

NETWORKS IN EVALUATION

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Introduction

The conception of a network is one of today's leitmotifs. On one hand, this is most likely the result of a specific trend dominant in science and media reports. On the other hand, it is difficult to negate the existence of such network phenomena as the Internet or social networks, both virtual (e.g. Facebook) and those existing in physical space. According to some thinkers such networks become so ubiquitous that they begin to provide the basis for explaining the modern world. This gave origin to the notion of the Network Society, popularized by Manuel Castells in his famous work "The Rise of the Network Society" (1996) . As a consequence, the increasing presence of networks in the theory and practice of evaluation comes as no surprise. However, despite the growing interest in them, networks in evaluation applications are still perceived as something new and promising. Broadly defined network analysis is still rarely used in evaluation practice. There are also very few studies discussing practical applications of networks in evaluation. This relative lack of practice-oriented studies of network analysis in evaluation is the main reason for this chapter.

In this chapter, I discuss elements of network analysis most important for the evaluation of development policy programmes and projects. The chapter begins with a discussion of the main concepts in network analysis, accompanied with a presentation of the sources in which particular issues are discussed in detail. The main part of the chapter presents cases of network analysis applied in evaluation research. They have been taken from literature on the subject and, predominantly, from my own professional experience, as I have performed some network analyses in the last few years as part of evaluation studies conducted in Poland (and scientific research of a similar nature). Moreover, network visualisations, presented alongside the discussed cases, are important for this study. They alone can provide inspiration for readers, who one day may confront the difficult task of visualising a complex network. The chapter concludes with a short summary of the strengths and weaknesses of applying network analysis to evaluation.

Networks in evaluation – the main concepts

Origins of the concept

Only recently has network analysis been used in evaluation, which is exemplified by the fact that it was only in 1998 that it first appeared as a methodological ap-

proach in the programme of a conference organized by the American Evaluation Association (Durland, Fredericks, 2005, p. 7). However, network analysis as such has a long tradition, rich literature and a number of impressive applications (see Freeman, 2004). A major part of network analysis research is developed within social sciences in the form of the Social Networks Analysis (SNA). However, it is not possible to imagine today's network analysis without the contribution of exact sciences, mostly mathematics and graph theory (see e.g. Wasserman, Faust, 2007, 10-17). One leading network researcher, Steven Strogatz, vividly describes network analysis as: "concerned with the relationships between individuals, the patterns of interactions. The precise nature of individuals is downplayed, or even suppressed, in hopes of uncovering deeper laws. A network theorist will look at any system of interlinked components and see an abstract pattern of dots connected by lines. It's that pattern that matters, the architecture of relationships, not the identities of the dots themselves. Viewed from these lofty heights, many networks, seemingly unrelated, begin to look the same" (Strogatz, 2003, p. 231–232; see also Bendyk, 2004 p. 257).

A basic, yet time consuming, introduction to social networks analysis is provided in an eight-hundred-page work by Wasserman and Faust (2007). The on-line manual by Hanneman and Riddle, "Introduction to social network methods" (www.faculty.ucr.edu/~hanneman/nettext), can also be recommended. Philip Ball (2004) in a very straightforward manner makes the reader acquainted with the latest results in broadly-defined network research. An interesting position related to network analysis in evaluation is the special issue of the "New Directions for Evaluation" entitled *Social Network Analysis in Program Evaluation*, edited by Durland and Fredericks (2005). An article similar in nature is "Network analysis: methods and application in evaluation" by Dominik Batorski (2008). An interesting overview of the integrated approach to network evaluation, called "Network Evaluation from the Everyday Life Perspective" (NEELP) is presented by Finnish researcher Liisa Hopelli (2009).

Background of the network concept

Every network consists of nodes and the relationships between them. Nodes may be people, organizations, their organizational units, events, projects, etc. Nodes have their attributes or characteristics (for people they may include age, education level, sex, etc.). The relationships may take the form of an exchange of information, cooperation, participation in the same projects, friendship, but also mutual competition, among other things. Flows pass between the nodes along the relationships lines, so to speak. These flows may include flows of funds, information, employees, etc.. Node, link and flow (see e.g. Barney 2008) are the basic concepts in network analysis. It should be noted, however, that in the development of this research approach a number of various specialized concepts have been coined which are not going to be discussed in detail in this chapter, as this would make it too long and because there is ample introductory literature available on the subject (see above).

Moreover, in evaluation practice the most effective analysis tools seem to be the most basic ones. One should bear in mind that evaluation has a very utilitarian aim, the results of which should be clear and easy for practical implementation. Accordingly, a particularly interesting feature of network analysis is the opportunity for creating visualisations; for example, presenting connections between employees in an organization in such a way that at first glance and without previous preparation one can understand the structure of the network: who is in its centre, who has many connections and who remains on the margin with just a few relationships with other nodes, what groups and cliques emerge, etc. The importance of simple methods is also emphasised by researchers dealing with networks analyses for enterprises. Based on many years of their research experience, Cross and Parker (2004) show the power and practical importance that a very simple graph may have.

Network data – collection, analysis and presentation

The most commonly used data collection method in network analysis evaluation practice is the questionnaire. A wide range of different tools are in use, among which the most important are: face-to-face questionnaires, telephone interviewing and more frequently as Computer Assisted Telephone Interviewing (CATI), Computer Assisted Web Interviewing (CAWI) and mail questionnaires. Network data are also collected by using other tools, such as: face-to-face interviews, observations, archival records and databases (for more details, see examples below as well as Wasserman, Faust, 2007).

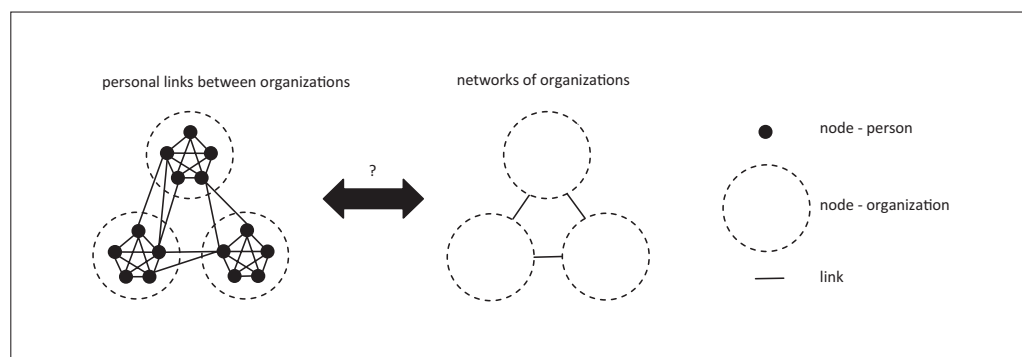
Network data needs special treatment in data processing. Fortunately, there is a wide range of network analysis and visualisation software available, both proprietary and freeware: Commetrix, EgoNet, InFlow, NetDraw, NetMiner, Pajek, and UCINET, just to name a few.

Network of people vs. network of organizations

From the point of view of evaluation practice it is important to pay attention to the multidimensional character of networks existing in organizations and between organizations. First of all, we can discuss networks of people, networks of organizations (see Fig. 1) or a network of organizational units (departments, divisions, institutes, etc.). As organizations consist of the people creating them, a network of organizations will be, *de facto*, a network of people affiliated with them. Transition from the level of relationships between people in various organizations to the level of relationships between organizations is not always simple and straightforward. It may be particularly troublesome in the case of research based on interviews (questionnaire-based or individual in-depth interviews). In principle, the research should include all the people from all institutions. In practice, however, this may be very difficult – due to organizational factors, but mostly to time and financial constraints. Consequently, analyses usually include only the most important actors from the con-

cerned organizations. They are either asked to describe the relationships between their organization and other organizations, or to indicate their individual relationships with members of other organizations, later assumed as a basis for conclusions on the relations between the organizations. This approach, however, raises some concerns. Firstly, selecting one representative of an organization, for example, as the source of information on its relationships with other organizations, one has to accept that the person does not have to be aware of all the relationships existing between the analyzed organizations. Moreover, the answers may be influenced by a given person's greater or lesser inclination to cooperate, as well as personal experiences in this respect. However, the discussed method of collecting data on organizational networks is quite commonly used (see e.g. Galaskiewicz 1985; Fredericks, 2005), mostly due to the organizational and cost aspects of the research.

Fig. 1. Organizational network on the level of organizations and on the level of interpersonal relationships



Source: prepared by the author.

The functioning of an organizational network (or other networks) may be analyzed from various perspectives. There are usually two complementary perspectives on organizational network analysis: the perspective of particular networking organizations and the perspective of the whole network (Provan, Fish, Sydow, 2007). Those perspectives are sometimes also referred to as the micro- and macro- level approach (Wasserman, Galaskiewicz, 1994), or the egocentric network perspective and the whole network perspective (Kilduff, Tsai 2003). Depending on the object and aim of a given evaluation one, or both, of the perspectives should be applied as appropriate, (see Provan, Milward, 2001). The rationale depends mostly on the kind of effects under consideration, i.e. whether we concentrate on the effects for particular organizations in the network or the real-life effects brought by the network as a whole. It is worth noting that the efficiency of an action on one of these planes does not necessarily translate into efficiency on another plane. For example, a lack of expected effects of state intervention on the whole network level does not preclude the possibility of positive effects for particular networking organizations. Moreover, particular actors may have individual, perhaps conflicting goals:

The main problem is that (...) there are a lot of actors involved, each with their own differing perceptions, goals, and strategies. It is not a clear case of which goal the evaluator should take as a starting point for evaluation, especially not if more than one public authority is involved. But even if there is only one public actor involved, the question still remains of whether the goals of this actor have to be the sole evaluation criteria. If one looks at interactions in policy making and management from a multi-actor perspective, it seems logical to look at evaluation from a multi-actor perspective too. It is not very likely, however, that the different actors will have a collectively formulated goal at the beginning of policy interactions that can serve as a keystone for evaluation (Klijn 2005, p. 273).

One-mode and two-mode networks

When thinking about a network we usually imagine a set of interconnected nodes of the same type, such as people, organizations, computers, etc.. In the case of such a network, called one-mode networks, we are dealing with connections between just one category of nodes; that is, connections between people and people, or organizations and organizations. An example of such a network is presented in the table and graph below (Fig. 2). The nodes may, for example, be cooperating scientists. In such a case A, B and C mutually cooperate with one another, while C additionally cooperates with D (who cooperates only with C).

Another type of network is a two-mode network, also known as affiliation network. In such case the nodes belong to two different categories, and their relationships are usually affiliation relationships. They can, for example, consist of participation in the same projects or membership in the same organizations. In relation to the example of cooperating scientists – the relation here may consist of participation in the same projects (Fig. 3). Let's assume that A, B, C and D participated in projects X, Y and Z. A participated in X and Y; B participated in X; C participated in all the three projects; while D participated only in project Z.

The large potential of network analysis lays in the fact that a two-mode network may be quite simply (using the appropriate function in SNA software) transformed into a one-mode network. Accordingly, from the network in Figure 3 we may obtain the network presented in Figure 2. Consequently, having the information that, for example, persons A, B, C and D participated in projects X, Y and Z (Fig. 3), and assuming that participation in the project requires cooperation, we may construct a cooperation network between the analyzed individuals. This technical procedure involving transformation of an affiliation network into a one-mode network is of significant practical importance, as the data on network characteristics are often much easier to obtain than the data on relationships existing directly between the elements of interest. Among other things, this method allows for studying the re-

relationships between scientific institutions. Having a database of projects and their participating institutions (i.e. affiliation network) we can easily learn which institutions mutually cooperate and how often (i.e. in how many joint projects), which of the institutions cooperate with a significant number of other institutions and which with just one or two other institutions .

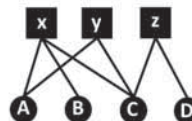
Fig. 2. One-mode network

Nodes	A	B	C	D
A		1	1	
B	1		1	
C	1	1		1
D			1	



Fig. 3. Two-mode network

Nodes	x	y	z
A	1	1	
B	1		
C	1	1	1
D			1



Source: prepared by the author. Source: prepared by the author.

Evaluation of networks and evaluation using network analysis methods

Network evaluation does not have to use network analysis methods. On the contrary, it is entirely possible to use methods other than network analysis in analysing a network, and such approach is quite common (see e.g. Rank, Williams, 1999; Ahrweiler, de Jong, Windrum, 2002; Szałaj, Ledzion, 2008). This does not mean, however, that network analysis may be replaced with other methods (e.g. standard quantitative research). Nor does this mean that network research not using network analysis lacks methodological foundations. Such an approach will simply supply somewhat different knowledge about the object of the study, and will not allow for characterizing the relationships in a given network in a systematic manner. That is why in such cases the application of network analysis turns out to be particularly beneficial.

It is important that the subject of evaluation using network analysis methods does not necessarily have to be a network. It can be any phenomenon conceptualized as a network. For example, relationships in a system of strategic goals or operational programmes (see, for example, Davies, 2005, 2007).

Evaluating networks – real-life examples

Network analysis can have a number of powerful applications in evaluation practice. In this chapter we will discuss some of the most important and impressive. The discussion begins with the cases of the programmes implementations networks, both at the level of organizations and organizational units. Then, network analysis is presented as a tool for the evaluation of cooperation in partnership projects. Subsequently, the case of identifying knowledge resources with network analysis is introduced. Another topic is the evaluation of formal institutional networks. The final case describes using Geographic Information Systems for network analysis.

Evaluation of programmes implementation networks

The implementation of programmes is usually a complicated process involving many institutions and individuals. Effective programme implementation requires proper operation of the whole system, efficient information flow and effective cooperation between the actors. A consecutive sequence, which is standard for implementation tasks, necessitates their performance in due time, so as not to create bottlenecks in the implementation system. A problem may also result from lower efficiency of particular elements in the implementation system and the resulting “bottlenecks”, slowing down the whole process. Moreover, the effectiveness is also influenced by the nature of the cooperation and information flow between the actors concerned. Network analysis allows for a systematic study of such issues.

We can analyze the implementation (or management) network on many levels. For example, on the macro-level we can analyze all the institutions in a given country dealing with the cohesion policy implementation; in the case of Poland in the current 2007–2013 programming period, this is over 145 organizations. One can also analyze the implementation of particular operational programmes or their parts. In the micro-level one can study a network of organizational units within a given organization or even cooperation between individuals involved in a given implementation/management process, etc. Moreover, one can study various aspects of the functioning of networks, such as information flow, cooperation on joint problem solving, mutual learning and exchange of good practice, as well as diffusion of innovations (see e.g. Rogers 2003).

Evaluation of programmes implementation networks

– level of organizations

An interesting example of programme implementation network analysis is provided by a study conducted by Swianiewicz *et al.* (2008). Even though it was not aimed as an evaluation, because of its character, we can treat it as an element of an evaluation study. The subject of the study was the informal network of institutions involved in the implementation of the Integrated Regional Development Programme (IRDP) in two Polish regions: Małopolskie and Dolnośląskie (Lower Silesia). In the case of Małopolskie there were 20 institutions covered, and in the case of Dolnośląskie – 52. The information on connections between them came from representatives of the institutions and was collected during interviews. The questions asked to particular actors pertained to the frequency of contact in general, and of individual contact (i.e. other than official) between the employees of a given institution with the employees of other institutions dealing with implementation of IRDP in the region. Thus, the data collected in this way pertained to the declared relationships between institutions from the perspective of representatives of the analysed institutions. The results show that the networks in both regions are similar. In both regions the central place in the implementation networks was occupied by the bodies formally

responsible for IRDP implementation: The Marshall Office and the Voivodeship (Province) Office. However, the authors of the study pointed out a couple of important differences. First, they pointed out the fact that the respondents from Lower Silesia were more willing to talk about their contacts than the respondents from Małopolska, which translates into a less dense network in Małopolska than in Lower Silesia. Moreover, the differences in the role of the Province Capital in the IRDP implementation network are also clearly visible. The Wrocław City Hall has a central place in the Lower Silesian institutional network, while the Kraków City Hall has a rather peripheral position in its province. In Małopolska non-governmental organizations (mostly NSZZ, the Solidarity trade union) were relatively important, while in Lower Silesia they were far less important. Moreover, the authors also mention some other features specific for the IRDP implementation networks in the studied regions. How can the aforementioned analyses be translated into the practice of evaluation? One potentially very productive application is the use of implementation networks' characteristics as variables explaining the course and effects of IRDP implementation in particular regions. The relationships between the institutions dealing with implementation may have considerable impact on, for example, the level and pace of implementation, as well as the effectiveness of investments. If during evaluation it turns out that the character of the links in the implementation network significantly influences the course of intervention, this may constitute a basis for making recommendations concerning the optimum structure of cooperation between the implementing bodies.

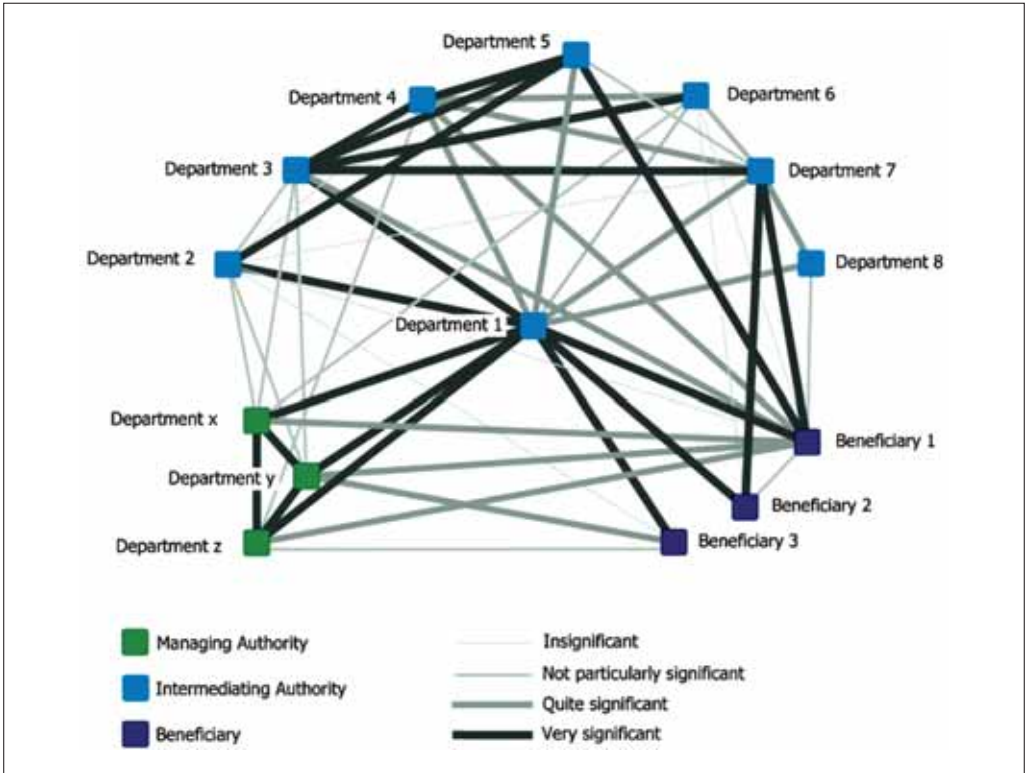
Evaluation of programmes implementation networks

– level of organizational units

The functioning of the programme implementation networks may also be analyzed on a level lower than that of particular organizations; that is, the level of particular organizational units in the analyzed institutions dealing with implementation. Such an approach was chosen in the study entitled “Ewaluacja pierwszego etapu wdrażania Działania 5.1 Programu Operacyjnego Kapitał Ludzki” [“Evaluation of the first stage of implementation of Measure 5.1 of the Operational Programme – Human Capital”]. Communication and cooperation were subject to analysis between 14 organizational units in a couple of organizations: The Managing Authority, the Intermediate Body and three beneficiaries. The data for analysis were collected from interviews with representatives of particular organizational units. Quite unexpectedly it turned out that cooperation in tasks connected with implementation is more complex than would seem from the organizational chart representing the Measure's implementation structure (see Fig. 4). This applied to the dense cooperation network between the organizational units in the Intermediate Body, numerous units of the Intermediate Body and the Managing Authority, and most of all to the direct contacts between the Beneficiaries (see Fig. 4. beneficiaries 1 and 3) and the Managing Authority. Network analysis showed the actual scope of cooperation,

which in this case turned out to be satisfactory, except for one case. Namely, the analysis revealed faults in cooperation between one of the beneficiaries and one of the organizational units in the Intermediate Body. In this case, network analysis allowed for the problem to be spotted precisely, and the resulting recommendations to include proposed suitable corrective measures.

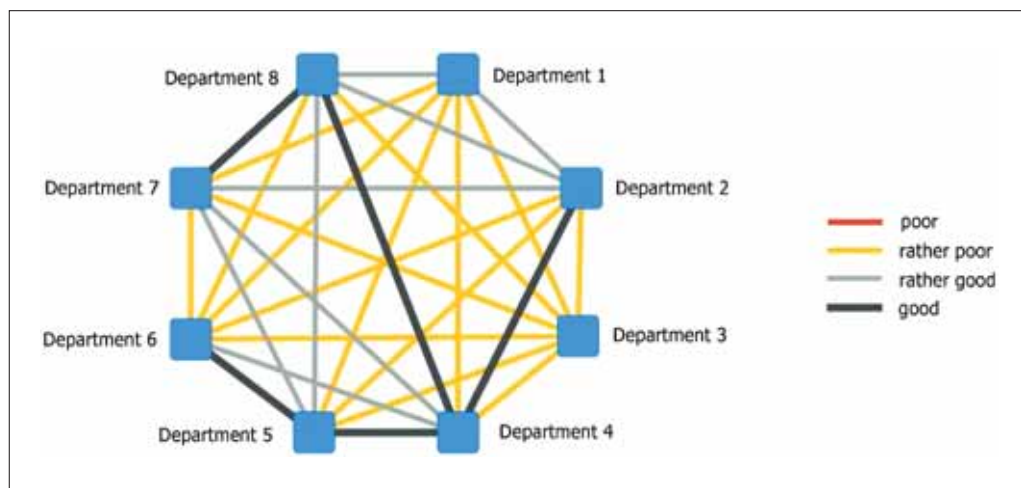
Fig. 4. Cooperation network – significance of relations



Source: prepared by the author.

A similar analysis on the level of organizational unit held for one body implementing the Operational Programme – Human Capital in one Polish region determined quite the opposite picture. In this case it turned out that the information flow between particular entities is generally poor (see Fig. 5). The network analysis showed, rather unsurprisingly for people working in the organization (even though the exact scale of the phenomenon might have been unknown to them), that no methods for quick and effective communication or information exchange had been worked out. In this case, problems with information flow quite significantly affected the assessment of cooperation, which had often been negative. The network analysis conducted at a relatively early stage of implementation allowed for taking proper corrective measures in order to minimize the situation's negative impact on the implementation of the programme.

Fig. 5. Cooperation network in the Voivodeship Labour Office – information flow



Source: prepared by the author.

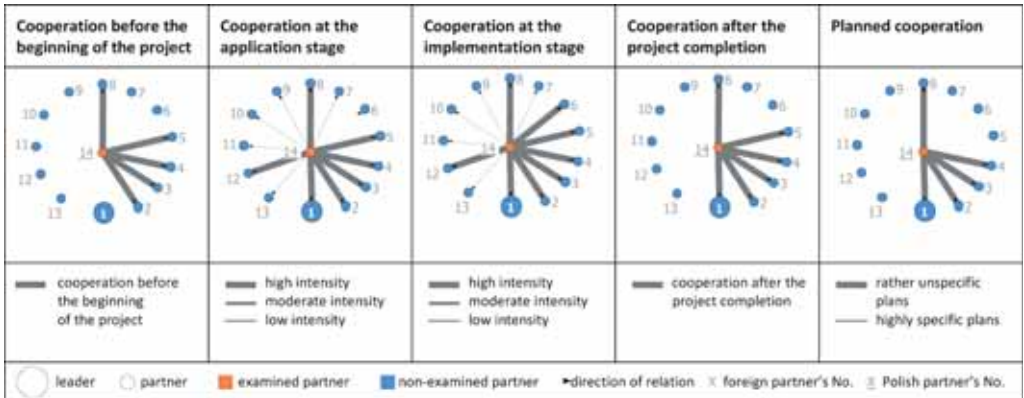
Evaluation of cooperation in partnership projects

A broad area of network analysis application is the evaluation of so-called soft projects, which are aimed at constructing partnerships between various institutions. By collecting information on the relationships between particular institutions in particular points of the project (programme) implementation, one can precisely characterize not only the state of the network, but also its dynamics. As a result, using network analysis one can quite see precisely whether the partnerships are lasting. In this case network analysis acts as a tool for results-oriented evaluation.

An example of such a study is provided by research on “Ewaluacja sieci partnerów w projektach INTERREG III B CADSES” [“Evaluation of partnership networks in INTERREG III B CADSES”] (Ego s.c. 2008). A characteristic feature of territorial cooperation programmes is the fact that they are usually implemented by a number of institutions from various regions and countries. It is supposed to lead to lasting cooperation and an exchange of experience and good practice. However, the actual cooperation may take various courses. Information on cooperation between partners in the projects was collected from representatives of Polish institutions (partners in CADSES projects) in a telephone interview. They were asked about the intensity of the cooperation between the analyzed institution and all the institutions involved in a given project at various stages of its implementation (formulating the conception and implementation of the project) and before it (whether they had cooperated earlier), as well as after its completion (planned and ongoing cooperation). This approach allowed for studying the relationships between project partners (and their influence on its implementation) as well as the assessment of how lasting the cooperation turned out to be after the project’s completion. The analysis allowed for differentiating between projects in respect to the greater or lesser intensity of

cooperation that they involved at particular stages and showed the extent to which the implementation of the programme contributed to establishing lasting cooperation between the projects' partners. Most importantly, the study demonstrated that participation in a project does not necessarily translate into mutual lasting cooperation (see Fig. 6).

Fig. 6. Evolution of cooperation within the partnership project



Source: prepared by the author.

Network analysis as a tool for identifying knowledge resources

Network analysis may be successfully applied in mapping competences, experience and knowledge of organization(s). Such an approach may be useful when, for example, analyzing cluster initiatives, evaluating regional research and development potential, or assessing the competence of the evaluated organizations' employees. This aspect seems to be very important, as knowledge is seen as a major capital in the so-called knowledge-based economy (see e.g. OECD, 1996).

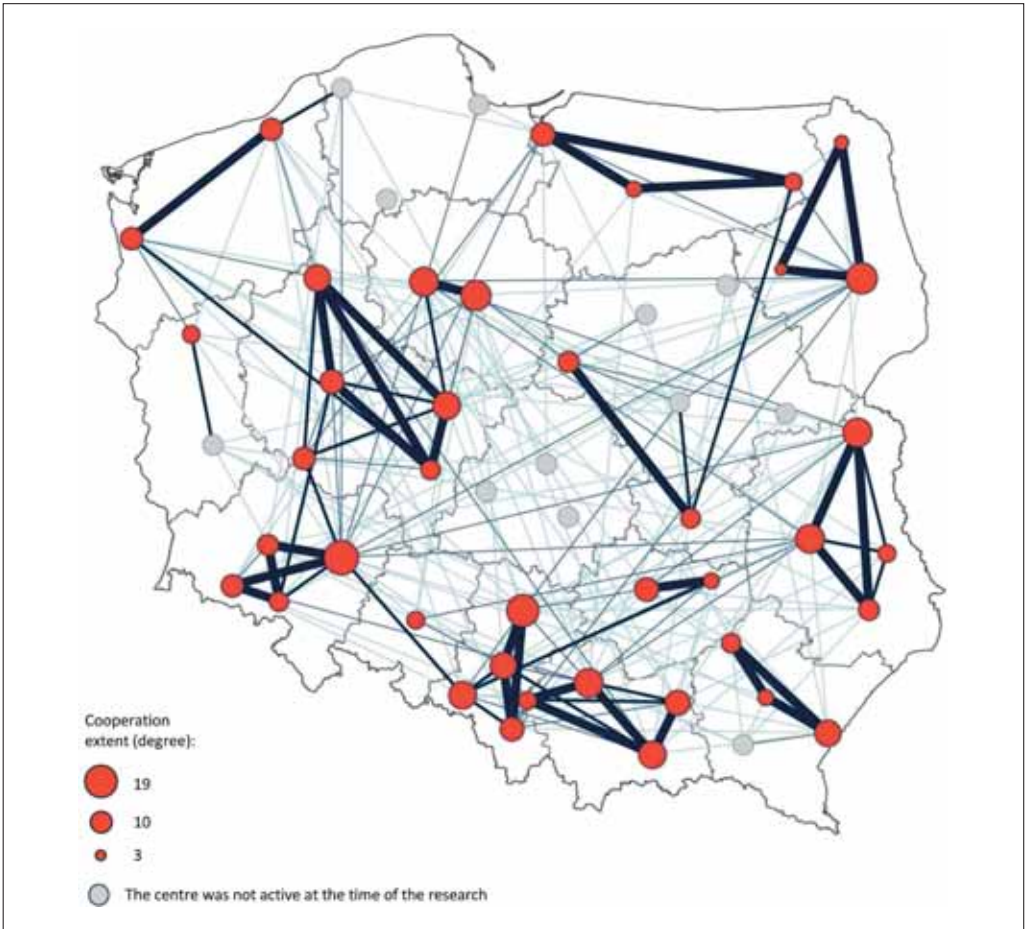
A study of this type was conducted in 2004 at the Idaho National Laboratory in the U.S.A. (Birk, 2005). The analysis was necessitated by the planned integration of existing separate research projects connected with hydrogen fuels into one large "Hydrogen Initiative Program". The programme was supposed to become the basis for the laboratory's new business strategy. In order to efficiently launch the new initiative, the assessment of the current laboratory's competences was made. This was particularly important due to the large number of researchers working in various buildings and locations. All the staff (38 people) to be employed in the new initiative was asked to indicate the people that they considered to be experts in each of 47 specified categories of knowledge connected with hydrogen fuels. The subjects could indicate both people from within and outside of the laboratory. The results of the questionnaire were analyzed using network analysis methods and resulted in the creation of 47 graphs presenting experts in particular areas. The results of the analysis were consulted with a focus group comprising some of the laboratory's researchers, who provided a detailed and reliable interpretation of particular

graphs. The results of the study singled out a group of researchers most frequently indicated as experts, i.e. key for the success of the initiative. They also revealed that in some areas the laboratory had more than one, while in others just one expert. Such information may have extreme importance for programme management. If, for example, one expert is expected to retire soon, measures aimed at recruiting or training a person to take his place when he retires should be taken beforehand.

Evaluation of formal institutional networks

Network analysis finds its somewhat obvious application in the evaluation of projects with names as well as characteristics indicting their network character, consisting of the creation of a system of networking institutions. An example of such an initiative may be the European Union project of Innovation Relay Centers, currently transformed into the Enterprise Europe Network. An interesting project of this type is the Regional ESF Centres network initiative, aimed at providing comprehensive support for beneficiaries and potential beneficiaries of the European Social Fund. The network consists of a few dozen centres located throughout the country. The creation of the network was accompanied with the assumption that particular centres will cooperate by exchanging so-called good practice, i.e. cooperating in finding beneficiaries for the partnership projects. Evaluation of this project was aimed at checking whether such cooperation actually takes place. The basic level of analysis in this case consisted of individual regional centres (there were 40 such centres at the time of the study); however, in order to make the results more credible, the study included the whole professional staff (241 people) of the centres in question. The study was held using telephone questionnaires. The results showed, among other things, that the cooperation between centres is quite frequent, although usually pertains to the centres located in the same region and relatively rarely involves centres from various regions (see Fig. 7). Therefore, the simple recommendation followed to expand the network by mechanisms stimulating interregional cooperation.

Fig. 7. Cooperation within the Regional ESF Centres network



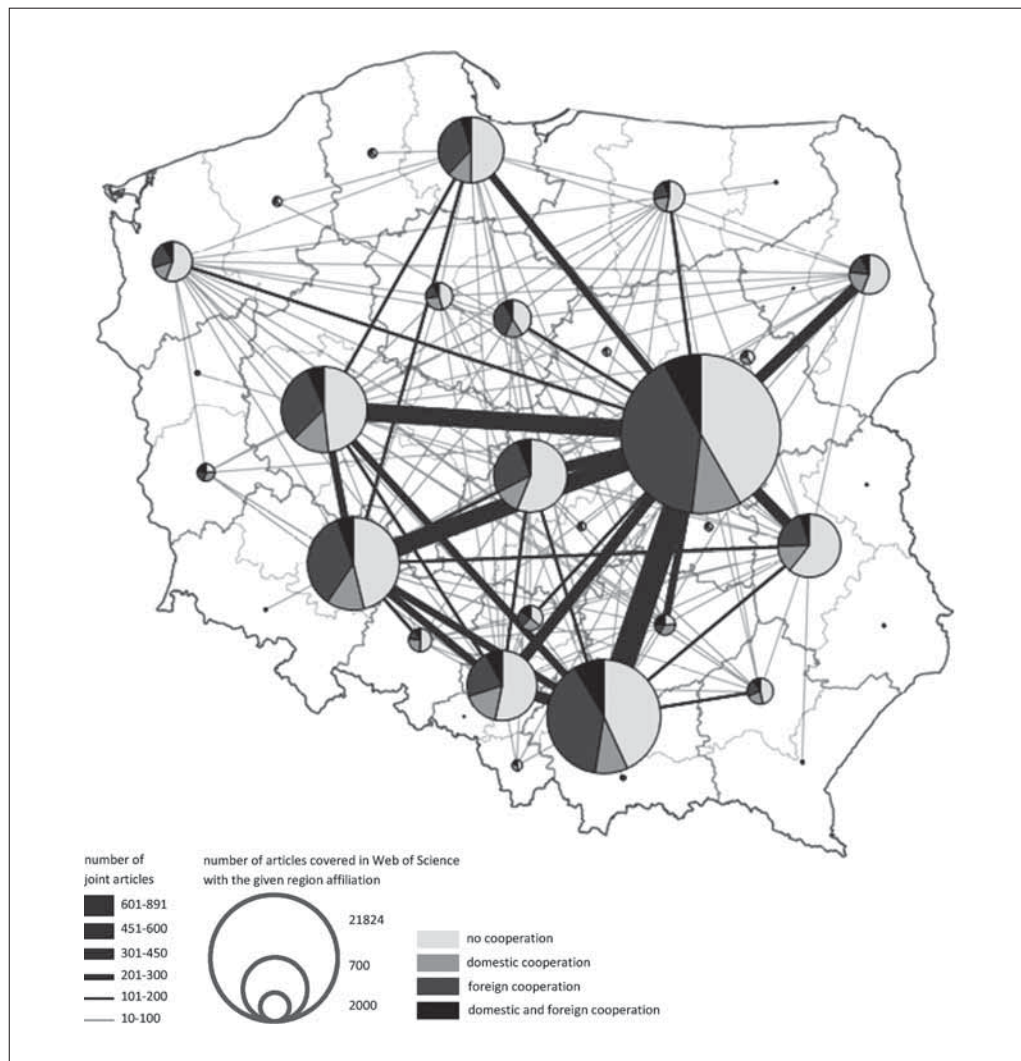
Source: prepared by the author.

Networks evaluation and Geographic Information Systems (GIS)

Many networks have a significant spatial aspect. This is exemplified by the previously discussed Regional ESF Centres network. The use of GIS tools in analysis and visualisation of the network is potentially very important. Most significantly, it provides an attractive presentation of spatial network data. Moreover, for a potential user the map presentation may be more familiar and readable than an abstract graph (not to mention a table or data matrix). An example of visualisation of cooperation network using typical elements of thematic map is presented below (Fig. 8) and shows the cooperation of research centres in Poland measured by joint publications. Moreover, it seems that GIS may provide good inspiration for visualising networks in an effective manner. Cartographers have for ages worked out various concepts and principles allowing for clear presentation of numerous pieces of information, even the most complicated ones. In practice, however, network visualisation frequently has to deal with the problem of making the graph readable. Consequently, it seems

that the GIS experiences may also be successfully applied to the visualisation of networks with no spatial characteristics, per se.

Fig. 8. Network of scientific cooperation



Source: Olechnicka, Płoszaj 2008.

Conclusions

The examples discussed above show how network analysis may be applied to the evaluation of state intervention. As already mentioned, it is usually used in combination with other research methods, which conforms to a more general postulate of triangulation of research methods in order to make the analyses more credible. In the case of regional development programmes, network analysis turns out to be useful in all situations where an important element of the programme (project)

implementation or its effects, are formal or informal relations between institutions or people.

Nevertheless, one should keep in mind that network analysis, as with every method, has its own strengths as well as limitations. To sum up the lessons learned from the examples discussed above, we will discuss the three main benefits of network analysis in evaluation and then three major challenges.

Network analysis' main benefit is the fact that it allows for capturing even very complicated and multifaceted relationships between numerous elements in an accurate and quantified manner. This increases the objectiveness of the analyses, and consequently raises the objective results of the studies and recommendations. It is also important that network analysis already has a solid theoretical basis, elaborated and well-grounded research methods and procedures (see the beginning of the chapter).

It is also invaluable that "network research can integrate qualitative, quantitative and graphical data, allowing more thorough and in-depth analysis" (Kilduff, Tsai 2003; p. 19). Consequently, "the network approach enables the analyst to retain the richness of the data rather than having to sacrifice richness for statistical power" (Kilduff, Tsai 2003; p. 25). Network analysis thus constitutes a perfect environment for using mixed-method methodology, particularly suitable for research on inherently complex state intervention programmes and projects.

Moreover, various methods of visualising networks (using suitable software, both specialized network visualisation software and standard graphics applications and GIS software) allow for interesting and revealing presentations of the research results, which can considerably increase their usefulness for final users. A visualisation of network connections may also be very useful in the analytical stage of research, providing a method for selecting institutions for deeper analysis (one can expect that the institution most connected with others will also be the most "aware" of what is going on in the whole network).

A very important difficulty in network research results from the fact that the analyses usually have to include the whole studied population. Network analysis is very susceptible to lacking data and it is practically impossible to extrapolate the results from a sample to the whole population. The necessity for the analyses to take into account all elements constituting a given network obviously results in many problems to be dealt with, especially in the case of questionnaire-based surveys, where obtaining a 100% response rate is practically impossible. Therefore, in gathering network data, interviews usually provide a better tool than questionnaires. Another method consists of using data confirming the existence of formal connections (for example, taken from official documents, such as membership in associations). The information stored in various databases is also frequently used (e.g., databases of institutions cooperating in research projects or networks of joint authorship of research publications; see, for example, Olechnicka, Płoszaj, 2008; Olechnicka,

Płoszaj, 2010). The necessity to take into account the whole network (no sampling possible) results in the fact that in some cases reliable network analysis may require significantly higher costs than standard quantitative study. Here, funds are not only a concern, but also the time needed to gather and compile the empirical material.

Another limitation results from the fact that network data cannot be analysed using standard statistical methods. A limiting factor here will be the competence for conducting such research. Also, it should be noted that network analysis requires the ability to use specialized software.

Network research is also complicated by its problematic ethical aspects. Network studies, especially those involving people, cannot usually be anonymous, which is not the case with aggregate data from questionnaires, for example. Network analysis, practically by its very nature, involves determining the relationships between specific, and not abstract, actors. While some methods of dealing with such problems have been worked out (see e.g. Penuel *et al.*, 2005), when planning network research one should still pay sufficient attention to assuring the subjects' privacy protection.

Despite the discussed challenges, network analysis seems to be a promising tool (or approach) for evaluation. The scope of its use is quite wide and not yet deeply exploited. There is still a lot of space for new practical applications as well as for the development of theoretical approaches of networks in evaluation.

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