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Cooperation and Innovativity: the Network Foundations of the Regional System of Innovation

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1 The basic problem

The regional process and the homogenous systemic architecture of innovation are embedded into the context of social contacts and their relevant networks which fundamentally determines their operation and efficiency. The problem here is that on the different levels of the domestic environment of innovation we do not have exact information on the mechanisms of their functional relationship. By moving off from the theoretical level we have not analysed and have not modelled the real patterns and configurations of this embedment. Putting in the simplest form of the major question of research sounds like that: *'What kind of role do institutional contacts and their relevant networks play in a region's skills for innovation?*'

In my research I set up two objectives. One is that I would like to explore all the possible details and interrelations of this embedment (problem exploration component) within the region by carrying out a series of investigations. On the other hand on the basis of accumulated experiences I would like to think over all the necessary steps of future actions (problem solving component). My hypothesis is that the innovation processes of West-Transdanubia region – the very field of my research – (and of most parts of Hungary) are based *on different type and purpose innovation cooperation systems grounded on social-institutional relations but functioning at a moderate intensity only*. This statement is valid for the entrepreneurs' sector, for its satellite, background and intermediary organisation system and also for the contact points between the two fields of force. In an economic and innovation environment lacking natural resources the utilization of these endowments is a must. This is the point where I am asking my question: *What are the reasons of this moderate intensity* or absence of cooperation or expressing it in a more sophisticated way – of the random occurrence of cooperation? The truth is that innovation is not an isolated phenomenon therefore its efficiency and success are the results of a coordinated series of actions performed by several actors. This is a systemic approach to innovation. As the system's performance depends on the interaction between its components – according to my hypothesis – even the existence of the regional innovation system is questionable. Thus, a further clearance of the problem raises the question *whether we can speak of an existing and viable regional innovation system in West-Transdanubia region?* To demonstrate this matter in a simplified approach I am starting from the assumption that we have no exact information on the system of regional cooperation in Hungary and even do not know what kind of systemic configuration is made up of them. My assumption is pessimistic and by my paper I would like to deny that the majority of the segments of Hungarian innovation processes are *isolated or poorly networked* which – if this assumption proves to be true – would be a serious obstacle of competitiveness and a total deadlock from the point of the development of the whole system. As we will see it later this is a fundamental

principle of innovation policy having been propagated for several years but its application and implementation in practice are still questionable.

2 The actuality of the issue

Starting from the most comprehensive dimension in socio-theoretical aspect networking as a *principle and mechanism of social organisation* has grown into a key research issue. 'The new social morphology of our civilization is built on networks. The spread of the logic of networking is significantly modifying both operational mechanisms and results in the processes of production, in social practice, in power and culture (*Castells,* 2005; 598). I am now searching for the regional level fingerprints of this new morphology. If networking has an impact on operational processes, and on results and if joining or leaving the network and the relative dynamism are the key factors of change, the study of the whole phenomenon on a concrete 'operational model' seems to be an exciting task.

We can approach the significance of *innovation and innovation related activities* mostly from the viewpoint of economic issues. Nearly in all cases emphasizing their role in increasing the level of competitiveness is the focal point of all analyses conducted on international level (World Competitiveness Yearbook 2002; *Porter,* 1990; *Porter–Stern,* 2001), national level (*Kiss–Pandurics–Lapid,* 1997; *Papanek,* 2006) or regional level (*Rechnitzer–Grosz,* 2005). By today the role of contacts, cooperation projects and networking initiatives and structures has been definitely increased in innovation activities. Nowadays the success of modern technical solutions to an increasing degree stands or fails on the basis of the entanglement and mutual linkage of heterogeneous actors with 'knowledge fields'.

The importance of 'networked cooperation generating and integrating' knowledge-based innovations can be well measured on international level by the number *of inter-firm technological cooperation projects*. A rapid growth in the number of R&D and technological exchange projects can be observed since the late 70s in international data archives. Besides growth the transformation of the formal mechanism of cooperation into a more heterogeneous structure is another significant element of innovation oriented cooperation patterns as the structure of firms showing cooperative attitude towards research and development comprises now several actors (*Hegedoorn–Kranenburg,* 2002: 16).

The impacts of the above-mentioned trends of global transformation have emerged on the national and local levels of *innovation policy* as well in Hungary. It is the domestic planning-development policy and its institutional system that need most of all empirical analysis in this field. *All the documents of national and regional level development* deal with innovation related cooperation and its re-

lated organisational-institutional background. It should be considered as an important reason that in 2002–2003 the building of *a national system of innovation* started with the purpose of the 'economic utilization of innovation' (Lippényi 2004). Among the objectives to be realised were not only the development of the institutional system of knowledge transfer, the enhancement of the innovative skills of SMEs but also fostering *cooperation* among innovation oriented institutions and companies as well as the *systemic* development of the regional institutions of innovation [with the purpose of closing up the regions on knowledge basis]. From an innovation policy and economic development perspective regional level [in our case the territorial integration of several counties] from organisational-institutional-infrastructural-human-social-cultural (etc.) aspects a more or less homogenized spatial structure can serve as a basis for a new economic (and maybe) a new social organisational force.

3 Starting point, hypothesis and research topics

The description of the Hungarian system of innovation – as a *starting point* – is clearly referring to problems and tasks to be solved. The national system of innovation is covering an area of spatially uneven development level. The strong dominance of Budapest – the capital – cannot be counterbalanced by the largest regional centres. The largest network structures lining up and serving as an organisational framework for Hungary's R&D organisations and companies on national, regional and local level are missing or underdeveloped. The contacts between innovation organizations and between companies and innovative institutions have rather an occasional character. Only few organisations are involved in innovative cooperation projects. We cannot speak of innovation clusters (networks) in a real sense. There are only a few cases when a regional level enterprise is a member of R&D or innovative cluster.

Fostering cooperation between innovation-oriented institutions and firms, and the systemic development of the regional institutions of innovation are priorities as it is the region that is the most adequate spatial level of network building and networking. The development degree of innovation is determined by the 'intensity and density' of contacts between the active, catalysing and cooperative actors of network. The task therefore is complex as it comprises 1) interconnecting the existing elements of network 2) setting up the necessary infrastructural background 3) generating the missing elements and fostering clustering 4) building a network of business promotion organizations 5) accessing and integration into international networks (*Lippényi,* 2004: 4–5).

My investigation is proceeding from four hypotheses:

H1: Social-institutional relations having coordinative role in building various forms of and functions of inter-firm cooperation have only a limited role in the innovation processes of Hungarian regions.
H2: If any co-operations exist between companies, companies and research institutes or between companies and universities they are weak, occasional and unstable.
H3: The majority of innovations are implemented by isolated or weakly connected actors who are rather bilateral cooperation partners than members of multi-agent cooperation networks.
H4: The embeddedness of knowledge generator and knowledge transfer organizations into the region's innovation system is the weakest.

The questions I have formulated for the research are referring to the network parameters of the actors of the two institutional groups of innovation (company sector and innovation institutions).

Economic sector

Q1: What parameters does the cooperation system of business organizations have within the region (size, density, contents, dimensions, directions)?
Q2: Are there any differences between innovative and non-innovative firms regarding the affinity for cooperation? If yes, what is the size and the content of this differentiation?
Q3: Can enterprises be categorized regarding the nature of their organizational network?
Q5: To what extent are innovation cooperation activities are localized?

On systemic level I am investigating the cooperation of the region's network of innovative institutions consisting of nearly forty members for assessing their degree of networking and of their integration into the system.

Q6: Can we speak of a well-functioning, viable regional network which can be regarded as a complex system of relations?
Q7: If not what factors are hampering the networking process?
Q8: What contacts and cooperation activities are grounding the cohesion power of the network of innovative institutions? What kind of interrelationship has been formulated between differently functioning organizations?
Q9: What kind of form has the innovation network has been shaped into? Who are in the centre (who join the threads), and are there any holes or gaps within the structure?
Q10: How can the relationship structure between the institution blocks be characterized?

4 Methodology

The two research fields demand two differing survey methods. The survey conducted within the framework of project 'The Foundation and Operation of Pannon Novum West-Transdanubian Regional Innovation Agency' by the commission of the tender of the Office of National Research and Technology the *questionnaire survey of companies* prepared by the West-Transdanubian Research Institute CRS HAS assessed the innovation activity and network capacity of companies operating in the region (*Csizmadia–Grosz,* 2007). The survey in the region was made in the autumn of year 2006. It was gathering information on innovations having been implemented by West-Transdanubian companies during a three-year period between 2003 and 2005. The majority of questions inquired about new or significantly updated goods or services, about the introduction of new or significantly updated logistic or diffusion methods and about the introduction of new organizational-corporate or marketing methods.

In the sampling period we did not intend to provide a comprehensive survey on the enterprises' and region's general situation of innovation by investigating all the business enterprises. Instead we rather selected a group of firms being presumably rather more concerned and more active in innovation activities. Therefore our survey data are not relevant for all enterprises of the region as we rather focused on a limited scale of 'highly innovative' enterprises who according to their main business profile are more involved in or expected to more actively participate in innovation. For this reason our survey data are not relevant for the innovation activities of all the enterprises in the region but they inform us on their trends in the region's dominant sectors. There were three outstanding factors taken into account during the sampling process. One is – as it has just been mentioned – the limited scale of enterprises was selected according to their main business profile. The other is that micro- and private enterprises employing less than 5 people were excluded from our survey. Besides main sampling another 53 innovative enterprises – selected on the basis of expert proposals – were queried. And finally, some enterprises operating in certain economic sectors by their main profile were also precluded from the survey. The purpose of all the three set-up criteria was the maximization of the elements of relevant responses so our conclusions drawn from the representative sample can be generalized only with taking the above-mentioned sampling criteria into consideration.

Surveying innovation-related activities in the servicing, knowledge generator and transfer organizations *by structured interviews* was the project's other research component. This survey was conducted in the second half of year 2006.[1] In

[1] An expert meeting cleared the list of interviewees representing the following organization types: incubator houses, innovation centres, technology transfer centres, competence centres, cluster organizations, business promotion foundations, chambers of commerce and industry, research

the majority of cases the interviewed persons representing the queried organizations were the company's top managers or experts working in the field of innovation services. The list of queried organizations was filtered by network analysis criteria. Only the most important, existing and not redundant organizations were interviewed (this means industrial parks, local governments and certain authorities were excluded from the survey. This does not mean their role is unimportant but the size of network sample had to be kept at a reasonable level). The total number of queries was 36 in which all the queried persons gave a summary on their innovation services they rendered and on the parameters of their contacts and cooperation activities (who they were cooperating with, who they had cooperated with in the past, who they were intending to cooperate with in the future, when they had established their contact, in what concrete forms these contacts had been realized etc.).

Thus, the research problem this investigation is focusing on can be divided into *two layers*: on the one hand *it refers to the contacts of firms interpreted as inter-organizational cooperation* where relations refer to social capital as a spatial resource-configuring element. On the other hand it refers to *the regional innovation cooperation network of non-economic actors* which is also an indicator of the organization's social capital but here the whole structure of contacts is revealed as well. In both cases we queried the details of contacts maintained with the actors of the 'other layer' to look for the trails of innovation oriented cooperation between the economic and civil sector. In the research model on the one hand the effect mechanisms on the other hand the intra- and inter-sectoral (intra-economic and socio-economic) relations are highlighted.

In my paper I am going to analyze the directions of inter-organizational integrations and the forms of the relation systems resulting from them *in a division of three layers* (*Table 1*). I mean cooperation in this context as innovation-oriented cooperation (Williams 2005) where inter-organizational contacts are established through the exchange contacts of autonomous in legal sense and independent organizations having set up common or complementary targets and they are based on long-term social relations. In this sense two relational variables can be defined: we may differentiate R&D-oriented cooperation and other innovation-oriented cooperation.

The variable of *R&D-oriented cooperation* indicates which firms have participated in such cooperation project which has been launched between 2003 and 2005 for developing 1) *a new product or service* or a significantly enhanced *product or service* or 2) a new or significantly enhanced *technology, know-how or application, production system or sales method*. The secondary less precise indicator of innovation-related cooperation indicates the existence of cooperation

institutes of cooperation, institutes of higher education, research institutes and other professional federations, organizations and associations (*see Annex, Table 3*).

between the region's enterprises and the other actors of the innovation system in innovation process but not necessarily in the development process itself. Following the suggestions of Ritter and Gemünden (2003) here they can serve as exchange and cooperation components of inter-organizational contacts. Here I mean such a technological, personal and organizational exchange mechanisms (principally in case of products and services or information and knowledge) which have an impact on the operation of an enterprise but cannot be regarded as bilateral or multilateral professional networks.

Table 1

The four forms of the questionnaire survey on inter-organizational relationships

	Relational variables	Number of elements	What does it investigate?	What conclusion can we draw from it?
I	R&D-oriented cooperation	56 enterprises	Concrete inter-organizational relation	– The existence, directions, number and intensity of contacts – The composition of the contact system – Firm typology
II	Innovation-oriented cooperation	205 innovative enterprises	Concrete inter-organizational relation	– The existence, directions and number of contacts – The spatiality of cooperation contacts – The composition of the contact system – Firm typology
III	Information exchange demand	356 firms, the full sample	The institutional basis of satisfying information demands	– The directions, intensity and complexity of information demands – The types of information contact systems

Source: The author's own compilation.

The third type of variable is independent from the concrete innovation activity, so it can be used for an empirical analysis for the whole of the economic sector. Here we cannot speak of concrete inter-organizational relations, only of their *imprints*. One of the major advantages of networked regional innovation systems is the efficient utilization of resources flowing between agents having interactive contacts with each other. Information is one of the most valuable elements of the flow space of networks. Meanwhile the increasing complexity of the operation mechanism of enterprises and the increasing degree of specialization increase the

demands for services as well (*Burt,* 1992). Thus, I am on the opinion that the access to information and the finding and the utilization of the most convenient service providers can be more efficient through building contacts and cooperation networks which also enables actors for establishing them at the same time. During the assessment of *information demand based relationships* all the queried firms had to evaluate[2] twelve different information sources from the aspect how they are important for their competitiveness. Besides internal information sources eleven other sources of information were listed on the questionnaire. They covered all the elements of the innovation system such as market and institutional source[3] but personal contacts and public forums[4] were also mentioned on the list. The directions and composition of the company's information demands can be regarded as a variable assessing contact system as it shows who are open at what agents of the innovation system and at what degree of intensity for the sake of increasing their own competitiveness.

The relations between the region's innovation oriented organizations are making up the second set of relational variables. The interviews revealed more than 25 *forms of contact* (*Table 2*).

The range of interdependency may vary from proprietary relations to the mere exchange of information or professional cooperation. There can be *three types of relationship* differentiated which involves a kind of ranking sequence regarding the degree of interdependency.

In case of *'interdependency'* the interconnection of proprietary, checking and coordinating licenses stands as a basis and it can further be enhanced by the layers of project and information-based relationship. '*Project based*' inter-organizational relationship is an interconnection stemming from some kind of common activities for a definite period of time for performing partial or complex tasks. The '*info-professional'* linkages are presumably the most frequent channels of relationship in the system, which do not even require setting up a common, coordinated target.

By simplifying the real picture and interpreting it as a model *we can observe the simultaneous presence of three 'forces' in the networking process of the system*. In certain cases corporate interdependency (proprietorship, overriding decision and coordination, funding etc.) serve as a ground for the coordination of activities. Furthermore, on the basis of external and internal motivations – incited and coordinated through a tendering system – temporary projects act as coordinating and tuning forces in the region. And finally for increasing the efficiency of the members and of the info-professional flow tracks are lubricating the operation

[2] The degree of importance was grouped into three categories: the contribution of the given information source to the firm's competitiveness could be high, medium or low.
[3] Customers, suppliers, other entrepreneurs, universities, innovation and technology centres, business promotional and professional organizations.
[4] Conferences, fairs and displays, scientific and professional publications.

of the whole machinery in which the communication mechanisms necessary for the performance of own tasks are the most frequently occurring elements. The initial structure of all the relations of the network (307 links) provides a lot of the probability occurrence of the three types of relations. Of them interdependency is the least frequent (16%), 41% of the total relationships is project based while another 43% of interrelationships has info-professional character only.

Table 2

The contact types of the members of the innovation system

Relationship type	Forms	Features
1 Interdependency	– Proprietary rights, founder, associated partner – Involved in the organization's management by position (personally or as head of organization) – e.g. trustee, committee chairman – General meetings, chairman sessions (for the county or regional level coordination of network) – Funding, crediting and capital investment relationships – Place holding, Office rent	– formal, contract-based, strictly regulated – it may occur that it works only formally or documented in papers only
2 Project based cooperation activities	– Common tender, consortium membership, tender opening and evaluation, tender support – Consultancy rights and function – Cooperation for organization development – Service contacts	– co-influence of formal and informal components – the tightest – predefined timescale – task-oriented
3 Info –professional	– General meetings, discussions, lectures, professional consultations (conferences, workshops, businessman meetings etc.) – Regular exchange of information, bulletin, publications, running a website etc. – Partner finding services, institutional representation, introduction and promotion of institution	– the most frequent contacts – do not necessarily require institutional framework – more ad-hoc character – serves as a basis for network

Note: Obviously interdependency and project-based relationships comprise info-professional relations as well. Thus, this linkage indicates that only these forms of relationship occur while in case of the other two relationship types they are preconditions standing on the basis of common activities or interests.

Source: A survey on the innovation supply side of West-Transdanubia region, 2006.

5 Inter-organizational networks in the corporate sector

5.1 Directions of cooperation and intensity

13% of the enterprises of our sample were involved in the cooperative development of products or processes during the past three years. In the supplementary sample of our innovation survey this rate increased to 30%. If we look at innovative firms only then every fourth enterprises are involved in it. And finally if we look at those firms only that implemented any product or process innovation the ratio of companies with cooperation related contacts reaches the figure of 33%. Of the 205 enterprises regarded as innovative in our survey 56 reported on some kind of development-oriented cooperation in the research period. In the further part of my analysis I will concentrate on this special group only and my statements will be relevant to this group, instead of the full circle of entrepreneurs.

Let us start from the probability of occurrence of the different organization types (*Table 3*). It refers to *the role of the different institutions of the innovation system in developments*. Most of them are grounding their new product or process innovation on their own supplier contacts. They can be regarded the most important cooperation partners in the relation system of innovations. Customers/clients have moderate but still important role in innovation-oriented networking as they got involved into it at 40% of the enterprises. Cooperation within a firm group is regarded as a special case (36%). The region's knowledge generator and transfer institutions and innovation-oriented organizations have much less weight in the development oriented contact system of enterprises. 20% of the queried 56 firms cooperated with a university or with a kind of expert or research-development organization and only 16% reported on cooperation with innovation centres or business promotion foundations.

The results make it clear that 1) the majority of enterprises is a 'lonely wolf' implementing their innovation projects on the basis of their own resources; 2) if the region's typical firm is not the only one who implements *innovation it can predominantly count on its own major business partners: suppliers and customers*. All the other components have only marginal role in the innovation system. *The complexity degree* of development-oriented networks tells a lot of information on the structure of cooperation chains. This value is not very high. 40% of firms cooperated with maximum one organization and another 20% cooperated with maximum two partners during the development of a product or manufacturing process.

Not only the number of businesses involved in development-oriented cooperation is low but also if we ever can speak of such inter-organizational relations in the majority of cases *they cannot be regarded as a complex system*. At most companies a development oriented contact system is not unidirectional but as it can be

seen supplier and client/customer centred. Those who have only unidirectional contacts within innovation system are cooperating with their own suppliers only. Only one fourth of the queried firms can build complex structured contact systems. To sum it up we say that the number of innovation-oriented contacts targeted at the realization of common development projects is low, contacts are one-dimensional and built on already existing supplier and customer relations. The other actors of the innovation system (especially knowledge generator and transfer organizations) are only in a few cases have key position in the networks of innovators.

Table 3

The probability of occurrence of organization types involved in development-oriented cooperation

What type of organization did your organization cooperate with during development process?	Yes, %
Suppliers	61
Clients or customers	43
Other enterprises within the firm group	36
Universities, colleges	21
Experts, private R&D institutions	21
Innovation and technology centres, business promotion organizations	16
Public research institutes	04

Source: A corporate survey on the innovation activity of the enterprises of West-Transdanubia, 2006.

The *expanded version of our survey* on innovation projects is investigating any kinds of interdependency among 205 innovation-oriented enterprises. We did not inquire about the 'details of the exchange action' the sole criteria' of inclusion was that the enterprise should report us the type of its innovation-related partners. The *probability of occurrence* of partners in this case was similar to the values of our limited survey (*Table 4*). Here the frequency of the occurrence of market-oriented contacts is the highest. 75% of enterprises did not build their contacts on knowledge (university and research expertise) and neither on innovation and business promotion institutes who were also excluded from their network building strategy.

A kind of layer scheme can be outlined on the basis of the *complexity of contacts*. 11% of contacts are isolated and more than 40% is oriented towards concentrated cooperation by building relations in one direction. In the institutional sphere 15% of the total firms had complex structural cooperation activities. These

results are verifying the prognosis set up in the earlier part of this paper. *The majority of the region's enterprises are not embedded into the wider system of innovation beyond the economic sector not even through a bilateral form of interdependency*. For us comprehensive and complex contacts are important. In their characteristics there are several significant differences at many points. Companies seated in big cities are over-represented (90%) and 40% of firms with complex contact systems receive more than one billion HUF gross revenue annually (their ratio is 17% in the total sample). 65% of the total 17 innovative big firms have a complex or comprehensive contact system. On the basis of a combined firm typology based on the sum of annual gross revenue and on the number of employees we must say that the role of gross revenues is very important in contact building. Among micro, small and medium-sized enterprises firms with comprehensive and complex contact system were over-represented in all cases.

Table 4

The frequency of occurrence of innovation-oriented inter-organizational cooperation relations

Directions of inter-organizational innovation-related cooperation relations	%
Suppliers of equipment, materials, spare parts or software	75
Clients or customers	74
Competitors or other enterprises within the sector	33
Experts, private R&D institutions	26
Universities, colleges	24
Innovation and technology centres, business promotion organizations	21
Public research institutes	08
Had no contacts with any organizations between 2003 and 2005	10
N=203	

Source: A corporate survey on the innovation activity of the enterprises of West-Transdanubia, 2006.

From the point of innovation system I would like to highlight two tendencies. The integration between the corporate and the innovation service provider, knowledge generator and transfer sector can clearly been identified through two very different set of actors. *The present key players here are big firms and small-sized, knowledge intensive development companies*. In their case the frequency of occurrence of cooperation strategies involving not only customers and clients but also research institutes, universities, innovation and technology centres into their action plans is one and a half – twice higher than the average.

5.1.1 The spatial differentiation of contacts

The spatial breakdown of cooperation contacts between each institute is also worth for analysis. This is necessitated by the fact that the entirely different functional elements of the innovation system might show a totally differing spatial concentration. To make it simple the question in this context is where the cooperation partners of firms are located (*Figure 1*).[5]

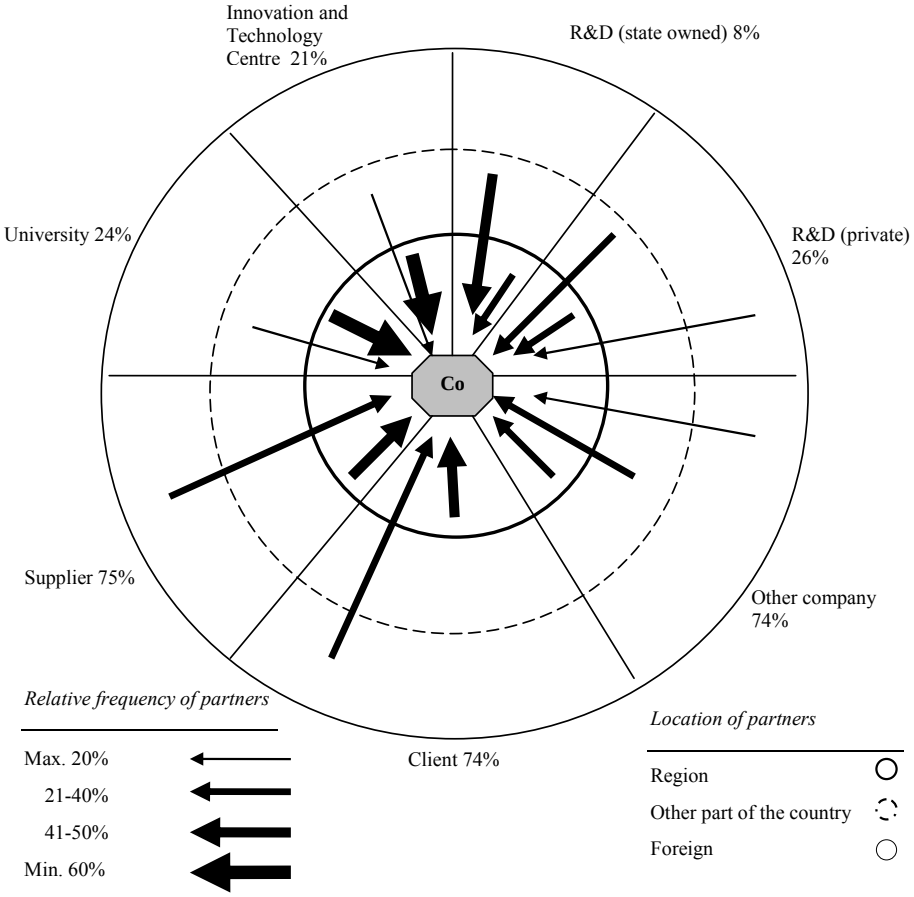
The enterprises integrating into the regional system of innovation have very different parameters of spatial distribution and *the spatial features of their contacts targeted at different types of institutions also show very differing patterns*. In case of the companies of business sector supplier and client contacts are predominantly bilateral. In their case the frequency of occurrence of regional and foreign partners is the highest. R&D institutions have more or less an equal rate of contacts with regional level and national level partners. Spatial proximity, the knowledge and supply profile tailored to local facilities and demands are very important factors of universities and innovation institutions. In this aspect more than 60% of enterprises have contacts with the region's institutions only (and in case of contact building with universities this figure goes up to 72%).

To put it simple *three spatial organization schemes can be set up* in this context. 1) In the most frequent inter-firm market oriented cooperation scheme two firm groups can be differentiated. The first group (42% 46%) has innovation cooperation partnership with suppliers or clients within their own region only. The second group (30% 30%) has a spatially complex cooperation system expanding up to international dimensions. 2) Both public and private research organizations have partners from other regions of Hungary and 28% of private R&D organizations have even foreign partners. 3) From the point of regional innovation system it might be very important that the majority of economic actors cooperating with universities, innovation and technology centres, business promotion organizations (21–24%) have so far established contacts with those operating in their own region. This is the field where space has the strongest impact on contact building and development. Presumably the value of local tacit knowledge, of special expertise and of interpersonal relations is dominating in building such types of contact.

[5] The data of the spatial breakdown of contact forms can be categorized into four spatial categories but they are not exclusive. The 'dominantly other region' label truly means that the firm has no partners in the region, the 'everywhere in the country' label means a homogenous country-wide dimension of contacts while the 'in foreign countries as well' category refers to such firms that have cooperation partners in all the four spatial categories.

Figure 1

*The spatial features of the cooperation contacts of innovative firms grouped by the seven types of interaction**



* The name of interaction type is followed by its full occurrence ratio. The arrows indicate how much percentage of enterprises has cooperation partners in different spatial categories (going outside from inside: region, country, foreign countries). For example 60% of those firms that had contacts with universities had this partnership with a higher education institute within their region.

Source: A corporate survey on the innovation activity of the enterprises of West-Transdanubia, 2006.

5.1.2 Information exchange networks

Information flows through networks. The access to new, up to date information influences the total palette of economic activities. Today the mechanisms and structures providing quick, fresh and not redundant knowledge and information for institutions are considered as key resources of power and their importance has significantly increased. Bogatti and Fosters (2003) labelled them and their researches as 'access to resources'. Mark Granovetter (2005) researching the impacts of networks on economic processes considers a major argument that they are influencing the flow and quality of information. Ronald S. Burt (1992) analysing the social structure of competition demonstrated that a network having been built on inter-organizational relations is valuable itself as it creates information and information-related advantages for the actors adequately embedded into the system.

For these reasons I would like to continue the presentation of the network building activity of the region's enterprises by *typifying their demands for contact through their 'degree of hunger for information'*. Assessing the demand for information by the hunger for information means measuring the degree how much importance do firms attach – with the purpose of preserving their competitiveness – to such information sources as customers, suppliers, universities, research institutes, consulting and development organizations, professional federations etc. The data collected help us to understand the characteristic features of relation (information exchange) serving as a basic texture for the interdependency of knowledge generator, consulting and developmental organizations.

Information sources are structured in a surprisingly diverse way in the region (*Table 5*). Most firms use personal contacts i.e. interpersonal relations and the notes and remarks of their own clients/customers for gathering new information, for orientation and for decision-making (concrete elements of the content of information were not specified). A great number of enterprises consider the role of professional forums, fairs, publications, suppliers, other firms in the firm group and other players within the sector also very important. These are signs indicating a normal/expectable functioning in the economic sector. The rank of distribution is highlighting the weak points of the system as well because 75-80% of firms do not pay any attention for universities, research institutes, consulting and developmental organizations. These firms have not been embedded into this very important, new and increasingly dynamic network of information flow. The region's typical enterprise for the sake of preserving its own competitiveness focuses on its interpersonal network resources and – from functional aspects – on partners: clients and suppliers.

The affinity for innovation significantly differentiates the demand for contacts manifesting in the demand for information. On the one hand almost every chan-

nels of information – the breakdown percentages are higher and on the other hand their information background is more complex. Big firms' hunger for information is much different (bigger) and built on a more heterogeneous resource base with a more complex structure of an average market-oriented viewpoint of a regional level enterprise. The difference is extremely big in the complexity of information channels where more than 20% of non-innovative enterprises did not use any information sources at all.

Table 5

The probability of occurrence of the most important information sources for the enterprise's competitiveness (N=303)

Information sources	%
Personal contacts, acquaintances	81
Clients or customers	79
Scientific journals and professional/technical publications	73
Member firms of the enterprise or firm group	71
Suppliers of equipment, materials, spare parts or software	71
Conferences, trade fairs, displays	67
Competitors or other enterprises within the sector	64
Professional or industrial federations	61
Experts, private R&D institutions	35
Universities, colleges	24
Innovation and technology centres, business promotion organizations	23
Public research institutes	20

Source: A corporate survey on the innovation activities of the enterprises of West-Transdanubia region 2006.

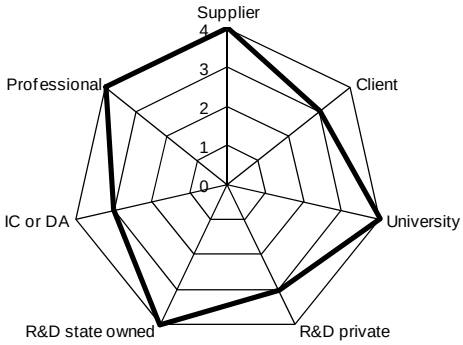
We will get a more complex image on the degree and structure of embeddedness into information networks if we sort the queried enterprises by the importance attitude attached to the different sources of information. This we call as the structure of information system and it can be assumed that the sample *can be divided into separate, homogenous clusters with homogenous firm profiles*. By cluster analysis we can differentiate eight groups in the full database of firms (*Figure 2*).[6]

[6] The values indicated on the axis of the web diagram are indicating the importance of the types of institutions – as information sources – from the aspect of competitiveness/innovativeness of firms. (1= plays no role; 4=plays an important role). Thus, higher values can also indicate the intensity of information flow related interdependency. The higher this value is the greater is the importance the

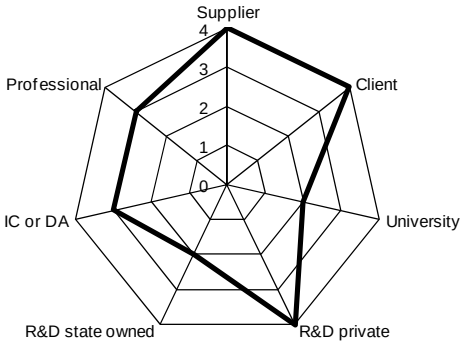
Figure 2

*Firm profiles based on the structure of the information contact system**

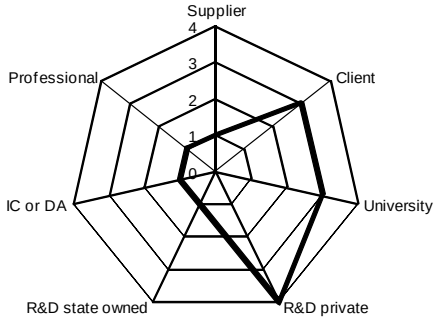
Spider – 6%



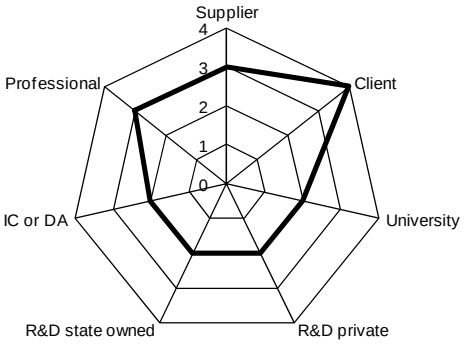
Market-oriented integrator – 5%



Client-oriented developer – 4%

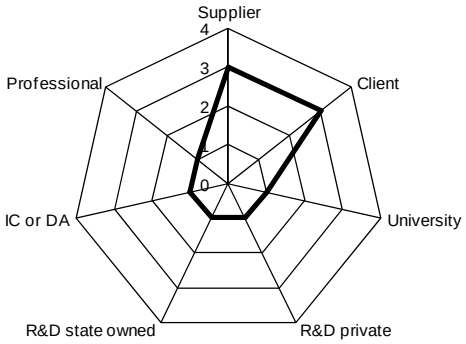


Open manufacturer – 12%

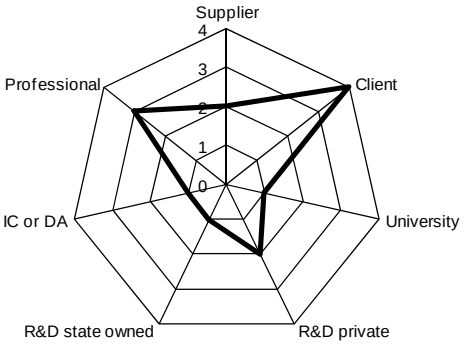


enterprise attaches to the type of organization from the point of its own competitiveness. The eight groups were separated from each other by cluster analysis (two-means cluster) by the application of seven ordinal measure level contact variables. The 'R&D private' label marks private funded research-development organizations and consultants while the 'R&D public' label refers to public research institutes, research groups; Professional = professional and industrial federations; Innovation/Development = innovation and technology centres, business promotion organizations.

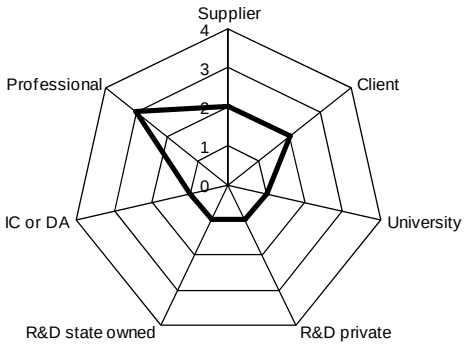
Closed manufacturer – 23%



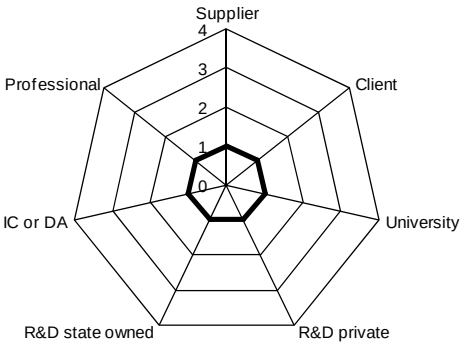
Client-oriented service activity – 19%



Moderately isolated professional – 13%



Island – 18%



Source: A corporate survey on the innovation activity of the firms of West-Transdanubia region, 2006.

The structural differences of contact systems built on demands for information are matching with the earlier conclusions drawn from the spatial breakdown data. 10% of firms in the region can be defined to have a complex information system. The '*Spider*' is such an enterprise which intensively builds on institutionalized information contacts and considers multi-lateral connections very important for information flow. Market '*Integrato*' has a similar structure but attaches lower importance to universities and public research institutes and preferably involves private firms into its development projects. *The 'Customer Oriented Developer'*s (4%) information contact system is unilateral: it considers universities, research institutes and customers the only important sources of information.

In the rest of groups the information source base structure gets simplified (as only one or no axis shows intensive demand for information). The '*Producer*' type enterprise primarily focuses on its customers and suppliers: one fourth of the queried firms are '*Closed Producers*' as their activity is based on such information sources. 12% are '*Open Producers*' as their information providers are several types of institutional contacts but they preserve the high importance of internal market zone (especially customers are important for them). The typical '*Service Provider*' type actors (19%) on the one hand consider information flow important on the side of their customers and professional organizations but they neglect building contacts with the organizations of the knowledge generator, consulting and development sector. '*Profession oriented' enterprises* (13%) are not fully isolated, their demand for information flow is low, they use only the information channels of professional organizations, production oriented suppliers or customers but they do not appreciate them too high from the point of competitiveness. '*Islands*' (18%) are such lonely wolf firms that do not see any importance in any institutional info contacts and keep themselves intact from them or at least they refrain from the complex information packages flowing in the economic sector.

The structure shaping up from the different directions of contacts can roughly be summarized as follows: *10% of enterprises have complex information background* and *15% use the facilities of knowledge generator and transfer organizations* intensively as additional sources. The dominant behaviour in the majority of cases is openness towards the actors closely bound to the firm's activity (35%). *20% of the participants of survey are customer oriented firms and about 30% are definitely isolated, lonely wolves building only occasional channels of professional information*. The forms of structure – although they are not exact copies of the cooperation contact system – are suitable for expressing the openness and *orientation* of the actors of the economic sectors. On estimation level on the basis of the given proportions there is a possibility to build a classification system on the region's economic actors by their demands and affinity for cooperation. On the basis of this assumption it seems perhaps not an unrealistic deduction that the majority of firms (55%) may be interested in participating in producer-servicing networks and a rather significant group (30%) is maintaining a dominantly isolated activity and only 10–15% have a complex structured cooperation network system.

The characteristic features of these firms are differing in many aspects. There seems to be a correlation between the affinity for innovation and the structure of information basis. In the first three firm groups the proportion of innovative firms is above 70%. The revenues of spiders and integrators with complex demands for information and with built on complex information systems are the highest, they have high demands for skilled labour and their research-development expenditures are also by far higher than the average. In the group of spiders the ratio of

small enterprises and in the group of integrators the ratio of big firms is higher than the average. In the big producers' group there is also some correlation between the affinity for innovation and the demand for information. Among other producer firms the ratio of innovative and high-skilled employees and research expenditures is by far higher than the average. Closed producer firms are smaller with lower income and under average parameters of innovation. In the schematic structure of information demands it is the group of isolated lonely wolves (the last two groups) who have the lowest number of innovative enterprises with by far lower than the average R&D expenditures.

6 The network structure of the regional innovation system

Mapping the contacts of the region's enterprises helped me to detect interactions within the economic sector and the special features of contacts targeted at other actors of the system but did not help in analysing *the structural features of the whole system*. This task can be performed on the *provider/supply side* of the innovation system. Thus, I am going to give an overview on such inter-organizational cooperation activities which may be involved in innovation or participating in research-development processes (e.g. universities, research institutes) or supporting, facilitating (innovation centres, technology centres, business promotion organizations, chambers), coordinating (development agencies, innovation agencies) or forming such networks which integrate all the actors of an economic sector (clusters). The corporate survey was targeted at verifying that the connection between the economic and the public sector is weak and casual and the transfer and division of resources on system level is inappropriate therefore all these are hindering the integration and networking of the regional innovation system. My analysis of the 'service' sector is starting from the assumption that *the interrelationship between non-economic components and structures is treated as a comprehensive network which is also influencing the efficiency of innovation processes.* Thus, this organization system should also clarify its relations as this can serve as a basis for a future network.

Before the empirical analysis of the network it is necessary to take a short turn-out. The typifying of interdependencies highlighted the importance of the different competition based and organizational type relations. They reorganize both the activity and information based relations and their dynamic development started during the past few years as a result of the 'reform' of the Hungarian innovation system. Practically we are talking of such top-down interventions which - as a regional imprint of interventions taken for the development of the national innovation system – generated changes in the organization and development of the network (*Lippényi–Imre–Peredy,* 2006: 47–52). The 'reform programmes'

launched during the last two or three years reconfigured the earlier structure of the regional innovation system through two mechanisms. On the one hand a fundamental restructuring can be seen on the level of network members which can be interpreted as an *extension of the network*. On the other hand such fundraising, distributional and controlling *mechanisms* were introduced in decentralized forms which generate new roles and the driving engine of cooperation can work not only on the level of research-development but of the coordination system as well.

The comprehensive reform of the innovation system started in year 2003. In 2003 an *Act was passed on the Research and Technology Innovation Fund* (KTIA). This is a separate government fund consisting of company contributions (in 2006 this was 0.3% of their total annual turnover) and from matching government funding. As companies can reduce their due contributions to the Innovation Fund by the sum of expenditures spent on their own or ordered from public or non-profit research institute R&D activities the number of R&D profiled institutions quickly started to grow and a more intensive cooperation started between the economic and research sectors. Thus, the number of system members and the affinity for cooperation may gradually increase. On 1st January 2005 the *2004 CXXXIV Act on Research-development and Technology* came into force. This is Hungary's first innovation act facilitating research-development, technology innovation and the utilization of results comprehensively by several provisions. I would like to highlight the importance of provisions targeted at the funding of innovation and at the utilization of results for intensifying cooperation within the framework of the regional innovation system.

In year 2004 not only new legal regulations but also *new actors* emerged in innovation policy. The Science and Technology Policy Council (TTPK) is the top level governmental forum of science, technology and innovation policy. The National Office for Research and Technology (NKTH) with national authority scope considers the improvement of the regional system of innovation with the enhancement of cooperation between the knowledge and business sector its most important task. The Research Technology and Innovation Council (KTIT) is responsible for the planning, operation and utilization issues of the Fund. And finally, the Office of Research-development, Competition and Research Exploitation (KPI, operating since the August of 2003) is managing the innovation programmes of KTIA and GVOP [Economic Competitiveness Operative Programme].

From the perspective of this research the *reforms having been introduced on regional level* are the most important issues and they created new actors and directions of cooperation during the past few years. The presentation of secondary data revealed spatial disparities in the elements of the national innovation system. As it has negative impacts on the development of the whole national economy an increasing attention is paid for developing the region's innovative skills. This

means more or less a series of simultaneous strategic interventions. One of the most important ones affects KTI Fund as 25% of resources should be utilized for regional-level purposes. This is a known regional basic problem as it may force regional cooperation as a measure for tackling economic development problems arising from living in an environment poorly provided with resources.

In 2004 two programmes of key importance were launched for creating an institutional and instrumental system facilitating knowledge generation and transfer (2006; 51). The Pázmány Péter Programme by stimulating the utilization of the university's R&D results and cooperation with the industrial sector enters new actors into the network through *university knowledge centre*s (RET) which is in this way can influence the direction of contact schemes and their composition. The establishment of the network of *regional innovation agencies* is a key element in the Baross Gábor Regional Development Programme. Since the end of year 2004 the system has been expanded by such a new actor which stimulates the cooperation of the R&D and entrepreneurial sectors by providing information and various innovation services. The *Innocsekk* Programme which started in 2005 is also targeted at stimulating regional cooperation through providing support to micro and small enterprises who are engaged in innovation related initiatives. And finally, the role of *regional innovation development programme package* should be mentioned here as it provides a chance for regions to determine their own development priorities in the awareness of their own local circumstances so 'it depends on the regions' own activities how much support they will receive from the regional resources of the Technology Innovation Fund and how they will use it for increasing their own competitiveness' (2006: 52).

Institutes of higher education and research centres are the oldest players in the system. The chambers' network and the institutes of business promotion were established in every county in the first half of the 1990s. Innovation centres and regional development institutes entered into the system in the second half of the 1990s not much earlier before the millennium. This means that one part of the institutions of innovation has at least 8–10 years of experience and they put such amount of knowledge and competence portfolio into the innovation network. These organizations in fact belong to the historical core of innovation network. The clusters, competence and knowledge centres attached to universities are new, just formulating so in this way they are just 'way seeker' types of organizations. Consequently, research is done not of just on the network which is not only a structurally complex and heterogeneous system but also has a chronologically divided structure.

6.1 Centralization

The analysis of *network positions* was always a cardinal issue in the complex structured attitude of network analysis. The identification of the central elements of network and the impacts of the over-centralized structure are unavoidable issues in a general analysis. The question here is that who are the key players of innovation cooperation network and of the system formulating from it and what is the centralization degree of the whole network?

The literature reviewing the *interrelations between network structure and positions in the network and affinity for cooperation* shows several proofs. Gulati and Ganguilo (1999) referred to the fact that the probability of cooperation increases if there is a common partner between the two partner institutions. In this way the key players are intermediaries who can push the different players of the system towards cooperation by their pure existence and their extensive ego-networks. They also proved that central position in the network increases the probability of their own cooperation. Moreover, key players prefer cooperating between each other. Williams (2005) approached this question from another aspect and surveyed more factors such as formalization, density and stability. He was on the opinion that over-centralization and concentrated power in the network would decrease the chances of cooperation due to the companies' striving for autonomy. It is evident that the first opinion is more relevant for an institution while the second one better fits for networks as a whole. If we get acquainted with the key players of the system we will get a more detailed impression on the hardcore group who have greater affinity for cooperation. If we get exact information on the degree of the networks' full centralization it will be possible to decide whether the presented institutional structure works for or against cooperation.

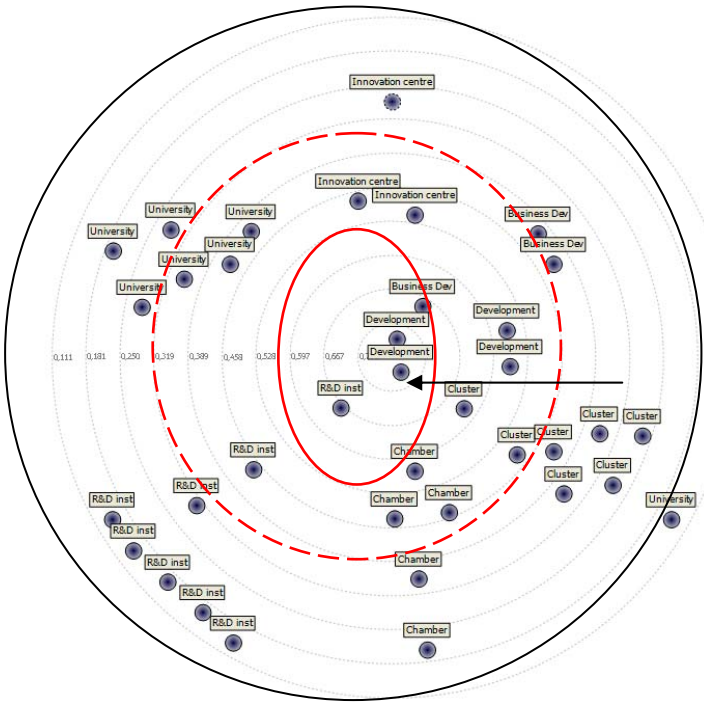
I apply the three classical, most frequently used basic indexes in my analysis which starting from the number of the degrees of proximity and of transitions will give a standardized transition index of the whole network and of the members. During the definition of indicator figures *let us start from three assumptions*. 1) The value of the degree is correlating with the central role. Innovation organizations having extensive contact relations within the network play more important role within the whole structure. 2) Those players have central role who are the closest to the other members of network from the point of accessibility. This means they have not only many direct contacts but also their indirect contacts are short in such a sense that they do not need many intermediaries. 3) A player is successful in the network because it plays intermediary role either between two members or between two groups. Thus it takes such a position where his role is indispensable therefore just cannot be avoided. It seems evident that by the three methods we can identify the central players of the network by different aspects. With the simultaneous application of these methods it can more clearly be seen

who play the role of core organization within the cooperation network of the region's innovation system (*Figure 3*).

In the network of concrete cooperation contacts the centralization indexes are relatively higher so the centralization of the network should be accepted as a fact. *There are significant differences in the positions of organizations* within the system. A small group bears extraordinarily high values while the majority – I mean the peripheral zone of the figures – cannot be regarded as key players in fact. It is clearly seen that the majority of educational, research and cluster type organizations are in peripheral position by all the three aspects. On the given organizational level the nucleus of the network consists of developmental organizations of some active chambers, business promotion organizations, innovation centres and cluster organizations.

Figure 3

Interdependency and the indexes of central position in project-based contacts



Degree centrality-DC

Network centralization index
42.5%
Average centralization index 0.254
Smallest 0.056
Biggest 0.667

Source: A survey on the innovation supply side of West-Transdanubia region.

I would like to emphasize that there are significant differences even among central positioned organizations in indexes and the West Pannonian Regional Development Agency has an outstanding role in cooperation organization showing high values in all the three indexes. The *simplicity* of the picture results from the fact that the majority of central players as members of the innovation agency have close contacts with each other formulating an internal network within the network system. Thus, as a whole the system's central players can be identified by relations standing on the basis of institutional cooperation and originating from the requirements of competition and support schemes. There are extremely big differences among members in the university and research sector and the newly formed clusters are not valid network points.

Concerning the centralization parameters of the system's interdependencies I would like to call the attention for *two important characteristic features*: 1) There are no signs of independent from innovation policy incentive cooperation configurations in the system. If there were any then centralization index values would be more equalized. 2) Whatever network dimension is taken as a basis and whatever centralization index is applied the players of the education and professional training sectors (here I mean not only university knowledge centres of cooperation research) are rather only joint agents of the central core structure but they cannot be considered as integral parts of it.

6.2 Ego-networks in the network of the regional innovation system

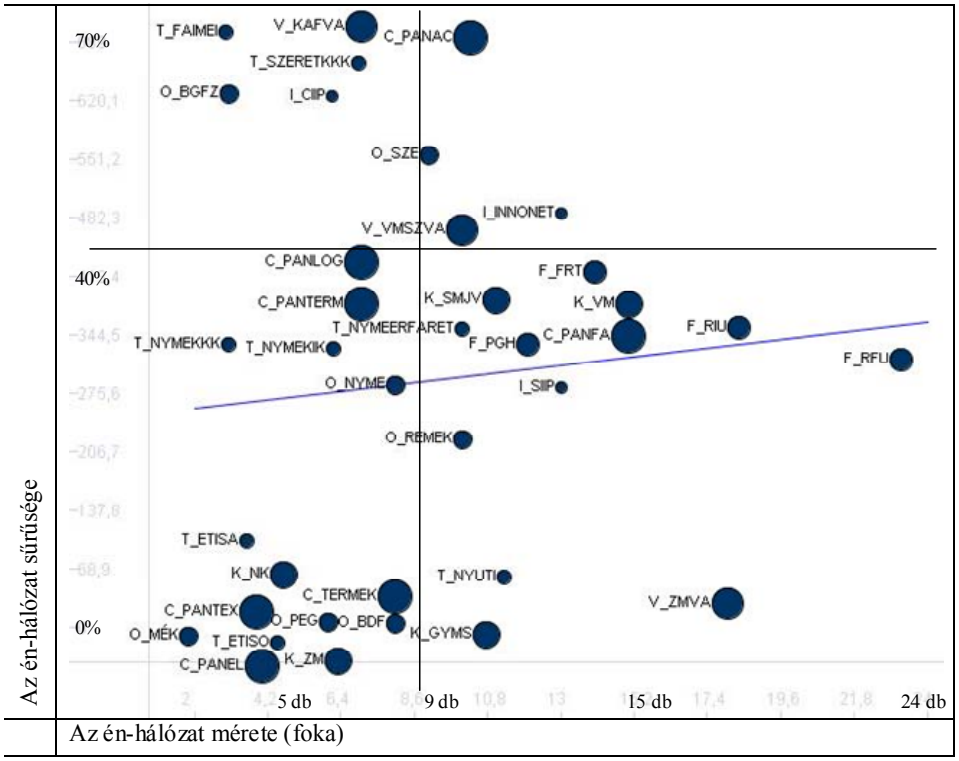
The characteristic features of the direct contact system can also be analyzed by taking both the *degree* (the number of contacts) and the density of ego-networks (the probability value of cooperation between partners) into consideration. By the application of such method several cooperation contact patterns can be identified: 1) complex but of low density; 2) complex and of high density; 3) small but dense; 4) small and low density ego-networks can be formulated in the region *(Figure 4)*.

By following a *vertical* logic the density of the organizations' direct individual contact system can be grouped into three categories: below average, average and very high density ego-network. The differentiating feature here is the intensity of cooperation in the organization's contact scheme. Naturally it really matters how big the network is – this is the reason why making a *horizontal differentiation* is necessary. Eight organizations types can be separated in the lower left corner of the figure (university, research-development and cluster sectors) integrate into the network of the regional system through no or very few contacts but their partners are isolated from each other. In the upper left corner of the figure we can also find members of the network with low number of contacts but the density of their ego-

networks is very high therefore they have partners of similar indicator values who also cooperate with each other (here we mean an approximately 60% network density indicator). Typical organizations with average indexes are located in the central zone. As it is expected the density of the ego-network of central positioned organizations cannot be too high due to their known summarized parameters (the blank zone in the upper right corner). For an easier interpretation of the different configurations of ego-networks I would like to cite just some examples: the Pannon Automotive Cluster's (C-PANAC) own cooperation system is built on higher than the average number of cooperating partners who also cooperate with each other.

Figure 4

The size and the density of the actors' ego-network in the innovation system – interdependency or project oriented cooperation



Legend: average size (degree) 9, average density 45%. Dot sizes mark different organization types.
Source: A survey on the innovation supply side of West-Transdanubia region, 2006.

The Zala County Business Promotion Foundation (U_ZMV_A) plays a central role in the system because on the one hand it plays an intermediary role among partners isolated from each other. The Regional Development Agency (F_FRFU) has contacts with almost every actor and for this reason its ego-network cannot be very dense. The Material and Product Testing Laboratory of West-Hungarian University (T_FAIMEI) cooperated with four organizations only but this network consists of partners cooperating with each other as well. As a whole, the ego-network structure of system members is not homogenous and it has not a strong correlation with the organization profile either. The low angle of regression line indicates weak relation between size and density in the network.

6.3 Beyond the organization – contact points between the types of organizations in the system

The cooperation matrix between the 37 queried organizations can be suitable for an empirical description and interpretation of the patterns of the intra- and inter-sectoral cooperation in the region. In other words: we transform the network into a simpler form where instead of the earlier 37 actors we work with seven, namely with seven types of organizations. The relations between the organizational segments of the innovation system are generated by the aggregation of inter-organizational relations. On this level of the network we can find an answer for the question, how the internal and inter-organizational cooperation affinity of different organization types look like on the level of closer cooperation contacts. The *block model* analysis was introduced by White – Boorman – Breiger in the 1970s (1976)[7]. In our network the following criteria can be applied. The density of the network is 25.4%. In this circumstance we assume any contact between two organizational segments if between all of its members more than 25.4% of all the possible relations are realized. To put it simple if the probability of interdependency between the two segments is higher than the average value measured for the whole network.

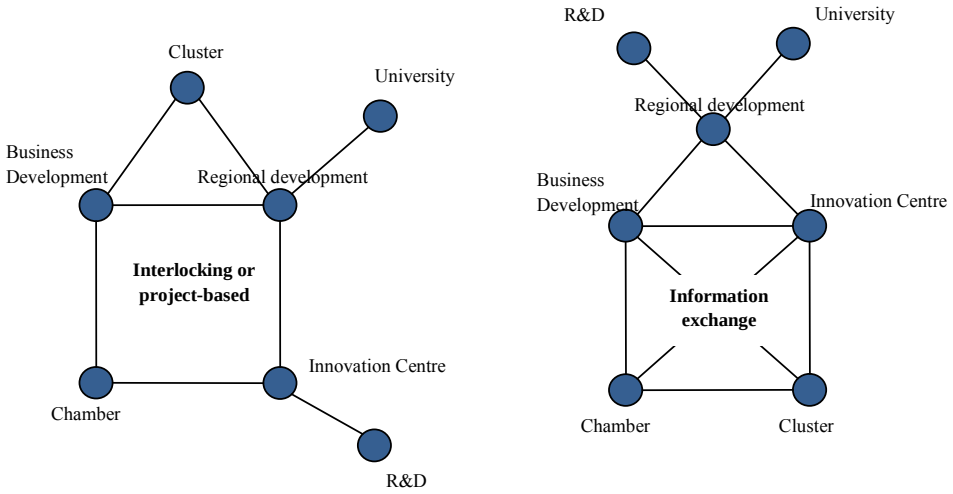
The answer for our original question may be found in the contact network shaping out from the new block matrix. Thus our target is checking the fragmentation degree of inter-organization relations within the regional innovation system

[7] To put it simple it means that the members of the network are divided into structurally equivalent positioned parts – blocks – and these equivalent 'classes' are named as positions – then by the application of a so-called block model analysis we map the strength of bindings between positions. Several criteria exist for the identification of bindings within and among blocks. The essence of *density criteria* applied here is that the density of the network is taken as a basis, as a limit value and if the density of contacts within each group or between groups is higher than the average of the whole network then we can define it as a contact (*oneblock*) but if it is lower we cannot define it as a relation (*zeroblock*).

and the mapping the missing links between the 'knowledge generator', 'transfer' institutions and those organizational blocks who are involved in the 'utilization of innovation' and in the development of the region *(Figure 5)*.

Figure 5

The density matrix and block network of contacts among the different institutional types of the system



Density table	Innov.	R&D.	Higher ed.	Dev.	Chamber	Business Prom	Cluster
Innovation	0.67	0.25	0.19	0.75	0.27	0.56	0.04
R&D		0.32	0.14	0.19	0.10	0.12	0.10
Higher education			–	0.35	0.17	0.14	0.22
Development				0.67	0.25	0.75	0.75
Chamber					1	0.27	0.11
Business Prom.						1.00	0.29
Cluster							0.19

Density limit value: 0.253
Source: A survey on the innovation supply side of West-Transdanubia region, 2006.

Figure 5 is demonstrating the essence of our whole empirical survey. From a remote and deforming or to name it as a simplified perspective it gives an answer to our question and verifies the fundamental thesis of earlier surveys and strategic situational evaluations concerning West-Transdanubia region. In case of stronger and more intensive organizational interdependencies, the degree of research and

higher educational institutes is minimal and realized through central developmental organizations only.

The info-professional flow space of the network is operating by a similar principle. Here besides the above-mentioned two problem sectors there are transfer lines between other institutional groups running into all possible directions. *The general problem is that the actors of the research and educational sector are not embedded into the network mechanisms of the regional innovation system on this less formal level of cooperation either.* In general it can be stated that the present integrated network is the result of the top-down oriented institutional reform of the past years. Without regional innovation agencies the institutional actors of science and education would be excluded from the network.

7 Conclusions

The survey has provided several new results. Many of them have verified the hypotheses of this paper and tested the results of former researches on regional level. We consider its most important conclusion that the intensity of inter-firm cooperation has not increased in the last fifteen years in Hungary. The cooperation system is characterized by a low number of entirely bilateral connections and by the absence of complex development and innovation networks. Furthermore the majority of cooperation contacts are closed with partners operating in the economic/market sector. Thus, only a small number of firms have been integrated into the regional innovation system during the past years.

The other major finding of the survey can be seen on regional level. We cannot speak of a fully operating regional innovation system yet instead we can identify an evolving network. The main problem of the structure is that it is organized by a few players only and there are very few signs of making up a bottom-up schemed system of complex cooperation activities. The past 4–6 years of experience are certainly not sufficient yet for making out a clear picture but it seems definite that the key parts of the innovation system are not free of problems: the absence of decentralization, unsolved cooperation issues, anomalies in the distributional system of resources, the malfunctioning of the intermediary system in the region etc.

The mapping of the network between innovation organizations operating in the economic sector has revealed the position and relation of actors with some elements of the structural logics of the sector manifesting in networks. The methods and procedures applied here may further be enhanced and distributed countrywide to get a more precise picture on the different forms of the complex structures of the socio-spatial organizations both on national level and in the regions standing at various levels of development.

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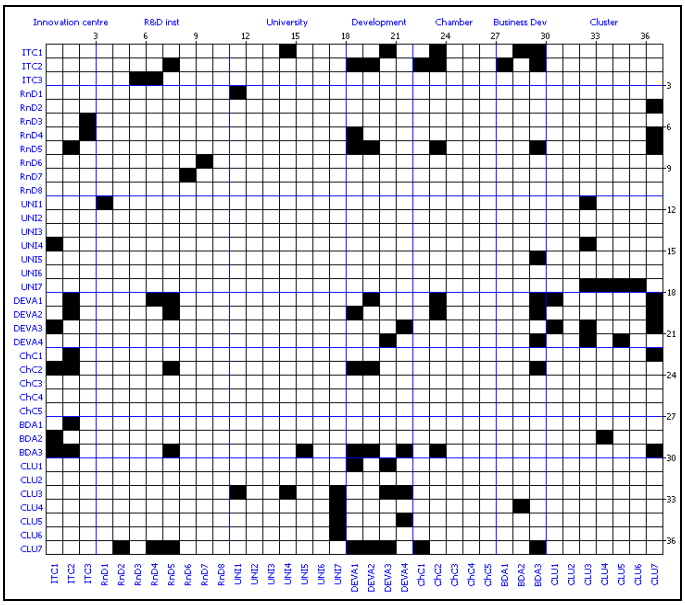
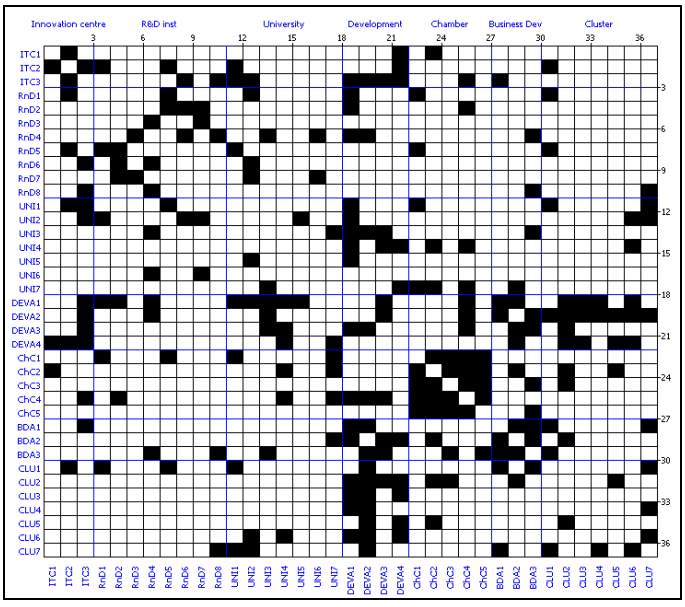
Annex 1

The contact matrixes of the institutional system of innovation

Interdependency



Project



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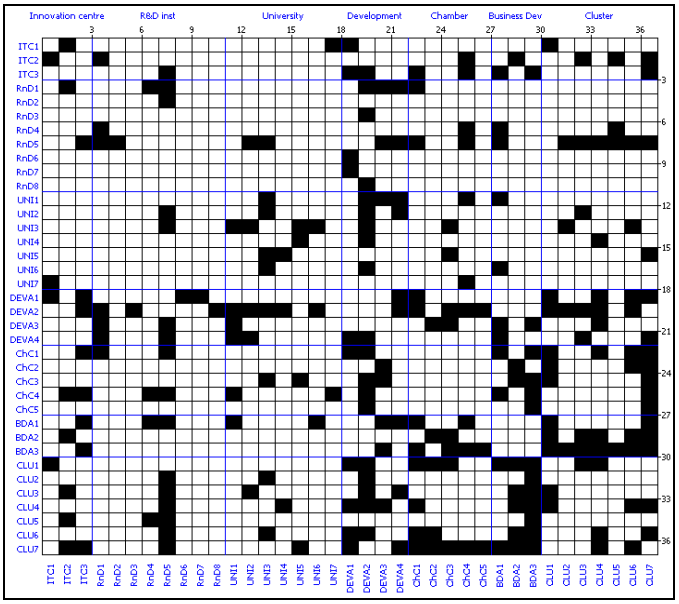
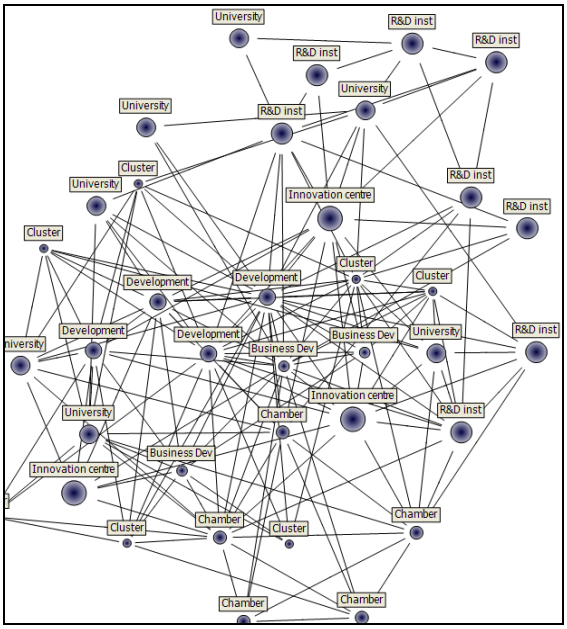
Information-related



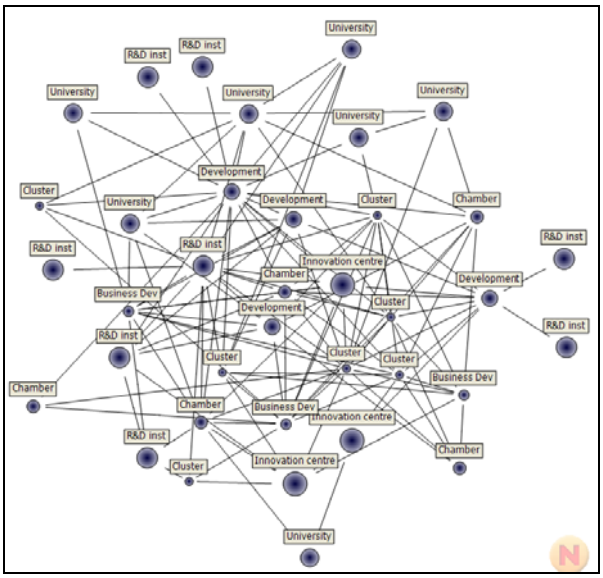
Annex 2

The layers of the regional innovation network

Network 1: Stronger ties – interlocking or project-based relations



Network 2: Weaker ties – only professional cooperation or information exchange



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