

University doctoral (PhD) dissertation abstract

Evaluation of development and usage characteristics of Next Generation Networks, economic and rural development aspects of the improvements

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1 BACKGROUND, OBJECTIVES OF THE STUDY AND DESCRIPTION OF THE RESEARCH HYPOTHESIS

It is indisputable that the presence on digital platforms, i.e. the online presence and the speedy transmission of information became crucial for all economic sectors and for the society. In parallel with the development of digital technology a so-called digital ecosystem is emerging, in which all areas of living and business are supported by digital solutions.

In the digital ecosystem millions of users (population, enterprises, public institutions) and tens of millions of tools communicate with each other, using tens of thousands of contents and applications. The constantly emerging new infocommunication services and its accessibility, technical characteristics and affordability now have a central role in shaping the structure and development of the economy. These are important in the improvement of the quality of life and provide new business possibilities and advantages. As the result of the process thanks to the significant increase in the number of users the data traffic has been also notably increased. The need for speed of new services and applications, and the network security expectations have also become higher. The development of a network infrastructure suitable for reliable and secure data transmission has become crucial which now means the construction of the Next Generation Network (NGN).

The NGN has been developed as the result of a telecommunication convergence started after the millennium, because the network development became crucial for the service providers for the purpose to maintain competitiveness. Though the conception of NGN developed years ago, the problems of implementation are issues of special interest. The related technological, social and economical aspects are discussed in scientific articles and forums.

Currently the rural development policy has been acquiring a stronger role in the strategy of the European Union and its Member States, since the social and economic role of rural areas is very important. These areas constitute more than 91% of the EU's territory and here is

the place of residence of the 56% of EU's population. The 66% of Hungary's territory is classified as a rural area, where 48% of the population lives. In addition our country has a significant agricultural and food industry which is the typical sector of rural regions. Consequently, for network developments the analysis of the aspects of rural development has become essential. Therefore in my thesis, within the economic and social role of the broadband and NGN networks, the assessment of rural areas and rural developments have been particularly considered.

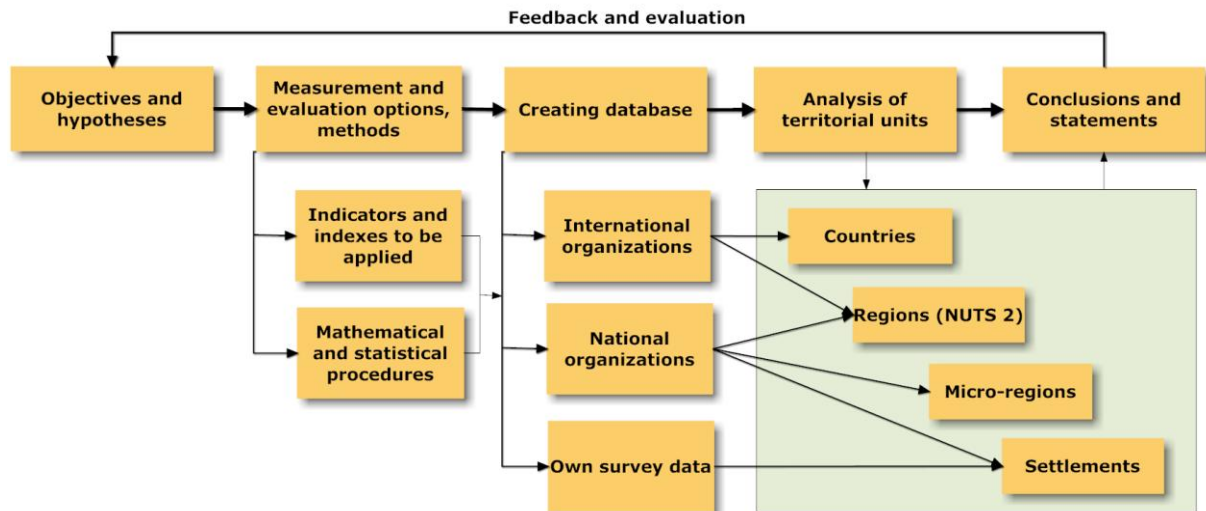
Notwithstanding the high competition on the telecommunication market, the lag behind of rural areas is significant both for network accessibility and use of applications until now. However the development of sectors strictly connected to rural areas is crucial, because it includes several activities (food security, contacts, trade, logistics, etc) which require advanced IT equipments and broadband infrastructure. For those reasons, in the sectors less attractive for business the EU and the state have contributed to the development of network infrastructure by supporting projects in the last ten years.

The correlations between broadband networks and social and economic characteristics should be considered not only at amcro-economic level, for the creation of national strategies but also at different regional levels. In the current strategy of the European Union and Hungary the reduction of digital divide has unequivocal priority which can be partially reached by the development of micro-regions.

The assessment of efficiency and results of regional developments beyond the empirical research has increasing importance in development strategies and projects. In economic terms there are only a few data concerning the impacts of the presence of a broadband network on a smaller region or town. The effects of complex regional development programmes, particularly of broadband development should be monitored by impact assessment. I consider important particularly the assessment of areas where the broadband network development has been supported by state assistance and EU funds.

After the review of scientific literature it was revealed that the selected research theme required multiple layers, cascading analysis and assessment from a territorial and functional point of view. The main trend of my study is the analysis of broadband, especially NGA networks considering economic and rural development aspects. My objectives and hypothesis were formulated and my research strategy was elaborated accordingly, which are summarized in Figure 2.

Figure 1: Research strategy



Source: Own edition

Objectives:

- Detection of measurement and comparison possibilities of infrastructure and utility characteristics of broadband networks at four territorial levels: country - region – sub-region - town, and the ranking of regions in clusters.
- Represent the change of network development of different regional levels by time series analysis of the available simple indicators and composite indices and detect the current level of development.
- Detection of connection between network infrastructure, usage specific indicators and socio-economic characteristics.
- Creation of an analysis model which enables the complex measurement of network development at regional all smaller territorial levels and the comparison of territorial units.

In accordance with my objectives five research hypothesis have been formulated in relation to current and future development of broadband networks, to the impact analysis of developments and analysis of smaller territorial units.

H1: The accessibility and usage characteristics of broadband infrastructure are connected to certain economic and social features both at macro and micro level.

H2: For indicators related to network development the values of smaller territorial units show great variations compared to country average value which are caused by the different local characteristics and other social factors.

H3: After the EU accession the aids for development of ICT (Information and Communication Technology) infrastructure and the trainings strengthening usage intensity played important role in the development of rural regions.

H4: The use of services accessible on broadband networks for economic purposes depends on the activity of the given company and from the micro-environment.

H5: The IT attitudes of small and medium enterprises have been changed in relation to the reduction of company costs and the increase of business possibilities, and it consequently increased the importance of services accessible on network.

Though the analysis of infrastructure realized using state funds and the assessment of indicators applied by the projects used for the selection of development target areas and for the measurement of development and impact assessment form an integral part of my study, I don't intend to create a methodology to base the development decisions. I only try to reveal the measurement possibilities that can help in complexity the selection of the places of implementation of these developments and the assessment of the impacts of realized infrastructure or effects of trainings.

2 THE MATERIAL AND THE APPLIED METHODS OF THE EXAMINATION

2.1 Aspects for selection of secondary data sources

In this thesis the broadband, especially the Next Generation Network infrastructure coverage and the use of network services were evaluated according to four territorial levels (national, regional, sub-regional and local level). Statistical data were available for all territorial levels and the related sources are listed in Table 1. For detailed analysis at local level an own questionnaire-based study was carried out. The range of statistical data related to this theme is continuously widening, many indicators are available especially for the European Union and Hungary, at different territorial levels and for several periods. The detailed analysis of smaller territorial units of Hungary was supported by the wide range of statistical data available at national level which is wider than the statistical data base of the European Union regions.

Table 1: Data sources used in the thesis and its availability

Data source:	Availability
World Economic Forum	www.weforum.org
Organization for Economic Co-operation and Development	www.oecd.org
International Telecommunications Union	www.itu.int
Economist Intelligence Unit	www.eiu.com
National Media and Infocommunications Authority	www.nmhh.hu
Budapest Internet Exchange	www.bix.hu
National Development Agency	www.nfu.hu
Hungarian Central Statistical Office	www.ksh.hu
Eurostat	epp.eurostat.ec.europa.eu
GKIE NET IT services and consultation Ltd	www.gkienet.hu
Central Office for Administrative and Electronic Public Services	www.nyilvantarto.hu
National Spatial Development and Spatial Planning Information System	teir.vati.hu

Source: Own edition

Based on data sources my own research data base have been created which includes economic, social and ICT data at national and regional level, especially for the period from 2008 to 2012. Since for some indicators there were several data sources available, at the selection I considered the method of statistical review (representativeness), and its availability from territorial and interval aspects. Based on secondary data the assessment of the situation and the comparative analysis of 27 Member States of the European Union and of NUTS 2 region of 13 Member States have been performed.

For indicators showing the development of broadband infrastructure and usage of Internet 2008 as a basic period and 2012 as a required period was selected in order to determine the extent of development. For some indicators and countries there was no data available for 2008 and 2012. In these cases data of previous or subsequent years were used.

A regional level study has been also performed, whilst in recent years the modelling and analysis for smaller territorial units are more important in the studies. In order to justify my H1 and H2 hypothesis the indicators applied for the comparison of countries have been collected. The analysis included 123 regions of 13 EU Member States. 5 Danish, 17 Dutch, 9 Austrian, 11 Belgian, 8 Swedish, 18 Italian, 19 Spanish, 7 Portuguese, 8 Czech, 4 Slovakian, 7 Hungarian, 8 Romanian and 6 Bulgarian. The data of countries can that not be divided in regions (Malta, Luxembourg, Latvia, Lithuania, Estonia) and countries which have no data available for the selected indicators in a number of regions exceeding the half of the country were not been considered. In order to justify my H3 hypothesis the data of Hungarian development projects have been used.

2.2 Primary study data sources

In relation to my H4 and H5 hypothesis a questionnaire-based study was performed for the assessment of network preparedness and usage characteristics of the business segment, among the small, medium and micro-enterprises in Hajdúböszörmény. The data collected by means

of questionnaire were needed for the selection of necessary indicators of my model.

The 106 business organizations involved in the study have been selected by stratified sampling based on area statistics of the Hungarian Central Statistical Office. The basis of sampling was the distribution of staff employed and business activity of the enterprises. The sample well represents the distribution of the SME-s in the town, since the majority is composed of service and trade enterprises, or those connected to agriculture in any way. My questionnaire-based study included only those enterprises which have subscribed to any landline Internet services as my research is mainly related to the use of optical upstream and access networks. Hajdúböszörmény is an adequate city from another aspect of the study, because in the period from 2006 to 2008 the broadband network implemented only with investments of service providers was integrated with an NGA infrastructure realized in the frame of GVOP 4.4.2 tender. So I could analyse a town where the total network coverage has been reached with the participation of the EU and the state.

The data collection was performed in the first quarter of 2012. The questionnaires were completed by the managers of enterprises in all the cases, as within the enterprises they are the decision makers in relation to the application of ICT. The test method is essentially considered a closed, guided interview, but in accordance with the questions of the questionnaire an interview was performed with the owners and in case of bigger business organizations with professionals responsible for IT functions, since their opinion can be decisive for the conformation of future company ICT trends. The information obtained during the interviews have facilitated the explanation of the results formulated based on the questionnaire's data.

The data collection, applied during the questionnaire-based study include 4 questions, as follows:

Question 1: Contains general questions in relation to the respondent business organizations. These data allow the comparative analysis of different types of companies and are necessary for cluster analysis.

Question 2: This question concerns the characteristics of basic Internet infrastructure, the use of telecommunication tools and Internet use.

Question 3: The third part of the questionnaire has been drawn up for the survey, review and assessment of Internet use. For the review the factors related to satisfaction, utility and importance have been indicated, the respondents had to classify these factors on Likert-scale (1: strongly disagree, 5: Strongly agree).

Question 4: This question assessed the network characteristics of computers used by the enterprise and the attitudes related to the use of Next Generation Network services (outsourcing of services, remote data access, cloud computing services).

2.3 Methods of analysis

In case of indicators originating from secondary data sources, for the simple comparison of territorial units percentage qualitative criteria were applied. In case of countries and regions a correlation analysis has been performed for the data series of the selected indicator. The aim of the study was the determination of economic and social factors which are or could be connected to the development of broadband networks. For the correlation calculation according to the data types of variables the Pearson's correlation coefficient was determined, by two-tailed test. The correlation was evaluated on 0,01 and 0,05 significance level.

For the assessment of the questionnaire, descriptive, statistical method with one or more variables was applied. In the questionnaire in relation to the use, the importance of the factor had been assessed in 23 questions. First the internal reliability of questions' variables has been analysed by Cronbach-Alpha test. The result of the test is that the variables are suitable for further analysis.

The variables were subject to a principal component analysis. This was necessary for the grouping of the 23 variables in some background variables. The principal components have been used also for cluster analysis, and the aim of the analysis was to determine how the activities of the enterprises affect the views regarding utility of

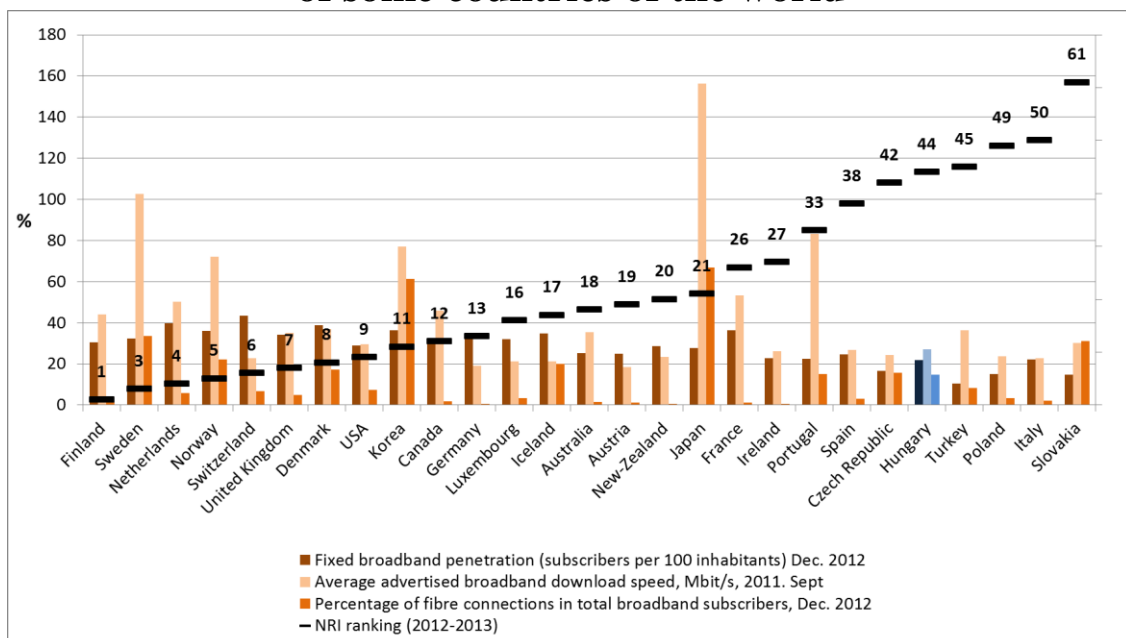
network services. In case of clusters the average value of the principal components has been evaluated. The aim of the cluster analysis is to classify the observation units in relatively homogenous groups based on the variables involved in the analysis. The process is successful when the units are similar to the other components of the group but are different from the elements of other groups. In the cluster analysis the fundamental task is to determine the variables which cause the difference between the groups, therefore the cluster analysis is frequently performed with variables produced during factor analysis. For my studies the Ward's method was applied because it minimises the loss of information caused by the combination of groups. The Ward's method is favourable because of the use of scale variables and there was no extreme value. The deviation of the groups was nearly identical, and the correlation between variables was eliminated during the principal component analysis. The Ward's method calculates the average of all elements for each cluster, than the Euclidean squared distance for all observation units shall be calculated. The Euclidean squared distance was selected because it is suggested by the main scientific literature for Ward's method. The characterization of created clusters was made based on variables measured on grouping, not metrical scale, by cross tabulation analysis.

3 MAJOR FINDINGS OF THE DISSERTATION

3.1 Main results of national-level study

I have concluded that the popular index NRI (Networked Readiness Index) applied for ICT ranking of countries considers too many indicators which are not strictly connected to the Next Generation Network penetration and to its usage. Figure 3 shows that in case of three indicators of broadband network development (broadband penetration, published average download speed, rate of optical access) there are extremely developed countries, for example Korea, Iceland, Japan and Slovakia. However these countries had a relatively low place in NRI ranking in 2012-2013. Other countries which had much worse performance for the same relevant indicators had better ranking. From the assessment of the index elements it was revealed that these countries had a worse score for components as economic, business, political or regulatory environment. In my opinion the NRI contains many elements which should be rather considered as an element of preparedness index.

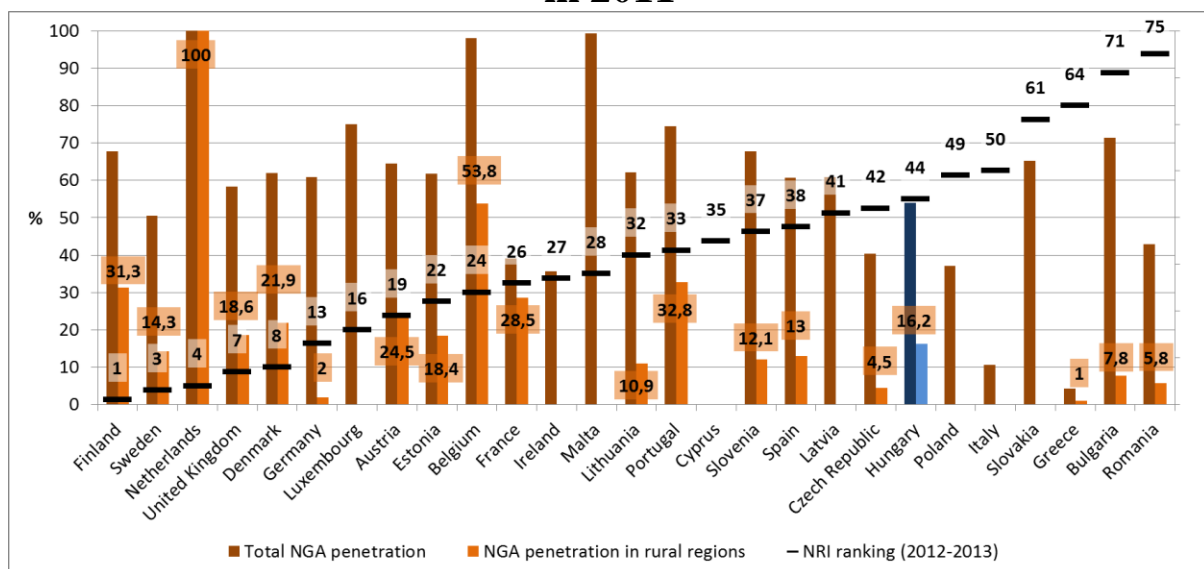
Figure 2: Network infrastructure development and NRI ranking of some countries of the world



Source: Own edition - data sources: OECD, WEFORUM

For rural regions a lag behind can be detected both for accessibility and usage. Figure 4 clearly shows that there is a great difference between urban and rural areas in Next Generation Network coverage. In most countries the penetration of next generation infrastructure is 35-75%, the most developed countries are Belgium (98%), Malta (99,3%) and the Netherlands (100%). There are some countries of expressly low coverage, as Cyprus, Greece or Italy. For rural regions the average NGA coverage is 15%, 53,8% in Belgium and 100% in the Netherlands.

Figure 3: The NGA coverage of rural regions in EU-27 countries in 2011



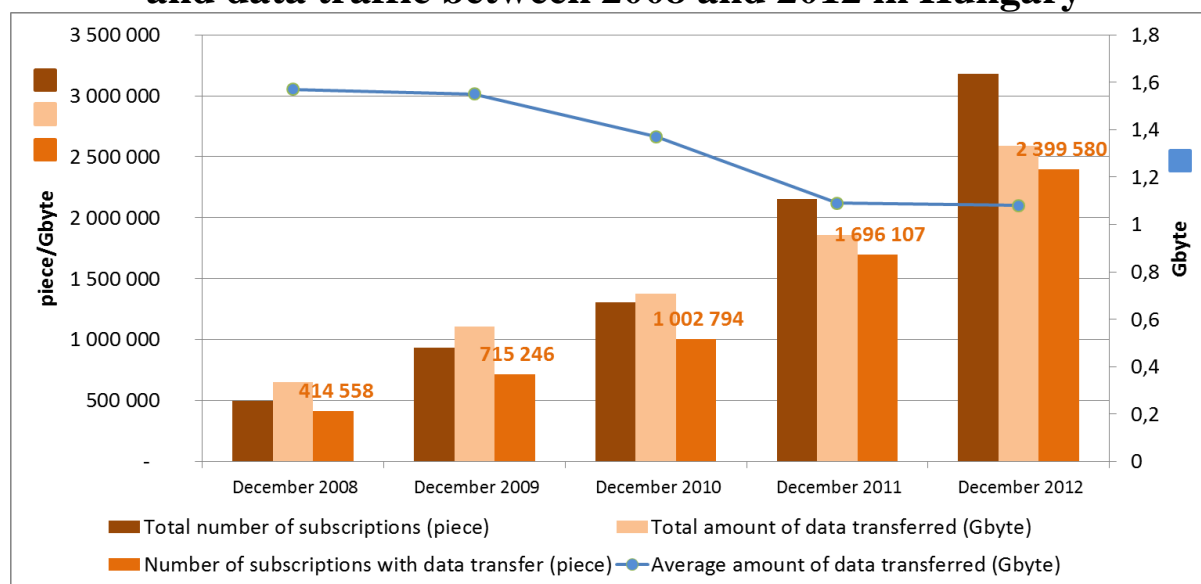
Source: Own edition - data sources: PointTopic, WEFORUM

In my opinion for Hungary there is no further lag expected for network indicators. Hungary is ranked in the middle class of NRI ranking with its 44th place among 144 countries in the 2012-2013 survey. For network indicators in most cases there is a lag of only a few percentage points with respect to the EU average. This means that thanks to the continuous improvements we can develop with the average. We can maintain the current path in infrastructure development in rural regions, using additional EU funds. In relation to usage we probably can follow the average EU development in the following years. Based on my analysis I have concluded that the usage of eGovernment services is growing. This growing is caused by the obligation to arrange certain matter only online and the advantages of online procedures appeal the users.

Based on the above mentioned conclusion my **H3 hypothesis** is justified. The implementation of development projects can be considered efficient when it helps to avoid logging, not causing an over-overdevelopment because both can be significant problem. The lag behind from EU average means a competitiveness gap. At the same time, the demand of services requiring broadband network is growing gradually, so there is no need to focus too much funds for this purpose. According to the analysis the infrastructural development maintains the path of the previous years, i.e. there is no lag or over-development.

In rural regions the alternative of fixed access to the Internet could be the mobile internet of which usage is constantly increasing (Figure 5). In December 2012 the number of mobile Internet subscription in Hungary exceeded 3 million. Among these subscriptions, almost 2,4 million were used also for data traffic. This represents almost a sixfold increase in four years. The data traffic per subscription is slightly decreased in recent years. However the optical cable connection is required also by mobile service providers in order to provide a rapid connection between base stations.

Figure 4: Change of the number of mobile Internet subscriptions and data traffic between 2008 and 2012 in Hungary



Source: Own edition - data sources: NMHH

Based on my correlation calculations I make two conclusions. From infrastructural aspect a strong connection with socio-economic characteristics can be revealed mainly for broadband accessibility of households. In case of the enterprises there are fewer determinant factors. This is the result of the small difference between the Member States from this point of view, on an average the 90% of the enterprises has a broadband connection.

At my analysis the NGA coverage, the broadband infrastructural and usage characteristics of individuals and enterprises (19 variables) and several socio-economic factors (10 variables) have been considered. The analysis has been performed for 27 Member States of the European Union.

5 factors (*unemployment rate, rate of graduates from tertiary education, GDP per capita, the rate of employment and the share of agriculture in the GDP*) are strictly correlated with the concerned network characteristics. 3 factors (*rate of mainly rural regions by population and territory and the proportion of the population of 10-35-year olds*) had no correlation with any network characteristic. 2 factors (*agriculture and the share of agriculture in the GDP*) have negative connection with the values of network indicators.

The indicators currently have negative correlation with the indicator of the weight of agricultural sector. It is problematic, since many new applications and services connected to agriculture are available or obligatory.

Based on the situation analysis between the countries and correlation calculations I have concluded that the development is higher and more equitable for infrastructure than for network usage. There is no significant difference for infrastructure between the EU Member States in relation to broadband network of households, the deviation is 11%. For usage characteristics between two groups of activity an extreme difference has been detected. For the characteristics related to official procedures and financial transactions (*product and service orders, electronic banking services, contacts with institutions*) the deviation is 21-23-18%. This represents a great difference between countries. For the general characteristics of Internet usage the deviation is much lower, its value is between 6 and 15%. For usage

indicators the lowest results, about 50% (southern European countries) and the highest results, exceeding 75% (Nordics and western European countries) were reached by the same countries.

According to my correlation calculations there is no connection between the NGA penetration and economic development. In my opinion this is a benefit which indicates that the territories with lower development starts to close up. For rural regions the results were supported notably by state and EU funds. According to the objectives of the European Union each Member State could improve the Next Generation Network infrastructure from significant tender financial resources. In Hungary in the period from 2004 to 2008 14 billion forints were spent in total for supporting three infrastructure improvement and national development projects.

3.2 Main results of studies at regional level

I have concluded that the level of development is significantly influenced by the performance of the several regions within the given country. For countries at the top of NRI ranking there is a minimum difference between the most advanced and the less developed regions. By the decrease of the development at national level the regional differences are more and more revealed. In the concerned region the broadband network access of households varies strongly. In certain cases there are significant differences also within the country. The regional data concerning broadband coverage are listed in Table 2.

Table 2: Broadband coverage of the less and the most advanced regions of certain countries in 2008 and in 2012

Country	Penetration in the least developed region (%)		Penetration in the most developed region (%)		Difference between the least and the most developed region (%)	
	2008	2012	2008	2012	2008	2012
Austria	47	72	61	82	14	10
Belgium	47	65	69	87	22	22
Bulgaria	12	38	31	59	19	21
Czech Republic	26	58	53	69	27	11
Denmark	67	81	78	87	11	6
Hungary	33	59	51	77	18	18
Italy	18	43	38	64	20	21
Netherlands	63	79	79	92	16	13
Portugal	31	47	50	72	19	25
Romania	9	41	21	71	12	30
Slovakia	33	67	39	80	6	13
Spain	32	58	58	77	26	19
Sweden	73	94	84	98	11	4

Source: Own edition - data sources: EUROSTAT

Listing the countries by GDP per capita, three groups can be determined. The first group includes the Western European countries, where the development of the regions has already been considered average or above-average in 2008. The average progress is 12%. The second group includes the Southern and Central European countries, where the performance of the regions was below the average for both years. The third group contains Romania and Bulgaria having a significant lag.

The deviation between countries of the analysed indicators was lower on the average by 2-4% respect to the regions, therefore hypothesis H2 is to be rejected, but I have concluded that this could be considered sufficient for proving further studies of smaller territorial units, and I presume that in relation to sub-regions and localities the value of deviation increases. Further research needs to be conducted.

Based on my regional analysis it can be generally concluded that in the single countries the capital and the capital agglomeration provide the highest penetration. In the less developed regions in 2008 the coverage was approx. 60-70% in Denmark, in the Netherlands and Sweden. The same level has been reached by the most developed regions only in 2012. The infrastructural differences between the most and the less developed regions have been reduced in 6 countries

(Austria, Czech Republic, Denmark, Netherlands and Sweden). The difference is in the same range for Belgium, Bulgaria, Hungary and Italy, but in Portugal, Romania and Slovakia the difference is significantly higher. For 8 countries the highest development has been detected at the region with the worst situation in 2008. The related results are summarized in table 3.

Table 3: Detailed data of regions with highest development

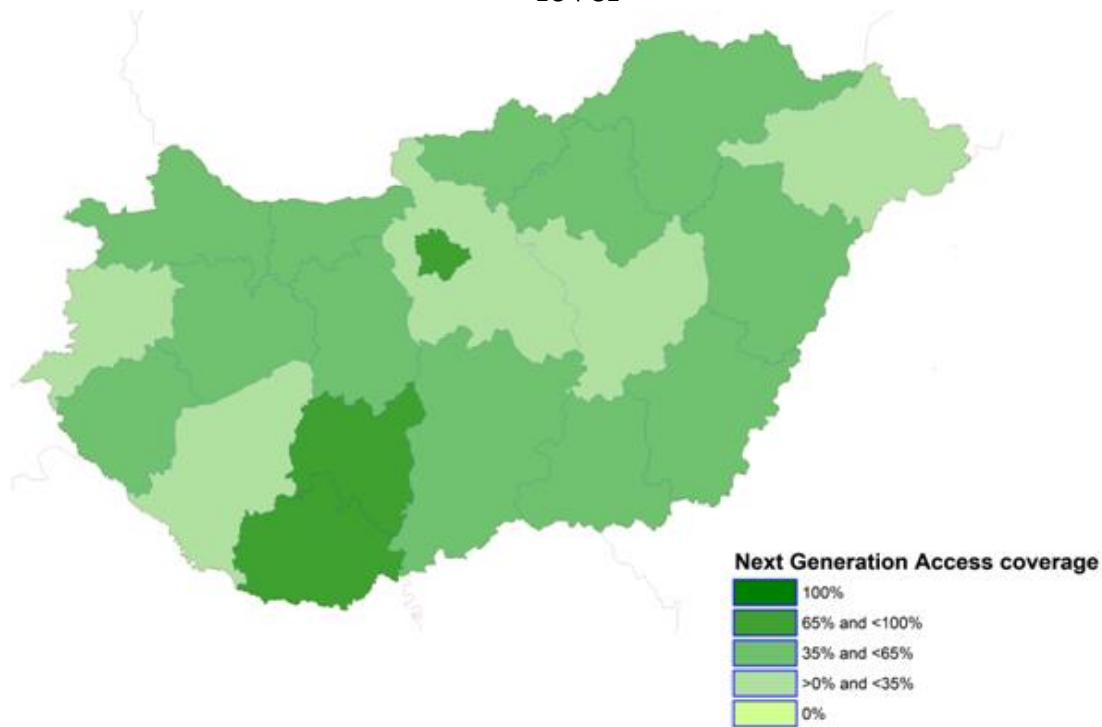
Country	Region which achieved the sharpest increase between 2008 and 2012		Type of the region	GDP/capita in PPS (national)
	Name of the region	Rate of change		
Austria	Kärnten	29 %	The least developed region in 2008	126
Belgium	Prov. Brabant Wallon	24 %	Other region	119
Bulgaria	Yugoiztochen; Yuzhen tsentralen	33 %	Other regions	44
Czech Republic	Severozápad	32 %	The least developed region in 2008	80
Denmark	Nordjylland	18 %	The least developed region in 2008	127
Hungary	Dél-dunántúl	28 %	The least developed region in 2008	65
Italy	Valle d'Aosta; Sardegna	31 %	Other region	100
Netherlands	Drenthe	23 %	The least developed region in 2008	133
Portugal	Região Autónoma dos Açores	25 %	Other region	80
Romania	Bucuresti-Ifov	50 %	Capital region	47
Slovakia	Bratislavský kraj; Východné Slovensko	41 %	Capital region; The least developed region in 2008	73
Spain	Galicia	30 %	The least developed region in 2008	100
Sweden	Mellersta Norrland	22 %	The least developed region in 2008	124

Source: Own edition - data sources: EUROSTAT

Based on the connection analysis performed by the secondary data base I have found that there are indicators between the countries and smaller territorial units which have a similar strict correlation with each other, but it was also revealed that there are some indicators which are strictly connected at national level, but there is no strict connection at the level of smaller territorial units. For regions the network indicators are in connection with unemployment, rate of graduates from tertiary education, GDP per capita and the rate of employment. Based on these results the **hypothesis H1** can be considered justified.

In Hungary it has been concluded that the additional aids are very important to reduce the differences between regions.

Figure 5: Hungary's NGA coverage in 2011 at NUTS 3 territorial level



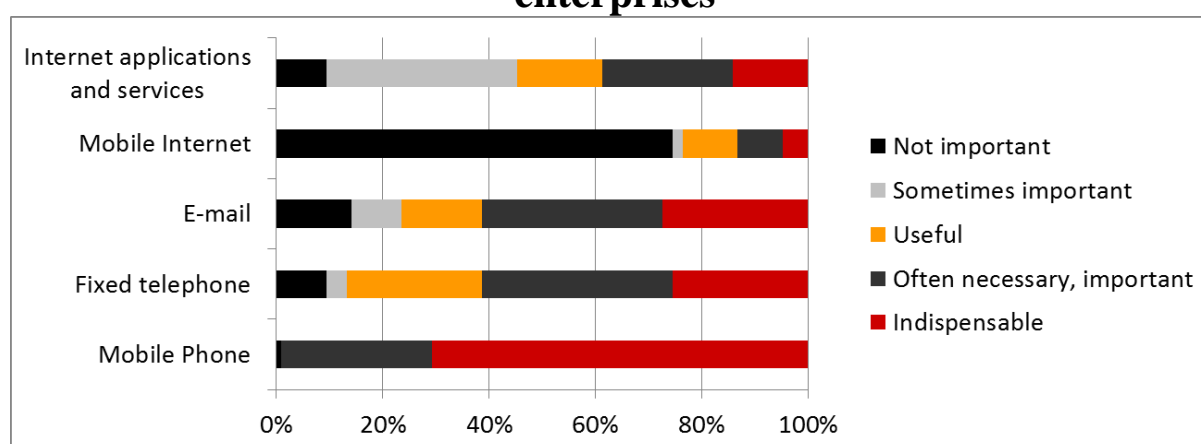
Source: European Commission, 2011

The regional NGA coverage is shown on the map obtained from PointTopic study (Figure 5). The Next Generation Network penetration is below 35% in 5 counties, in 12 counties it is between 35% and 65% and in two counties (Baranya and Tolna) it is between 65% and 100%. The results of tenders have been compared to coverage and usage indicators. In the eastern part of the country rather the tenders for the local governments, while in the western part the tenders for SME-s were popular. Comparing the results of the map to the above mentioned network characteristics it is evident that while in Szabolcs-Szatmár-Bereg county many of tenders have been realized, the average NGA coverage has remained under 35%. Respect to the other regions the South Great Plain region has better results not only at infrastructural, but also at usage level, and in my opinion the tenders have largely contributed to these results. From the three tenders for e-services, in two cases the amount of the aid reached the highest value in the South Great Plain region.

3.3 Main results of local (primary) studies

In the life of businesses there are strong similarities between the importance of e-mail and landline phones. These are considered an important, rather essential communication forms by almost 40% of enterprises. These means can perform more functions in the business procedures as online options widen. The views of the managers of enterprises regarding the importance of single telecommunication services are shown on Figure 6.

Figure 6: The importance of single communication services for the enterprises



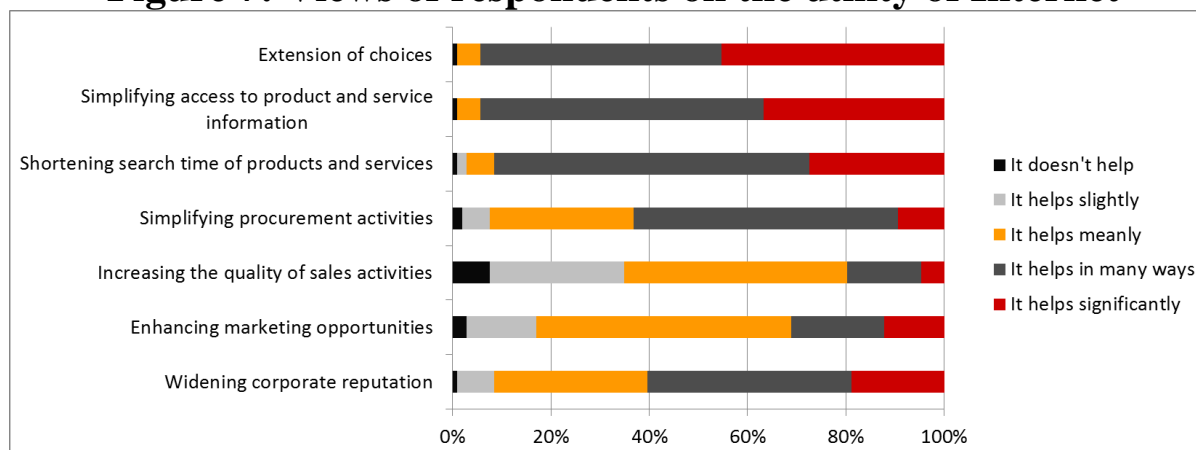
Source: Own survey

The respondents are the most divided in the question of applications available on Internet. The usage of these applications depends on the activity. For service providers or trade sectors the office work and the contact with public institutions are more important. By contrast, for the companies linked to agriculture the work processes directly connected to production are more important. Therefore for these enterprises the Internet applications are less or not important. Though the applications for aid and the other documents addressed to central institutions shall be submitted only in electronic form, there are some enterprises which give mandate to outside independent persons (e.g. village agronomist) for these tasks.

In many cases the company managers are searching for information on products and services on the Internet. However for own sales opportunities the Internet is considered only a little or average degree

support. The popularity of online purchasing is increasing very slowly because of the established practices. The views of respondents regarding how much the Internet promotes the efficiency of purchasing and selling activity are shown on Figure 7.

Figure 7: Views of respondents on the utility of Internet



Source: Own survey

Through the interviewed companies are able to find quickly and simply the necessary information on other websites, the personal contact is still remained a very important factor. When a product is found on Internet, it will be purchased in person. In the concerned micro-region the significance of e-commerce is reduced also by the fact that the client and partner relations of respondents are limited mainly to the city and city region. So they have local customers and the purchases are realized mainly on a local basis.

Based on 23 variables of questions 14, 15, 16 and 17 of my questionnaire a principal component analysis has been performed. According to the result of this analysis the five principal components have been ranked in five groups of indicators. These represent how much the company decision makers recognize the utility of Internet in relation to the single activities.

1. Function supporting internal and external Internet relations
2. Importance of online presence
3. Function supporting purchasing activity
4. Importance of online advertising
5. Sales promotion function

These groups of indicators are intended to express the views of company's decision makers. The reduction of the number of application characteristics was important for developing the model of assessment index in order to avoid the involvement of too many factors in the application component.

The variables were further studied by cluster analysis. The aim of the analysis was to determine how the activities of the enterprises affect the views regarding utility of network services. In case of these clusters the average value of the principal components has been evaluated, and the result is shown on Figure 8.

Figure 8: Result of cluster analysis performed by the assessment of utility of network services



Source: Own survey

To determine whether or not the differences between the clusters are significant, I made variance analysis (ANOVA) on the principal components. The result of it, that there is a significant difference between the clusters ($P < 0,001$). Table 4 shows the distribution the number of enterprises in the clusters by their activity.

Table 4: The distribution of the sample of enterprises in the clusters

Type of sector of enterprises	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Agricultural production and service	-	4	21	23
Agricultural commercial	1	3	-	5
Other commercial	4	8	1	3
Service	7	7	1	1
Building trade	1	6	-	1
Tourism and hospitality	7	2	-	-

Source: Own survey

The decision makers in the 1st cluster evaluated very positively all the components except for the third one. The members of the cluster consider really important and useful the services available on Internet. Mainly the enterprises on tourism and catering and service are ranked in this group. Considering the importance of the sector in the town this is a very good result, as the presence on Internet is a crucial factor to take advantage of development possibilities. It is crucial that - based on the results - the enterprises of the sector are aware of these possibilities. In the case of the 2nd cluster all of the components are positives, but the difference respect to the 1st cluster consists in lower component scores. The score of 4th and 5th components are much lower but the 3rd one is much higher. This cluster contains several types of enterprises, but most of the commercial, service and building trade enterprises are in it. The 3rd and 4th cluster contains mainly members of agricultural activities and some enterprises with other activity. The component scores are the lowest in this cluster.

Based on my questionnaire I have concluded that the situation of agricultural enterprises, especially of farmers is very serious, they have a significant lag in the use of broadband services. They don't use and do not consider necessary the use of these services, referring to the nature of their work. The company managers have recognized the advantages of network services only very slightly, and they have given a positive assessment mainly in relation to purchasing activities.

The use of ICT applications is the slightest among the agricultural enterprises. These services are not necessary for their activities, the contact with their partners and clients is maintained in person. The purchases are realized only from a few suppliers and selling is targeted to only a few clients. The trust and personal contact are the most important for them. The most of factors were considered important or expressly important by the decision makers of service and commercial enterprises, regardless from the application.

Based on the above mentioned result of my study **hypothesis H4** can be considered only semi-justified. On one hand it is true that due to the relevant role of agricultural sector many farms operate in the town, having similar attitudes. But it must be underlined that service and catering enterprises provide substantially better application characteristics. On the other hand the micro-environmental impact is less important, because in multiple cases the use of online services is obligatory in order to contact public institutions. This includes uniformity.

At the respondent enterprises the majority of decision makers rejects the use of network services. Neither the reduction of cost represents a motivation. The main reasons can be the lack of knowledge and skills, the low level of openness to change which are particularly present in the rural areas. In many cases these services obviously are not needed (farmers), here the main problem is the serious lag in the use of Internet.

Based on the results of the questionnaire I have concluded that the IT closing up of small, middle and micro enterprises is a very slow process, and I would like to underline two reasons. It shall be started from a level much lower than the average which will be restrained by the IT attitudes of decision makers. In relation to software and remote data access I detected poor performance results. The 60% of the enterprises does not use specific software for the activities, and the 29% does not trust in remote services. Only the 10% of the enterprises represents a potential development, notwithstanding that there are specific, cost-saving solutions also for small enterprises. The situation is more serious for remote data access. The 92% of the enterprises

consider secure when the data are stored in place, on own devices. Only the 8% of the enterprises considers secure this solution, while in reality the data are stored more safely at a company specialized in data storage than on a computer used by collaborators. At 48% of the respondent enterprises more employees use the same computer, therefore there is a greater chance of Internet attacks. Based on these results of 17 and 18 thesis **hypothesis H5** is rejected.

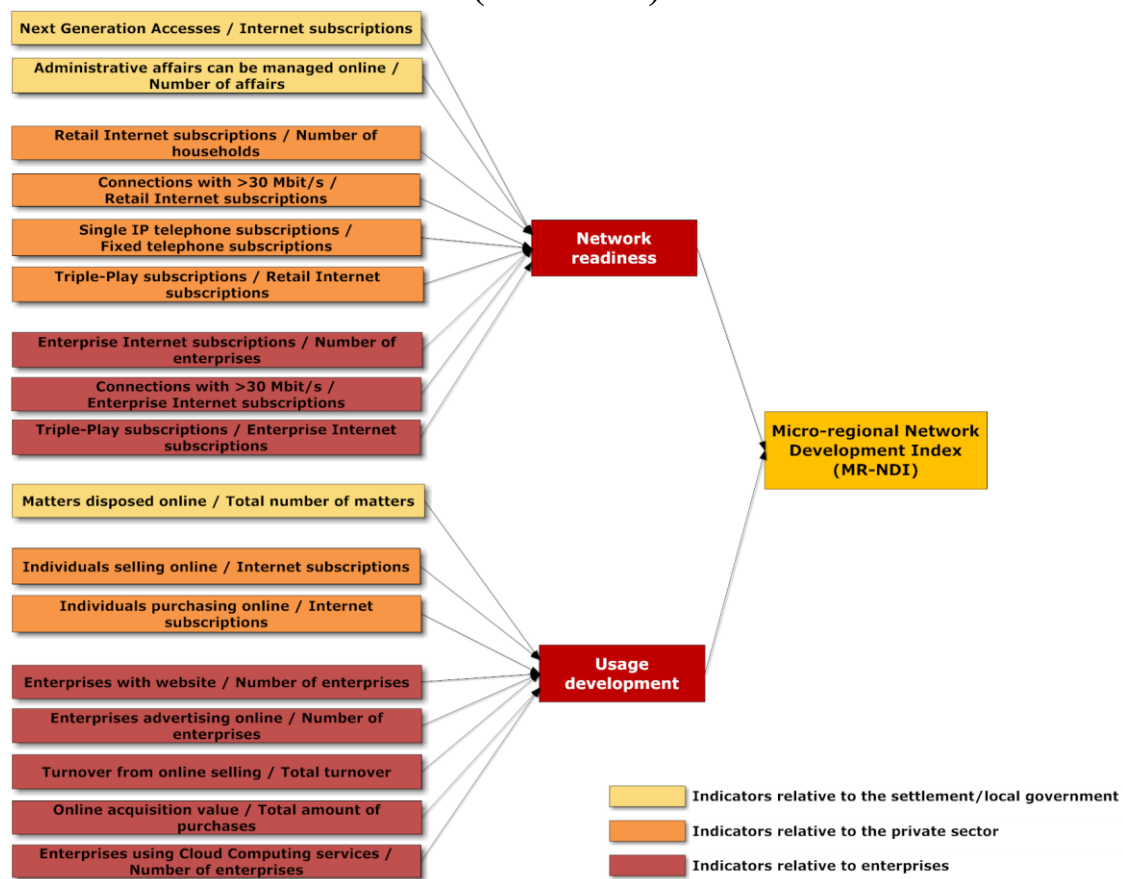
3.4 Model for micro-region studies

The results of my studies performed in order to justify or reject the hypothesis were needed not only for a more precise assessment of the situation and impact assessment. The assessment of efficiency and results of regional developments beyond the empirical research has increasing importance in development strategies and projects. In economic terms there are only a few data concerning the impacts of the presence of a broadband network on a smaller region or town. The effects of complex regional development programmes, particularly of broadband development should be monitored by impact assessment.

During the data analysis the popular NRI values, applied for the comparison of network development stage of the countries, have been taken into consideration, in order to involve only the strictly necessary elements in the creation of the own model. The ranking according to NRI specific indicators was found to be a suitable basis. During my analysis and review of the scientific literature I have concluded that the NRI contains too much unnecessary elements, therefore at the creation of the own model I decided to manage separately the indicators concerning preparedness and network development.

In the model of network analysis of micro-regions the infrastructure and usage indicators connected to network readiness and actual development, in total 17 indicators were involved. The infrastructure development represents the penetration and quality characteristics of the network accessible for the population and enterprises of the town. The component of usage development contains indicators relative to usage intensity of services currently applied or applicable. These are indicators which came from my secondary and primary data analysis. The factors included in the index are shown on Figure 9.

Figure 9: Structure of micro-regional network development index (MR-NDI)



Source: Own edition

The characteristics of the private sector have lower importance in the model than the indicators of business level, because in my opinion the last one is more significant. In my opinion the business sector is more important than the private sector, because these are present on supply and demand side with greater weight, while the private sector is present almost exclusively on the demand side. The availability of services for welfare should be measured, for this purpose the usage of IP and broadband services has been included in the model. In left column I listed the indicators in ratio and the denominator means the benchmark. The result in the case of all indicators is a percentage value and the final index also expresses the development in percentage.

The value of network readiness and usage development components is obtained by averaging the values of indicators in the first column. The values of the two components enter in equal ratio into the value of the final index.

Since my model contains only the indicators connected to the network, I considered appropriate to integrate the analysis with PEST analysis of which four factors are included in NRI, but I think these should be evaluated separately. The possible factors influencing the deployment of NGA networks at local level are the following:

Political factors/environment:

- The priority of NGN deployment in development strategies,
- The competitive environment between service providers, the presence of alternative service providers on the market.

Economic factors/environment:

- Availability of support measures, rate of support,
- Affordable service prices,
- Local application of so-called Smart Metering,
- Rate of environment function.

Socio-cultural factors/environment:

- Age structure and qualification of the population,
- Consumers' habits,
- Rate of agricultural sector in the business sector.

Technical factors/environment

- IT equipments of institutions, households and enterprises,
- Local level of accessibility and deployment of Next Generation access networks and metro Ethernet,
- Availability and quality of other infrastructures,
- Rate of innovating enterprises.

4 NEW AND NOVEL RESULTS OF THE DISSERTATION

The new and recent results are summarized as follows:

1. Based on the global studies and studies concerning EU Member States I have concluded that the NRI considers too many indicators which are not strictly connected to network development. There is no connection between network development and the coverage of Next Generation Network, and between network characteristics and the rate of rural regions, while the values of the countries are very different for these factors.
2. Based on the evaluated secondary data I have concluded that in the period from 2004 to 2009 the investment value of extension of infrastructure exceeding 25 billion HUF, and the aid amounts of other measures aimed to promote the use have contributed to the fact that Hungary could maintain the development path of the EU in relation to network characteristics.
3. It was justified by regional studies that in the period from 2008 to 2012, from the 13 evaluated countries in 8 countries the highest development has been detected at the region with the worst situation in 2008, and the countries with lower development could reach the development of countries in the best situation in an average of 4 years.
4. Based on the results of my primary research I have concluded that the network characteristics should be assessed separately both for infrastructure and usage, in case of companies with agricultural economics activity. It can be explained by the fact that its attitudes are significantly different from other operators of the SME sector. The current and future need for agricultural informatics researches and developments is justified by the same conclusion.
5. By the analysis of primary and secondary data I have proved that the assessment of development of smaller territorial units is necessary for supporting network development decisions, and a model has been formulated which - contrary to national

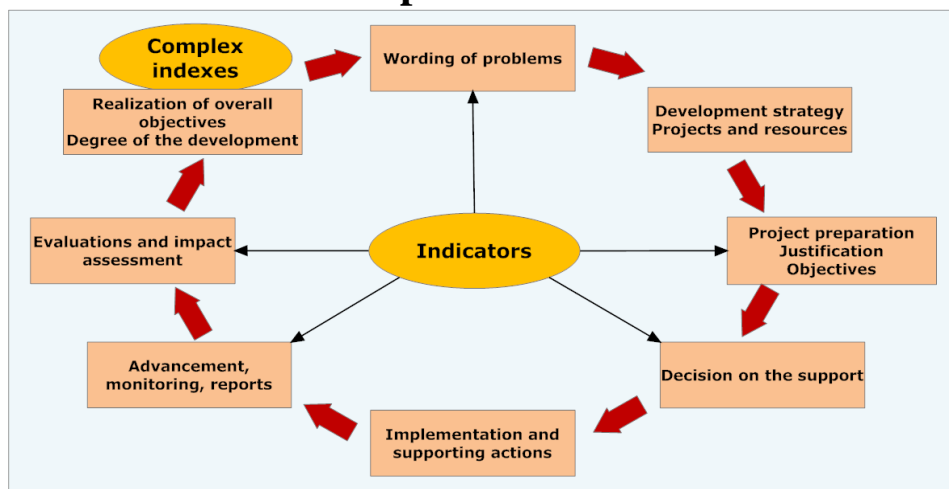
development studies - contains suitably fewer components in order to facilitate the survey, but which are enough to create a reliable result.

6. The attitudes of the business sector have been studied globally on a rural settlement, and I have concluded that the current result of network investments is principally the creation of the possibility and right of accessibility, and equal opportunities. The business SME sectors do not take enough advantage of business opportunities provided by networks.

5 UTILITY OF THE RESULTS IN THE PRACTICE

Concerning the practical use of the model, on Figure 10 the role of the index (MR-NDI) created by this study is highlighted in the process of a development project, and the application of indicators has been shown in the single phases of the project. The index not only supports the global assessment of development projects, but it can be applied for simple situation analysis for the identification of problems and supporting development decisions.

Figure 10: Significance of indicators and indexes in development processes



Source: Own edition

An exact state of a given region could support the design of specific development strategies and the more efficient allocation of development resources. In the various strategic and tender documents the primary objective is the improvement of the characteristics of society and business sectors, so the development of infocommunication sector is considered more as a tool promoting the reach of economic goals. Therefore, beyond the quantitative and qualitative changes of the characteristics of ICT sector caused by the results of developments it should be also assessed the direct and indirect impact of the network infrastructure, the application of services available on the network and network development with regard to the situation and development of a given region.

6 PUBLICATIONS RELATED TO SUBJECT MATTER OF THE THESIS

Publications which can be taken into account according to the regulations of the doctoral school

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