Behaviour of the Trans-border Co-operation within the European Framework-Programme

Especially Eastern Europe

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Abstract: Even though the Eastern European countries are not yet member states of the European Union they have had the possibility to take part in the frame-work programmes. The investigation shows which main fields they have been working in, especially which applicant countries have co-operated with which countries in which fields? The objective of this investigation has been to find patterns of co-operation and we have tried to answer the following questions: Which behaviour concerning the co-operation can be found especially in the fields of " Information Society Technologies" and "Quality of life and management of living resources" and on the horizontal programme "International Co-operation"? Which partners of member states of the European Union have been working with Eastern European partners in European projects in which fields? We have been using the data of CORDIS for the investigation. For structuring, visualising and analysing the huge amount of data the bibliometric method BibTechMon^{TM} has been used. BibTechMon^{TM} has been developed at the Department of Technology Management of ARC Seibersdorf research GmbH and uses the co-word analysis (Kopcsa and Schiebel, 1998). Furthermore conventional statistics are applied to find answers to our questions. With this analysis we could show clearly that the structured and visualised information is useful for all sorts of different organisation especially within Europe.

Keywords: collaboration, network, co-word analysis, visualisation of collaborations, patterns in collaborations, network analysis, density, actor betweenness centrality.

Introduction

Co-operations between different organisations, institutes, scientists, researchers play among other things an important role in innovation. Freeman, for example, observes that many studies since the 1950's have noted 'the importance of both formal and informal networks, even if the expression network was less frequently used.' (1991:500). Networks have been used for several decades in the study of science and technology. All network studies show that the ties between actors, which connect them into a system, are more important than their individual attributes. Many programmes of the various unions aim at the improvement of the output by supporting the co-operation between different disciplines and countries. It is investigated that successful innovations are created by heterogeneous teams. In the Fifth Framework Programme of the European Union applicant countries had access to the support of the Framework Programme. The Fifth Framework Programme sets out the priorities for the European Union's research, technological development and demonstration activities for the period 1998-2002. An international co-operation dimension allowed the European research community to benefit from the knowledge and expertise of third countries and institutions, through their participation in projects of the Fifth Framework Programme. Which co-operation patterns with organisations of non-European member states can we

find? There are seven different Specific Programmes in the Fifth Framework Programme, four of them are called thematic programmes. We concentrated on one of these four thematic programmes, namely “User-friendly information society(IST)". Then we focused on the Subject Index "Telecommunications". Furthermore we have analysed one of the horizontal programme “International Co-operation” (INCO). Some basic information about the Fifth Framework Programme of the European Union see under "Some information about the Fifth Framework Programme" at the end of these explanation. We focus on the network of the ten associated countries of the European Union (see more in chapter " Some information about the Fifth Framework Programme").

Methodology

Bibliometrics is the quantitative study of pattern in written communication that is in books, journals and other printed material. When it refers to scientific production and communication, it is usually called scientometrics. Relations between technological developments, different fields of application and leading experts can be determined by using bibliometrics. Due to the manifold possibilities of analysing large amounts of information and documents bibliometric analysis is also of interest in other fields of application like analysis of companies and their products, analysis of the co-operative behaviour of institutions and people, analysing news from press agencies or the internet, patent analysis or structuring of internal documents for knowledge management. Bibliometric methods are tools for structuring and analysing information which is stored electronically in databases. For analysing the citation behaviour bibliometric methods are very useful. Bibliometric methods based on co-word analysis are possible for analysis of co-author behaviour. Co-word analysis measures the occurrence of words together. Therefore it can be used for analysing co-authors attitude. To abstract the method it can be used for analysing the “behaviour” of co-objects.

Visualising of structured data is very helpful for recognising pattern. Therefore visualisation tools have been developed. BibTechMon^{TM} is a bibliometric tool for visualising.

2.1 BibTechMon^{TM}

The bibliometric method BibTechMon^{TM}, developed at the Department of Technology Management of ARC Seibersdorf research GmbH, uses the co-word analysis (Kopcsa and Schiebel, 1998). This method is based on the calculation of the co-occurrences of terms that is the common occurrence of terms or groups of terms in documents (Callon et al., 1983; Kostoff, 1993; Rip and Courtial, 1984; Turner et al., 1988). The basis for structuring documents and information are therefore objects, namely the considered contents of the documents (Leyersdorf, 1989). Before calculating the co-occurrences the terms describing the contents – the key-terms – have to be identified. While literature quotations are described by key-terms, patents, internet information or other documents do not have any descriptive terms. Therefore the software contains an automatic key-term generation module which allows the computer based generation of the relevant key-terms. Those key-terms are the input for the co-word analysis and for calculating the co-occurrences. The more often two key-terms are used together in documents the closer the relation between them. Using those co-occurrences, indicators can be determined which correspond to the intensity of the relation of any two key-terms identified. Through this procedure a network of relations is determined which

is based on the contents of the documents or in this case the connection of web-sites. In this contribution the method of BibTechMon™ is abstracted to data like web-sites and there linkage to other sites. Since the result of those calculations is a large matrix of numbers the analysis would be rather difficult. In order to allow an easy interpretation of the results the relations based on the indicators are transferred into graphical information and so- called networks are generated (Kopcsa and Schiebel, 1995). BibTechMon™ is based on the co-occurrences of terms / objectives. Therefore the method can be abstracted to other objects like analysis of contents in projects and for the co-operation of partners in projects.

2.2 The scheme of the network

Before describing the special analysis the scheme should by discussed.

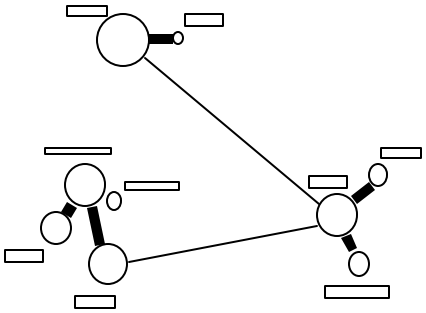


Figure 1: Scheme of a network

Each node stands for a term or another visualised object. The size of a circle symbolises the occurrence of a considered object that means, how often a considered object turns up. The width of the lines shows how closely a couple of objects are connected, or in other words, it is an indicator of the occurrence of considered couple of objects. The nodes find their position in the network on the basis of their relationship to all other nodes. Therefore the position of a circle shows the relation to all others.

2.3 Network analysis

The scientists of network analysis have developed relatively new techniques to describe indicators of networking. We use here general statistics of networks and density (J. Scott, 2000).

The density of a network is defined as the numbers of lines/paths in a network, expressed as a proportion of the maximum possible number of lines/paths. The formula for the density is

$$\frac{l}{n(n-1)/2},$$

where l is the number of lines/paths present (n is the number of nodes). The value can vary from 0 to 1, the density of a complete network being 1.

Furthermore we calculate the "actor betweennes centrality" like Faust and Wassermann (1994) defined in "Social Network Analysis":

The actor betweenness centrality presents how often an actor is located on path in a network. Actors with a high betweenness centrality play a central role in a network.

They have many direct co-operation partners. The node of an actor with a high betweenness centrality is presented often on the shortest path between other actors. The shortest path between the node A and the node B in a network is the minimum number of relationships which is needed to get from node A to B.
The actor betweenness centrality of the actor n_i is given by the formula

$$C_B(n_i) = \sum_{j<k} g_{jk}(n_i) / g_{jk}$$

where the g_{ik} is the number of paths.

The actor betweenness centrality index thus measures how ‘between’ each of the actors is in the communication paths over all pairs of actors (excluding the actor itself). The index takes on value 0 when actor i falls on no path and it reaches its maximum level [(g-1)(g-2)/2] when the i-th actor falls on all paths. The higher the value the better the "communication" of an actor in a considered network.

Finally we consider the "group betweenness" or "betweenness centrality index" as defined by Freeman (1979).
The betweenness centrality index is calculated by the formula:

$$C_B = \frac{2\sum_{i=1}^{g}[C_B(n^*) - C_B(n_i)]}{(g-1)\text{^}2(g-2)}$$

$C_B(n_i)$ is the betweenness centrality of the actor i and $C_B(n^*)$ is the largest realised actor betweenness centrality index of the whole set of actors.

The group betweenness centralisation index quantifies the overall level of betweenness in the set of actors taking the minimum value when all actors have the same actor betweenness index.

Data description

The analysed data are from the CORDIS database of the European Commission. As mentioned in the "Introduction" we used the data of the thematic programmes " User-friendly information society (IST)". The projects are classified by "Subject Index Classification Codes". There we chose the projects with the Code "Telecommunications" for visualisation and analysis. One of the three horizontal programmes in the Fifth Framework Programme is “International Co-operation (INCO)", which allowed the European research community to benefit from the knowledge and expertise of third countries and institutions through their participation in projects. Therefore the associated countries - besides developing countries of the whole world - participated in this programme. We have analysed and visualised the co-operation of partners of associated countries in INCOII. The projects that are being investigated are of the contract type " CSC (Cost-sharing contracts)". We consider 1.444 projects of the IST programme, 198 projects of IST with the Subject Index "Telecommunication" (IST/Telecommunication) and 303 of INCO II.

Results

First we show the networks of the programme IST (“User-friendly information society”). The nodes in the networks represent partners. Two partners are close if they participate together in projects. The nodes in the middle of the networks represent partners when they co-operate with partners in many projects. As a whole there are 3.994 different partners in our considered projects and there are 26.145 connections between the partners. In Figure 1 the marked nodes are partners of the ten associated countries

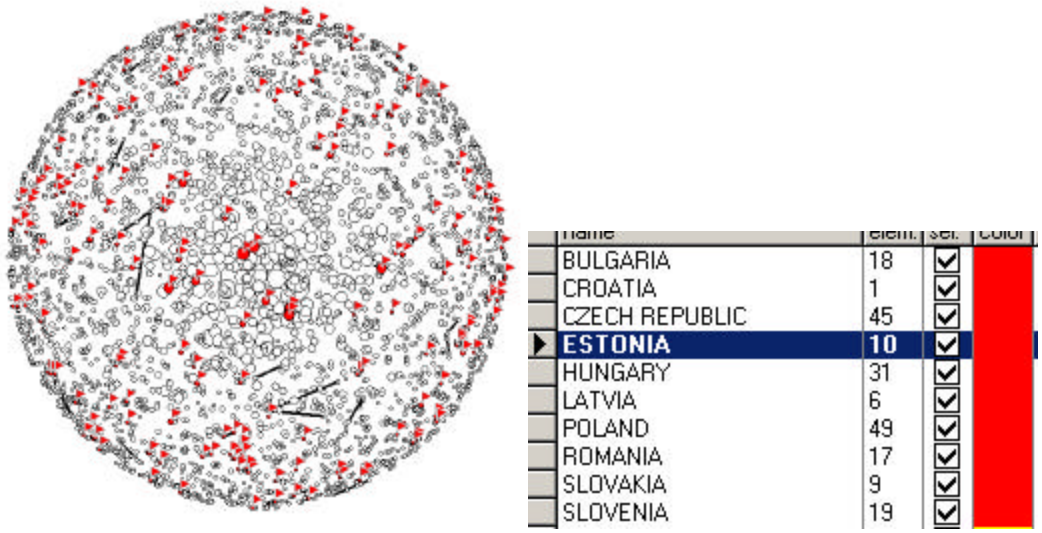


Figure 1: networks of partners in IST: the ten associated countries are marked

All ten candidate countries participated in the thematic programme IST. Some of the partners are in the middle of the networks. But most of them are more at the edge of the circle, which means that they don't participate so often compared to whole sample. There are 205 different partners of the candidate countries. The University of Ljubljana, Hungarian Academy of Science and the Academy of the Czech Republic of Science and the Czech Technical University Prague are represented at least 9 times in the IST programme.

In the Subject Index "Telecommunication" of the IST programme we consider 757 different partners with 4.496 connections between the partners. There are 49 different partners with a frequency (means in how many different projects a partner participates) between 1 and 4 of the candidate countries.

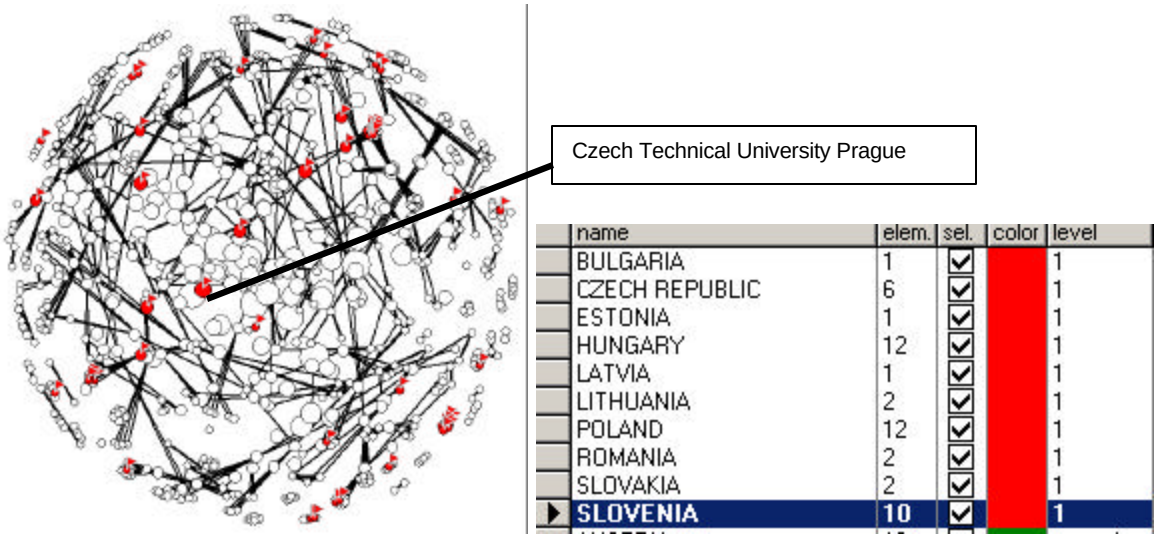


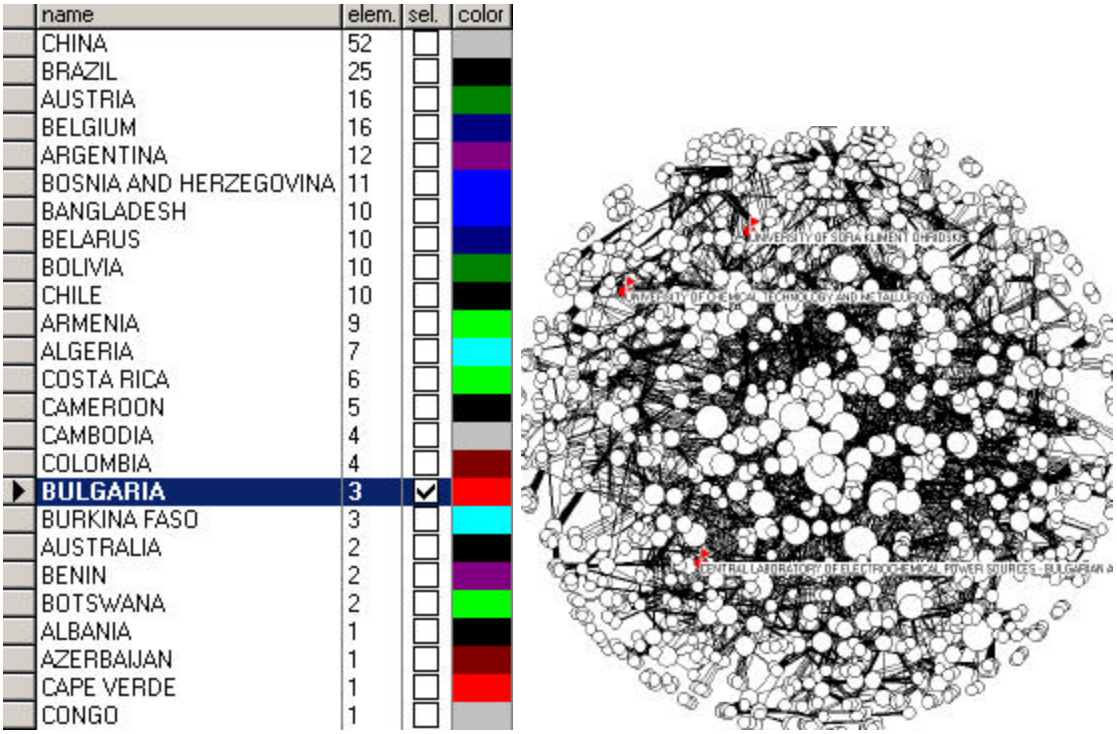
Figure 2: network of partners in IST / Telecommunication: associated countries are marked and listed.

The organisations of the associated countries with a higher frequency (participation in more than one project) are listed in the following table. It shows that the Czech Technical University of Prague is the leader. The node of the Czech Technical University Prague lies nearly in the middle of the network (see Figure 2):

Name	Frequency	Country
Czech Technical University Prague	4	CZECH REPUBLIC
Akademia Gorniczo-Hutnicza Im. Stanislawa W Krakowie	3	POLAND
Cesnet, Zajmove Sdruzeni Pravnickych Osob	3	CZECH REPUBLIC
Hungarian Academy of Sciences	3	HUNGARY
University of Ljubljana	3	SLOVENIA
Institut Jozef Stefan	2	SLOVENIA
Polish Academy of Sciences	2	POLAND
Politechnika Warszawska	2	POLAND
Telekomunikacja Polska Sa	2	POLAND
University of Technology Kaunas	2	LITHUANIA

Table 1. Organisation of the associated countries with a frequency higher than 1.

The analysis of the horizontal programme “International Co-operation (INCO)" delivers another image. There are 1.113 different partners of all over the world with only 4.045 connections.



name	elem.	sel.	color
CHINA	52		
BRAZIL	25		
AUSTRIA	16		
BELGIUM	16		
ARGENTINA	12		
BOSNIA AND HERZEGOVINA	11		
BANGLADESH	10		
BELARUS	10		
BOLIVIA	10		
CHILE	10		
ARMENIA	9		
ALGERIA	7		
COSTA RICA	6		
CAMEROON	5		
CAMBODIA	4		
COLOMBIA	4		
BULGARIA	3	✓	
BURKINA FASO	3		
AUSTRALIA	2		
BENIN	2		
BOTSWANA	2		
ALBANIA	1		
AZERBAIJAN	1		
CAPE VERDE	1		
CONGO	1		

Figure 3: list of all countries of INCO II and the network of INCO II with the three organisations of the associated countries**.**

China and Brazil are represented with 52 and 25 different partner. On the third position we find Austria. The associated countries are only represented by three organisations of Bulgaria. Most of the countries are from outside Europe.

In the following we compare the three networks with general statistics and the special network analysis indicators.

General propensities of the networks

Relationship in the Table 2 means that e.g. there are 1,298 co-operations between two determined partners which co-operate in more than one project together. A component is a group of nodes which are linked together so that every node can reach each other node directly or indirectly. The largest component in each of the networks comprises the vast majority of nodes (about 97 per cent in IST, 95 per cent in IST/Telecommunication and 87 per cent in INCO).

	IST	IST /Telecommunication	INCO
Number of nodes	3,994	757	1,113
Number of connections between nodes	26,145	4,496	3,320
Relationships with value > 1	1,298	229	116
Share of largest component	96.67%	94.58%	87.06%

Table 2: general indicators of the networks of partners in IST, IST/Telecommunication and INCO II. Source: CORDIS, author's calculations

The density and connectivity of the three networks reveal more details about the co-operations. In the programme IST the average number of connections per node is 6.55,

in IST/Telecommunication it is 5.94. There are not so many co-operations (a co-operation between two partners in a project is represented by a connection in the network) than in IST. In the programme line INCO there are only 2.98 connections in the average per node. The values of density are about 0.0033 in IST, 0.0157 in IST/Telecommunication and 0.0052 in INCO, the highest density has IST/Telecommunication. Another way to compare networks is short paths. The shortest path between node A and node B is the minimum number of connections which is needed to get from A to B. The length of the shortest path indicates how well the network is connected. Well-connected networks usually have shorter longest paths because the better all nodes are connected the less connections are necessary to get form node A to node B.

	IST	IST /Telecommunication	INCO
Average number of connections per node	6.55	5.94	2.98
Density	0.0032788	0.0157123	0.0052195
Longest shortest path	8	6	16

Table 3: Size, density and connectivity Source: CORDIS, author's calculations

In our case we see that the best value of a longest shortest path is that of IST/Telecommunication with the value 6.

The actor betweenness centrality of the top ten of each programme line is considered next:
First the programme IST:

Rank	Partner - ID	Value	Partner	Country
1	1312	0.11633	Fraunhofer Gesellschaft	GERMANY
2	593	0.07975	Centre National de la Recherche	FRANCE
3	2312	0.06144	National Technical University of	GREECE
4	3536	0.04402	Universidad Politécnica de Madrid	SPAIN
5	765	0.04399	Consiglio Nazionale delle Ricerche	ITALY
6	3636	0.03975	Universitat Politécnica de Catalunya	SPAIN
7	1702	0.03584	Institut National de Recherche en	FRANCE
8	1005	0.03533	Ecole Polytechnique Federale de	SWITZERLAND
9	3783	0.03504	University of Southampton	UNITED KINGDOM
10	1309	0.03214	France Telecom Sa	FRANCE

Table 4: actor betweenness centrality of the first 10 partners

No partner of the associated countries is under the first ten.

Can the ranking show the behaviour of the associated countries? The following table represents 4 partners of the associated countries of the best 100 in actor betweenness centrality. All of them lie over 72, thus they have low actor betweenness centrality.

Rank	Partner-ID	Value	Partner	Country
72	3762	0.0063847	University of Ljubljana	SLOVENIA
80	2625	0.0059186	Polish Academy of Sciences	POLAND
84	1561	0.0055524	Hungarian Academy of Sciences	HUNGARY
100	849	0.0045458	Czech Technical University	CZECH

Table 5: the associated countries in the ranking of the first 100 in actor betweenness centrality.

In the programme line IST/Telecommunication the first 10 partners are represented in the next table.

Rank	Partner-ID	Value	Partner	Country
1	404	0.1063666	National Technical University of Athens	GREECE
2	104	0.0870341	Centre National de la Recherche	FRANCE
3	511	0.0855675	Siemens Aktiengesellschaft	GERMANY
4	308	0.0822372	Institut National de Recherche en	FRANCE
5	646	0.0733932	Universidad Politécnica de Madrid	SPAIN
6	676	0.0689851	Universitat Politécnica de Catalunya	SPAIN
7	233	0.0560147	France Telecom Sa	FRANCE
8	234	0.0486198	Fraunhofer Gesellschaft	GERMANY
9	254	0.0470439	GMD - Forschungszentrum	GERMANY
10	174	0.0459778	Eidgenossische Technische Hochschule	SWITZERLAND

Table 6: actor betweenness centrality of IST/Telecommunication

The pattern of the associated countries is shown next. We find 8 partners of the associated countries in the ranking of the first 100 ones. The first rank of an associated country is on 32 for the Czech Republic.

Rank	Partner_ID	Value	Partner	Country
32	110	0.016460	Cesnet, Zajmove Sdruzeni Pravnickych	CZECH REPUBLIC
35	716	0.014455	University of Ljubljana	SLOVENIA
41	725	0.012439	University of Technology Kaunas	LITHUANIA
51	140	0.010116	Czech Technical University Prague	CZECH REPUBLIC
58	307	0.008632	Institut Jozef Stefan	SLOVENIA
60	282	0.008189	Hungarian Academy of Sciences	HUNGARY
69	459	0.007484	Politechnika Warszawska	POLAND
71	458	0.006969	Polish Academy of Sciences	POLAND

Table 7: actor betweenness centrality of IST/Telecommunication of partners of the associated countries.

Finally we consider the group betweenness centralisation of the network.

	IST	IST/Telecommunication	INCO
Betweenness Centralisation of the Network	0.11582	0.10389	0.10345

The highest value is calculated for IST, IST/Telecommunication follows.

The analysis as a whole shows that the programme line IST/Telecommunication represents in the average the best values for the associated countries. INCO is more frequented by countries outside Europe.

Conclusion

Networking of organisations has been enhanced to guarantee the success of research (Oliver and Ebers, 1998:565). Networks are viewed principally in functional terms as the channels through which knowledge is transferred. Many different models have been developed to analyse, to show, to confirm that networking in research community increase the success of innovation. But there are limits to organisations as well as to networks. An organisation or a company need resources of funds, time, know how to attend a network of research like the Framework Programme of the European Union – although there is a return of funds. Small organisations or small companies often need

their full capacity in their every day life so that they cannot render additional work, because the beginning of networking means additional work for an organisation. How can for instance SME enterprises get successful access to support programmes? How can Technology Transfer work successfully? We think there are limits comparing the size of a network group. If an organisation gets big it is divided into departments, or subsidiaries are founded especially for innovation purposes. To attend a network is of interest if a participant can find complementary attributes and can learn. The exchange of knowledge has to be assured. A win to win situation is necessary for the success of a collaboration in networks.

Some information about the Fifth Framework Programme

International co-operation in the field of research and technological development (RTD) was pursued under the 5th Framework Programme, through 2 complementary routes

- A dedicated co-operation programme “Confirming the international role of Community research”, which focused on specific RTD activities relevant to certain third countries or regions and not addressed by other programmes of the 5th Framework Programme
- An international co-operation dimension integral to each of the other specific programmes, which allowed the European research community to benefit from the knowledge and expertise of third countries and institutions, through their participation in projects of the 5th Framework Programme.

The candidates for membership of the European Union were associated with Fifth Framework Programme: Besides Cyprus (which requested EU membership in 1990), the group comprises the following eleven countries of Central and Eastern Europe (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia, all of which submitted their requests for EU membership in the period 1994-1996), and, since the 1 of March 2001, Malta.

Speeding up their integration into the scientific and technological community at European level and their preparation for membership candidate countries contribute to the budget of the programme; in return, their research institutes, universities and industry (including SMEs) could participate in the projects of the programme under basically the same conditions as organisations from the Member States. http://www.cordis.lu/inco2/home.html

The "Subject Index Classification Codes" divides the projects in nine different subjects: Industry and Technology, Energy, Physical and Exact Sciences, Biological Sciences, Agriculture and Marine, Resources and Products, Measurements and Standards, Protecting Man and his Environment, Social and Economic Concerns, RTD Horizontal Topics. In the subject Industry and Technology "Telecommunication" is located. More find under " http://dbs.cordis.lu/help/de/sic.htm#I" and about further information about the Fifth Framework Programme of the European Union see "http://www.cordis.lu/fp5/programmes.htm".

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