels, while the contracting forces are more pronounced at the operational level.

Background

In multinational companies, the use of dispersed constellations in R&D activities is seen to increase [1]. The rationales behind this may differ, and in many cases the ideal situation is not a dispersed development team. This dispersion of teams leads to increase challenges, due to communication and integration issues, and a co-location of development efforts is often seen as more advantageous when possible [2, 3]. Multinational corporations have traditionally operated with a centralized R&D structure. It has lately been argued that to achieve competitive advantage companies must continuously create, transfer, and exploit knowledge that is increasingly dispersed throughout their global operations [4, 5]. It has been claimed that the traditional centralized R&D structure that was seen in the post-war years is gradually being eclipsed by the emergence of global R&D networks [6]. Two reasons used to justify this change are that the number of knowledge sources is increasing and it is necessary to utilise the best to stay competitive [7, 8] and that the need to adapt to local needs calls for local presence. In addition, these multiple sites encourage the development of more ideas due to the varied international backgrounds in global networks.

The use of virtual teams poses significant challenges for organizations wishing to deploy them. In recent studies on dispersed teams it is observed that global teams has lower performance than co-located teams [1]. Although many of these challenges are present in traditional teams, they may become even more pronounced in virtual settings [9].

The observed dispersion of activities is counteracted by other trends. There is a continuous process of rationalisation and streamlining of activities in large companies. This process leads to a concentration of activities to centres of excellence, or core centres for various activities within the company. The same process is active between companies and within whole sectors of industry, where core competence is concentrated. In R&D the virtues of physical proximity is well established. Creative activities such as product development require informal interaction to resolve ambiguities [2, 10]. The relationship between professional communication and physical closeness in an R&D setting by has been studied Allen [2]. Communication is found to be greater within organisational units than between units [2]. A physical distance of less than 30 meters is highly influential on communication. When people are more than a few rooms apart, communication decreases drastically. The findings are used to argue that separation in a group should be minimised, preferably by a circular layout. The advantage of integration-promoting facilities is also discussed, such as copiers, coffee machines and water coolers [2]. The highlighting of these contact-points shows the importance of non-controlled and non-planned communication. Keller has investigated predictors of successful R&D projects [11], and finds that group coherence is the most important factor in a successful project. This presents us with contradicting forces on R&D location that we wish to address in this study.

Purpose of this study

The present study investigate how R&D activities are organised in multinational companies with several production sites and markets. Based on the theories above, there are apparently conflicting forces, and we wish to study how there act and how they are handled. Our focus is on the justifications given by the companies for the present geographical organisation of their R&D activities. We study what reasons and forces are mentioned in relation to the geographical structure of the R&D activities, assuming that there are opposing forces, both dispersing and contracting the R&D activities geographically.

The purpose of this study is to investigate geographically dispersing and contracting forces on R&D activities.

This is visualised in figure 1.

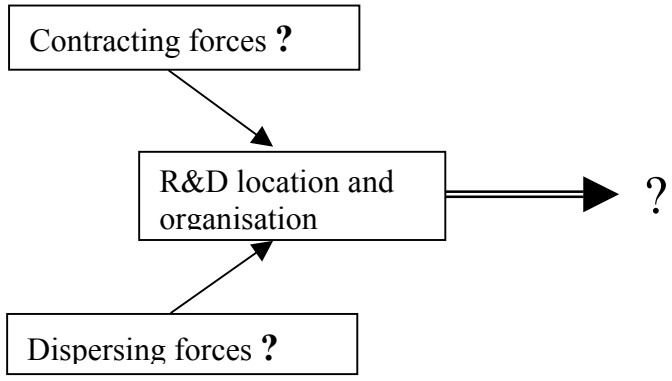

Figure 1: Research area

This study takes an exploratory approach to investigate the logic behind the location of R&D units. As a first step we need to know to what degree the companies R&D activities can be described as geographically dispersed. To do this we define four levels of geographically dispersed cooperation. Following this we study how the level of dispersion has come to be, what events or decision has caused the dispersion of R&D. The logic given by the studied companies for their R&D organisation, and arguments for location of R&D units are investigated. We then seek to identify how dispersing and contracting forces are handled in the R&D organisation.

Previous studies

The dispersion of R&D activities is studied in several ways. One tradition looks at the team, and the geographical dispersion or proximity of the actual team [2, 12-14]. This

tradition concludes that proximity within the team is central for a successful R&D process. Network theorists study log term relationships between companies, strategic relationships and long-term supplier cooperation [15-17]. This is based in marketing and transaction cost logic [18]. A related field focus on networks of organisations and short-term relationships. This is sometimes labelled virtual teams or virtual organisations [19-21], and focus is put on geographical distance and networks of organisations. The introductory discussion on globalisation of R&D uses arguments from several of these fields, but does not always admit the potential conflict of logic when mixing these lines of argument. A specific case is when strategic globalisation arguments are applied on the organising of R&D operations. This will be looked into when analysing the findings in this study. To do this, we first look deeper into the aspects of dispersing a team geographically.

Dispersed teams

According to previous studies there are several operational disadvantages with geographical dispersion. The fundamentals of global team success aren't very different from the practices that work for domestic work teams [22]. But there are more challenges and a more complex situation. Cultural behaviour, limited communication options, team leadership and group dynamics, logistics and challenges inherent in working in different time zones, and travelling.

Important social/contextual information, such as member's social status or level of expertise, may be lost or distorted in virtual team environments characterized by high levels of anonymity [23]. The ability to develop relational links among team members may be hindered, which may negatively affect such outcomes as creativity, morale, decision-making quality, and process loss [24]. The lack of a social context may alter or hinder the process through which team members develop trust [25]. As a result, virtual team communication may appear out of context and without focus [26], resulting in lost meanings, distortion, and misinterpretation of information.

Research suggests that virtual groups may still encounter significant problems in communication among team members [26, 27]. In this asynchronous environment, characterized by non-linear, multi-threaded topics, team members may experience information overload as they attempt to cope with a seemingly disjointed set of communications.

Global virtual teams composed of members with diverse ethnic, national, as well as organizational backgrounds, risking a broad range of misinterpretations or distortions, may reinforce communication challenges. Although these cultural differences bring a greater variety of perspectives to bear on a problem domain, they are likely to create additional communications challenges for team members.

Also on a more aggregate level, globally dispersed networks of R&D units create significant managerial challenges. The challenge is one of maintaining the responsiveness of individual units to the opportunities and demands of their local environment while at the same time capturing the latent benefits that a large, global network can confer [5].

The task of efficiently making use of R&D knowledge becomes more difficult as many MNCs continue to expand their global R&D operations**,** and thereby increase

the number of geographically dispersed locations, employees, functions, and external partners. Both the complexity of the network and the differences in language and culture lead to significant challenges [6].

Dispersed teams, definitions

One problem when studying dispersed teams is that co-operation is often not defined regarding level of complexity / ambiguity involved in the interaction between the various units. Based on this problem we propose a taxonomy of dispersed co-operation, with several levels.

1. Self-contained R&D: All activities takes place in one location, and within a defined R&D team. All major activities are carried out by this team, and there is no cooperation with other units. Input and information from outside the team is sought from non-personal sources, such as documents and databases, and the team is practically self-contained.

2. Sourcing: Development is carried out in a co-located team, but is also dependent on outside resources. The team use experts on a temporary basis to acquire expertise / knowledge. This may be in-house experts as well as external experts involved as suppliers of knowledge.

3. Networking: The development activity is organised as well-defined sub-tasks, which are sub-contracted to various (geographically dispersed) actors. The development activities consist of dispersed units, but with a central responsibility for coordination and interface management. There is little dependency and communication between sub-units; this is handled by a central project management team. A main challenge is to manage interfaces and define self-contained sub-tasks, to minimise communication needs between sub-units in the development project.

4. Dispersed development team: The development team is truly dispersed, with full cooperation on creative aspects of problem-setting and other ambiguous issues between dispersed units. Interfaces are not strictly defined, and all tasks and levels of responsibility can be dispersed. This utilises the full potential of all participating parties, but places high requirements on communication and mutual understanding.

The distinction between the various forms of geographical dispersion is not strict, but is more a continuum from contained and local development to dispersed and cooperative development. Various forms may be present within the same organisation, depending on level of analysis. This study seeks the most commonly used form for R&D teams in the studied organisations as well as the most dispersed form present.

Method

The study is performed by interviewing managers in a leading position in R&D departments in 14 large manufacturing companies. The companies are selected among major listed manufacturing companies with international activity, based in Sweden. The managers are interviewed on organisation of R&D, geographical dispersion, reasons for today's situation and future strategies and trends regarding location of R&D.

The selection of studied companies is based on companies listed on the Swedish stock exchange. From this group, the following categories are included: Manufacturing industries, Forest and paper industries, Chemical industry & conglomerates, Consumer products, Pharmaceutical and medical industry. In these selected groups, companies with less than 1 billion SEK turnover are excluded. The excluded sectors are: Trade and retail companies, Real estate and construction companies, Shipping, Investment and holding companies, Media, Natural resources (power production and oil trade), Transport, Bank and Finance. The reason to exclude these is that the concept of product development is different in these sectors. This group made up a total of 47 companies. Background information was collected from the internet, and contact was sought with the manager of R&D strategies in each company. We got positive response and access to interview persons in 14 of the companies, who was interviewed, either in person or via telephone. The interviews were of a semi-structured character, where some questions were specific, and some were of an open character, prompting the respondent to elaborate on an issue. The questions were regarding the situation today on dispersed teams, how cooperation were organised, reasons for today's structure, and thought about future development and strategies regarding concentration or dispersion of R&D activities. When doing this we also try to identify if the found dispersing and contracting forces are active on any certain part or level of the organisation.

The analysis aimed to find patterns in the data on the use of dispersed teams and to see the perceived trend in R&D dispersion / concentration. To do this, the answers were coded and classified into different categories, or themes. Some of these themes were related to what were the arguments for and the arguments against dispersion. This was used as a tool to sort the data, and thus to facilitate an interpretative analysis of the interviews. Responses were compared and patterns were sought. Answers were classified and given numerical values, on a scale from 0 to 5, 0 meaning none and 5 meaning very high/frequent, depending on how well criteria were met. As an example, the level of utilisation of the various forms of dispersed cooperation (level 1-4, according to the definitions above) was judged and classified for all companies, both for major projects and for minor product improvements. This is not presented in full here, but used as a basis for the analysis.

Studied companies

All studied companies are manufacturing companies, 9 of them mainly producing industrial products, and 5 producing consumer products. The product areas are: security products, antennas, safety systems, mining equipment, trucks, industrial doors, machinery, car/machine components, hygiene products, military systems and

consumer appliances. Many of the companies are multinational and world leading in their field. The average number of sites (manufacturing and / or R&D sites) are 12, ranging from 2 to over 20, and the average number of employees per company is 12.000, ranging from 1.000 to over 40.000. Of the studied companies, 7 companies claim to have a central R&D unit, while 5 do not have one R&D unit they choose to see as the central one. 3 of the companies have strong local centres of excellence, with a leading expertise in a particular area, while 6 companies do not utilise local centres of excellence, but have the necessary expertise dispersed.

The R&D activities are mainly decentralised for 6 of the 14 companies regarding new product development. When looking at product adaptation and minor development, 8 companies have a decentralised organisation. Cooperation between geographically dispersed units takes place in some form (level 2-4) in 9 of the studied companies. Of these, 7 have a level 3 cooperation, networks with clear interface management, while 3 have a level 4 cooperation in some part of the organisation, teams working on same task with close cooperation. Cooperation with external partners in R&D activities is very important for 5 of the studied companies, while 2 of the companies see this as less important.

Reasons for dispersion / concentration, empirical findings

The following section reports on the findings in the interviews with R&D managers. The aim of these interviews are to investigate how the level of dispersion in the R&D organisation has come to be, what events or decision has caused the dispersion of R&D. We also seek the logic behind the present R&D organisation, and look for dispersing and contracting forces in R&D organisation. The findings include both the organisation of internal R&D activities and the external cooperation with other companies, mainly suppliers, on R&D activities.

Reasons given for R&D location

Historical factors

Many of the interviewed managers (8 out of 14) claim that historical factors have a large influence over the location of R&D sites. This is linked to mergers or acquisitions in the past, and when fusing units, the R&D activities are kept in both locations. These are seen as temporary solutions by several of the managers, where the geographical dispersion brought by the purchase or merger is kept but not wanted.

> *Cooperation between units is limited, due to a short time as one company. There is little cooperation with newly purchased companies, and no central coordination of R&D activities, but R&D is present at several sites.*

This is a situation where the dispersion results from factors outside the control of the R&D organisation. It is in these cases often seen as an inconvenience.

Local competence

Another dispersing factor is the localisation of R&D activities to units or countries where a certain expertise is available. This factor is seen as less important, but still 3 of the companies claim that this is an important factor for localisation of R&D units.

The most common use of local competence is if there already are several units, one of these develop into a centre of excellence in the field. This is not necessarily utilised, but in some cases local units prefer to use local resources due to communication issues (see below). In several of the cases this is claimed to be used only in certain stages of projects, involving cooperation on level 3.

Proximity to production units and customers

The localisation of R&D activities near the production is seen as a influencing factor. 6 of the companies claim that this has been important for the localisation of R&D units. When production is dispersed, this also leads to a dispersion of R&D activities. Note that this is a case of proximity driving the location, not dispersion. If cooperation over a distance would be manageable, a co-location with production would not be necessary. The same goes for proximity to customers. This is seen as an important factor for minor product adaptations, but not for radical new product development.

> *Projects can be moved between units during phases. In the early phase it is placed where the core competence is, and later it is placed closer to production or the customer.*

Costs

A further reason mentioned for R&D location is cots. R&D is located where skilled labour is available at low costs. This is not seen as a first reason for location, but as an advantage if a choice is to be made between existing units.

Contracting factors

Management control

The wish to have control over the R&D process is brought forward as a reason to centralise R&D geographically. The overall R&D responsible wishes to be able to manage projects and shuffle resources between projects. This is facilitated by co-location. The reasoning behind this is both applying economy of scale to R&D, and emphasising the control element in R&D management. Several units are seen as less efficient than one central unit, according to one manager. The question of critical mass, or enough persons to have a vital discussion, is also brought up as a reason to centralise R&D.

Internal processes

The most commonly raised reason to co-locate R&D is the internal processes in the development teams. As discussed by Allen [2] the proximity of colleagues is central for a functioning creative process and cooperation. This is a fact that most R&D managers seem to be aware of. Communication is seen as central, and the need for close cooperation and discussions on loose issues prompts co-location. The proximity leads to better cooperation, and increases quality of the output. A term mentioned in relation to this is critical mass. There seems to be a minimum size to achieve a functioning R&D group. This does not work over a distance, only with co-location.

Dispersing factors

A frequently mentioned reason for several location of R&D units is the addition of new units to the company, either by purchase or merger. This is linked to the historical reason for R&D location discussed above. When integrating new sites, it takes some

time to reorganise and to integrate units with similar tasks as existing units into the organisation. If the acquired company had R&D, this leads to a dispersed R&D organisation. This typically takes a few years to handle. The popular argument in recent management literature in favour of dispersed, or global, R&D is the need to acquire expertise, to link to the leading experts in the field. The need to acquire technology developed by others, the usefulness of utilising suppliers as partners in cooperation, and the need for knowledge sourcing in new and not mastered areas is also mentioned as reasons for dispersed cooperation in R&D. This is mentioned as a reason for dispersed activities, but in all cases linked to level 2 or 3 of cooperation.

There are various ways to manage dispersion in the studied companies. The problem of forced dispersion is in most cases handled by task division and interface management. This is clearly seen in the low occurrence of dispersed teams of level 4 on the scale, dispersed development teams.

There are geographically dispersed groups working on the same task, but these get together in various ways. It is difficult to get around the need to meet. The problem is solved with well-defined work units, well-structured and broken down to well-defined modules. This creates sub-teams that don't need to sit together, and no need for extensive communication. A kind of black box principle. Project management is a lot about interface management.

When prompted on how dispersion is usually handled, the two most common answers were travelling and standardisation of interfaces. IT-based communication tools were seen as a way to manage standardisation of interfaces, but not as a replacement for co-location.

Cooperation is not a matter of databases or information systems.

The opportunity to discuss issues on a short term and informal basis were seen as important, and the main reason for co-location. If teams were dispersed, the need for these discussion were reduced by strict interfaces, or a black box approach, with well defined tasks. This means that the studied organisation were avoiding level 4 dispersed cooperation and organising dispersed R&D according to level 3 or level 2.

Geographically dispersed project are handled with a strict division of responsibilities. Each unit have their sub-task, and cooperation is limited.
There are projects that span over several units, but this is not common. This is not really cooperation, more a division of tasks.

Analysis

The interviews show that although the use of co-operation between different sites is common, it is seen as problematic, and the geographical dispersion is not always deliberate. The geographical dispersion of activities is often the result of a merger or acquisition leading to a dispersed organisation, rather than a deliberate scattering of R&D activities. It is observed that in the longer perspective, R&D activities are concentrated geographically in the studied cases, but this is counteracted by company growth and need for new technology and knowledge. Significant efforts and resources are used to avoid situation where closely related activities are dispersed. This links well to previous studies on R&D teams [2, 12]. In this study most dispersed R&D is found on the less co-operation intensive levels (level 2-3). When interaction takes

places over a distance, this is generally restricted to well defined interfaces. If a closer co-operation (level 4) is undertaken, this is often linked to a temporary co-location, or to frequent travelling. Most found cases of geographically dispersed projects are asymmetrical. One unit takes overall responsibility, and outsource well-defined sub-tasks to other units, internal or external. Cooperation and teamwork is limited. The most frequently found constellation is more a case of sourcing than of cooperation in the R&D process over a geographical distance.

Geographically dispersed development is mainly present for large system developers. This is shown ion other studies of industries such as car manufacturers, defence systems and major construction projects. If conclusions are based only on large OEM system builders, this may give a impression of a stronger globalisation trend than what actually is the case. This study involves a larger sample of companies. The findings in this study indicate that geographical dispersion is not sought, but forced in the case of large system builders. The size of the development makes co-location impossible, and calls for a solution of coordination other than for co-located teams. Integration rather than dispersed cooperation is the solution utilised. This difference needs to be taken into account, since several previous studies on globalisation does not distinguish between these [8, 21, 28, 29].

The found forces and logics behind R&D location are present at different levels of the organisation. This helps explain the two different lines of argument, and understand the possible conflicts.

The rhetoric regarding globalisation and the need for global R&D [6, 7] is mainly present on the strategic level. This line of argument favours a more global organisation, as shown in figure 2. On the other hand the arguments on the operational level, focusing on activities within the R&D departments and teams [3, 30, 31], favours a more concentrated location of the R&D activities, in favour of internal processes. These forces are both influencing the long-term organisation of R&D in large organisation, as shown in figure 2.

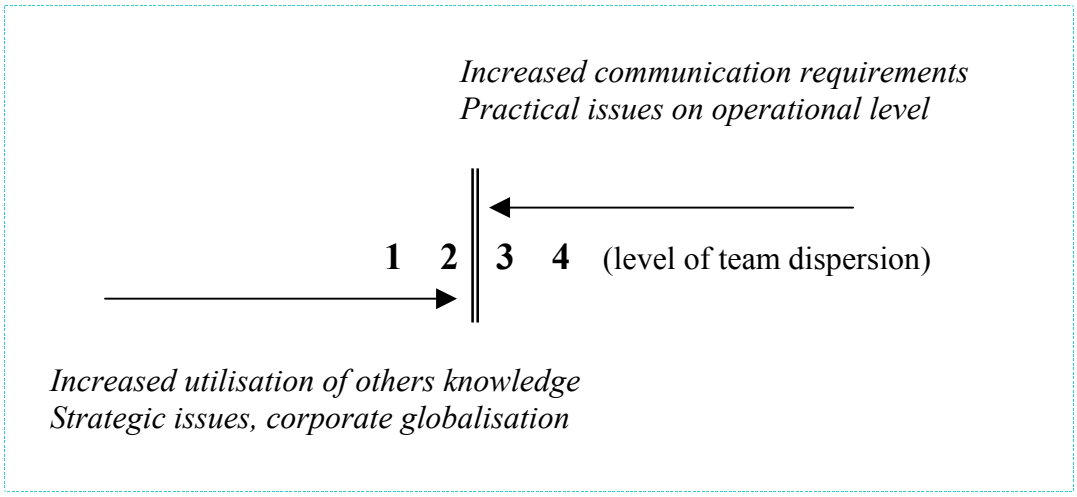

Figure 2, Operational and strategic consideration on team dispersion in R&D

There is a conflict in the lines of argument between the two groups. Problems are likely to occur when a belief at strategic levels that cooperation on level 4 is feasible over a distance, not taking operational impediments into consideration. As discussed in the introductory section, a dispersed teams involves the same challenges as a collocated team, but with the possibilities for rapid conflict handling by informal communication not present.

Discussion

The forces found in this study are both contracting and dispersing, as predicted. It is difficult to know the strength of these forces, but an important observation is that they are mainly present at different organisational levels. The dispersing forces are more prevalent at strategic levels, while the contracting forces are more pronounced at the operational level. This might explain the findings that many organisations are both increasing the globalisation and concentrating their R&D resources. The trends are both dispersing and contracting, dependent on type of cooperation, reason for the geographical situation in the first place, and where the emphasis is put in the R&D process. There are several different forms of collaboration or networks, but most of the found dispersed teams are not really collaboration over a distance (level 4) but more coordination or sourcing (level 3 or 2).

Note the different logic at the strategic level versus the operational level. Strategic level (or macro level) – incorporate new competitive technology, utilise global resources, communication and people are not the central issue. On the other hand, on the operational level (or the micro level), communication, team processes and productivity, problems in integrating dispersed teams are seen as central, causing a counter-force. What is a good idea on a macro level does not work well on an operational level. A possible conclusion is that cooperation over distance takes place when necessary, but not spontaneously. This might be necessary to obtain certain knowledge or technology, but hinders other processes in the development of new products. The global R&D organisation is created from the top of the organisation, creating more complex networks and global cooperation, but simultaneously being counteracted from the operational level, due to operational problems in a dispersed organisation. This is illustrated in figure 3, where influences at different levels of the organisation cause two outcomes, one dispersing and one concentrating.

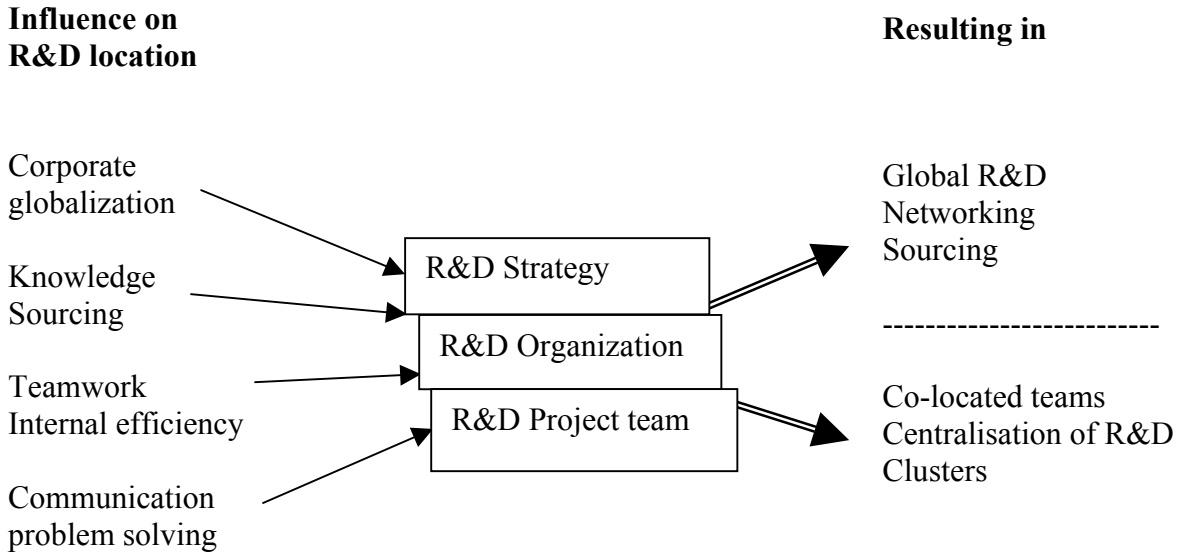

Figure 3. Forces on R&D activities, and geographical results

The respondents were asked how they saw the changes of R&D organisation in their company for the coming 5 years. This was a personal guess on how they thought the geography of the R&D organisation would change. Of the studied companies, 5 see a trend towards a more centralised R&D organisation in the coming 5 years, while the same number, 5, see a trend towards a more dispersed R&D organisation in the same period. The others could or would not answer the question. An increase in R&D dispersion could mean increased cooperation on level 2-4, but also includes a predicted increase in the number of R&D units, but not necessarily a change in the organisation of the projects. The increased centralisation either indicates an increase in projects located according to 1 or 2, or a reduction of the total number of R&D units in the organisation. [1]

Contribution and Implications

Theories on R&D management and organisation draw both on globalisation and communication theories. There is a conflict in this, which needs to be understood. The public discussion is mixing levels of logic, causing faulty conclusions. This paper is addressing this issue, and indication how this is handled by organisations.

This empirically based study links two discussion in R&D organisation, the issue of globalisation of R&D activities and global teams, versus the discussion on the efficient

[1] Due to the openness of the question, a more accurate interpretation of the answer is not possible based on existing data. This issue needs to be investigated further.

team and communication within and between teams. We show that the movement is in two directions, one dispersing and one contracting, and that these are partly working at separate organisational levels. This is not always taken into consideration in the discourse, since the discussion is often concentrated to either of the lines of logic, and not taking both into account. This study attempt to do so, and try to understand how this is handled in organisations. The most common way of dealing with this is by not distributing teams, but managing interfaces, or using cooperation of level 2 and 3, and not of level 4. Note that much of the "virtual team" discussion is focusing on level 4 cooperation.

We highlight the problems with geographical dispersion of R&D activities. One implication for managers is that although studies shows an increased usage of geographically dispersed groups, this is not necessarily implying that this is beneficial, or even deliberate, but in many cases an consequence of other mechanisms.

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