“Applying Network Analysis Methodology in the Area of Innovation Diffusion”

Research plan

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I. Field of interest

Nowadays, it is undoubted that innovation activity and its adaptation have become a determining factor in the life of those companies who want to be successful in international competition.

Innovation is a very complex phenomenon. In my research I would like to focus on the diffusion and the innovation flows. I do this because I find that in Hungary the diffusion is more determining than the innovation production in the companies’ life.

II. Research question

My aim is to study and define those determining factors by which the innovation flow becomes describable, and after this, my purpose is to map those kinds of relations and nodes whose absence or existence are the most important in the aspect of diffusion in Hungary.

If I am successful, and I find this kind of relation and node, then I could define those strategically important units, which we have to develop, and maybe I could answer the question: Which is the most effective system structure in the aspect of innovation flows?

III. Methodology

I would like to approach the subject with the help of network analysis. The basic concept of this methodology is that the connections among the actors of society determine the members’ behaviour with each other and with those who are out of the system. According to this I find that this methodology matches my objectives, because with the network analysis I can study the phenomena as a whole, and I do not have to survey only a group of actors isolated from the system. This aspect is important, because the diffusion of the innovation is the production of the interactions among the actors. So I hope, with the help of this methodology I can get new information about innovation flow, which would remain hidden with the other examination’s methods.
IV. The actual stage of research

I am still at the beginning of my research, so I do not have any spectacular findings. I am studying the literature of those essays and researches which use network analysis in the field of innovation research. I would like to find out how I can use the network analysis. Hereinafter I give a little summary about social network analysis and its role in the innovation research.

1.1 The social network analysis

The concept of social network analysis has evolved from the concept of sociometry. Sociometry is the study and measurement of interpersonal relationships within a little group of people (e.g.: in a school class). This methodology examines people’s relations through their sympathy-antipathy choice. After the collection of data there are two describing forms to analyze the group:

- Describing the group with graphs (sociogram), to visualize the relationships.
- Describing the group with adjacency matrix (a binary matrix) by which index calculation becomes possible.

This index serves the characterization of a group structure, and many of them (e.g.: central-marginal index which examine if the group has a huge (egy huge micsodája van-e a csoportnak?); cohesive index which studies the togetherness of the group…etc.) can be identified as a prototype of the network analysis indicator (Szántó, 2005).

The reason why network analysis can be viewed as the generalization of sociometry is that the nature of actors and their relation do not have an influence on the attributes of the network structure. Accordingly, irrespectively of observing a school class sympathy-antipathy choice (sociometry) or the information flow among companies, we practically use the same index, indicators and visualization methods (graphs and matrixes).

The major difference between the two methods is in the meaning of the relations and the type of actors. The differences are summarized in Table (1) below.
### Table 1: The comparison of sociometry and network analysis

<table>
<thead>
<tr>
<th></th>
<th>Sociometry</th>
<th>Network analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examined unit</td>
<td>- persons</td>
<td>- persons, social groups and organizations, nations, regions, etc.</td>
</tr>
<tr>
<td>Matter of the examined relation</td>
<td>- sympathy – antipathy connection</td>
<td>- cousinly, friendly, communicational, transactional, economic contact etc.</td>
</tr>
<tr>
<td>Source of data</td>
<td>- sociometry test</td>
<td>- observation, questionnaire, interview, documents, statistics</td>
</tr>
</tbody>
</table>


### 1.2 The definition and terminology of Social Network Analysis

In this chapter I try to give a summary of the terminology of social network analysis which – in my opinion – makes this methodology more tangible.

A network has two components: the nodes or actors and the relations. The nodes – as I have written in the previous chapter – can be anything: persons, social groups and organizations, nations, regions, patents etc. The other components of networks are the relations among nodes. Relation between two actors (dyad) can be directed, undirected or absent. Figure (1) shows the difference between directed and undirected relations when using graphs.

**Figure 1: The directed and undirected graphs**

1. Directed graphs  
2. Reciprocal directed graph  
3. Undirected graphs
Consequently, the figure shows that in case of directed graphs the origin of the contact can be described, and it can be defined whether the contact is symmetrical or asymmetrical. But this information vanishes if we use undirected graphs, which only show if there is some kind of relation between the nodes. In this case it is also not sure if the relation is reciprocal (Hanneman, 2005).

The network analysis is different from other methods in the level of examination too. With this method the position of the nodes, the groups and the whole network can be analyzed, the examined level depends on the study focus.

We start the network analysis with the description of differences of connections among actors and the distance between actors. These basic analyses give a lot of useful information. The difference of connections among actors helps to understand the actors’ behaviour and characteristics. The node which has a lot of contacts has stronger influence on the others, but the actor is exposed to more information too, that are needed to be filtered. A group with a higher rate of contact can mobilize its resources more efficiently, but its threat is also bigger in case of an epidemic. The distance between actors – density of connections and immediate contact of actors – is also an important factor. Adjacency matrix, geodesic matrix is used to define the basic characteristic of a network.

After the basic examination of a network we could distinguish three big areas of network analysis: power or centrality analysis (which includes the examination of degree, closeness, and betweenness); cliques and sub-group analysis; and the analysis of equivalence. A large scale of methods, indices and indicators exist to calculate these three aspects. The focus of the research determines which methods to use.

2. Network analysis in innovation research

Since 1999 there has been a permanent growth in the number of studies that examine the aspect of innovation with the help of network analysis. This quick development was possible because: huge networks can be visualized due to software improvements that are able to execute the necessary calculations (e.g.: UCINET) (Pajek, NetDraw); the appearance of the international conference sponsored by the INSNA; and the appearance of an electronical journal (Journal of Social Structure) which is sponsored by the INSNA since 2000 (Coulon, 2005).
Coulon examined the studies that used network analysis in the innovation research and that were written in English (Figure 2.).

**Figure 2.: The number of network analysis studies in innovation research per year**


In 46% of the studies examined by Coulon (2005) the nodes of the networks were organizations or firms, 30% of the studies used patents or scientific articles as nodes, in 13% of the studies the nodes were persons or inventors and in 11% of cases the nodes were markets or sectors. Consequently, the most often used observation unit of the studies was companies and patents; their total proportion is 76%.

The data used by 67% of the studies came from the domain of semiconductors and biotechnology. This is understandable first because the patents show the truest picture about the innovation development in these two sectors, and second because they are a good area to examine the influence of geographical closeness/distance on the companies’ relations.

The network size is pretty varied. When the patents or publications are the nodes, the size of network is between 2,000 and 500,000. The network size is lower in those studies that used companies or firms as nodes. In this case the number of the examined units is between 10 and 250 (Coulon, 2005).

In Hungary the use of network analysis in innovation research is rather insignificant. The four areas of network analysis research are (Csizmadia, 2004):
• Theoretical and methodological basis
• Social dimension
• Business, economics, labour market dimension
• Spatial dimension

From the Hungarian authors I would like to emphasize Letenyi’s works, who deals especially with innovation system and innovation diffusion in this aspect (Letenyi, 2000, 2000a, 2000b, 2002, 2003).

V. Questions

Permanently I have three questions to solve:

1. What are those factors by which the innovation flow becomes describable, and how can I measure the diffusion of the innovation?
2. In Hungary which is that industry and spatial impoundment that is the most informative in the aspect of innovation’s diffusion?
3. What kinds of innovation are interesting for me? I write it because I find that in Hungary there are three forms of innovation:
   • Classical innovation – I mean in this expression the definition of OECD:
     “An innovation is the implementation of a new or significantly improved product (goods or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.”
     (OECD and Eurostat, 2005, 46)
   • Adaptive innovation – not a really innovation, just a reformatory, regenerating innovation.
   • Innovation in the application – which means in my reading a combinative utilization of the existing technology or the complex new supply of some existing service.

In the future my aim is to find answer to this question.


Applying Network Analysis in the Area of Innovation Diffusion

Research Plan

Borbála Bodó
University of Pécs
I would like to find out...

- those factors by which innovation flow becomes describable
- those nodes and relations which absence or existence are the most important in the aspect of diffusion in Hungary
- the most effective network structure in the aspect of innovation in Hungary

Methodology: Network Analisys - study phenomena as a whole
Network Analysis

- Connections among the actors of society determine the members’ behavior with each other and with those who are out of the system

- Mapping the connection and examine them
The comparison of sociometry and network analysis

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<td><strong>Source of data</strong></td>
<td>- sociometrial test</td>
<td>- observation, questionnaire, interview, documents, statistics</td>
</tr>
</tbody>
</table>
Social Network Analysis

Basic examination:

- differences of connections among actors
- distance between actors

Three big areas of network analysis:

- power or centrality analysis
- cliques and sub-group analysis
- analysis of equivalence

(Hanneman 2005)
The centrality analysis gives information about the system’s power distribution and about the opportunity and compulsion of the actors with the examination of degree, closeness and betweenness.
Cliques and sub-group analysis

*Examination in the level of system*
- If there is overlapping among the group or subgroup
- How tight the relations in the group

*Examination in the level of the actors:*
- If they are part of one or more groups
- In which group have the actor the majority of its relation
Analysis of equivalence

It examines the actors role in the system by which it try to define the similarity among them.

Two form:
- Structural equivalence
- Real equivalence
Social Network Analysis in Innovation Research

Studies examined by Coulon (2005):

- nodes of the networks:
  - 46% organizations or firms
  - 30% patents or publications
  - 13% inventors or persons
  - 11% sectors or markets

- Size of networks:
  - In case of patents or publications: from 2000 to 500000
  - In case of organizations or firms: from 10 to 250
Questions

1. What are those factors by which the innovation flow becomes describable, and how can I measure the diffusion of the innovation?

2. In Hungary which is that industry and spatial impoundment that is the most informative in the aspect of innovation's diffusion?

3. What kinds of innovation?
   - **Classical innovation**
     “An innovation is the implementation of a new or significantly improved product (goods or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.” (OECD and Eurostat, 2005, 46)
   - **Adaptive innovation** - new for the market and the for the firm; not a really innovation, just a reformatory, regenerating innovation
   - **Innovation in the application** - combinative utilization of the existing technology or the complex new supply of some existing services.
Proportion of the hungarian firms (%) according to the aimed action to improve their competitiveness

<table>
<thead>
<tr>
<th>Actions</th>
<th>Number of employees of the firms</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21 – 50</td>
<td>50 – 250</td>
</tr>
<tr>
<td>Internal research</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>External R+D commission</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>License and patent buying</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Machine and instrument investment</td>
<td>56</td>
<td>66</td>
</tr>
<tr>
<td>Intensive market research</td>
<td>49</td>
<td>44</td>
</tr>
<tr>
<td>Selling network development</td>
<td>51</td>
<td>57</td>
</tr>
<tr>
<td>Powerful advertisement and PR activity</td>
<td>31</td>
<td>27</td>
</tr>
</tbody>
</table>

Source: Pakucs et al. (2002): Magyar kis-közepes vállalatok innovációs képességének fejlesztése
The most of the Hungarian firms belong to the 1. or 2. generation of innovation process (focusing on the technological development or reacting to the market demand)

But there are also firms which belong to the 3. generation of innovation process (integrating the market demand and technological trends)

(Pakucs 2002)
# Innovation Strategies and Characteristic of Companies

<table>
<thead>
<tr>
<th></th>
<th>Pioneers</th>
<th>Early followers</th>
<th>Delayed users</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategy</strong></td>
<td>To be leader</td>
<td>Keep abreast</td>
<td>Close up</td>
</tr>
<tr>
<td><strong>Skills</strong></td>
<td>− new combination of existing technologies</td>
<td>− technology modification</td>
<td>− problem solving innovation</td>
</tr>
<tr>
<td></td>
<td>− broadening of knowledge limits</td>
<td>− quality improvement</td>
<td>− productivity increasing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>− cost reduction</td>
<td>− copy of technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>− changing step by step</td>
<td>− technology adaptation</td>
</tr>
<tr>
<td><strong>Partner relationships</strong></td>
<td>Long-term R+D partnership projects with research centres, users and suppliers</td>
<td>Engineering faculties of universities, consulting firms, institutes for technologies, users</td>
<td>Learning in programs, productivity centers, customers, supplier and mediator of equipments</td>
</tr>
</tbody>
</table>

Thank you for your attention!