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Measurement methodology of regional innovation potential

1. Concept of regional innovation potential, justification of its investigation

As opposed to neo-classical and Keynesian economic theory striving for balance (and not counting with technical changes), the oeuvre of Schumpeter (1939) put technical development, research (R), development (D) and innovation (I) into a new perspective.
Following the recognition of the significance of technical progress and creating the related fundamental concepts (R+D+I) and the first analyses, the attention of researchers focused on the exploration of methodology relations. As a result, in the 1950s and 1960s a series of investigations proved the relation between R+D and economic growth. In the 1960s and 1970s research was given a new impetus by the emergence of what were called science-policy objectives, resulting in the state taking an active role in the R+D processes. In harmony with that, the attention of analysts was directed towards a better understanding of the impact mechanisms of research-development-innovation, and the impact of scientific-technical inputs on the national economy.

The concept of innovation

Concerning the conceptual definition, in general the definition by Schumpeter is taken as a starting point, who regarded "the introduction of new products, the technical changes in the production of products in use, the exploration of new markets or new sources of supply, the automation of labour, the improvement in logistics, the establishment of new type of business enterprises" as innovation (SCHUMPETER, 1939. p.81.). According to Schumpeter's view, innovation cannot be limited to invention; in the approach it is not the technical, but the economic side that is essential: to what extent a solution differing from the customary can bring benefits.

Naturally not all inventions or technical innovation bring economic benefits, that is a new technical solution is not necessarily innovation, which means that the new idea has to be proved to be marketable. That is why Schumpeter made a sharp division between invention and innovation (although in a considerable number of cases both activities are carried out by the same person).

Thus the process of innovation ranges from the emergence of the idea through research – and experimental development – and the elaboration of the finished product and technology to its application.[1/]

[1/] According to the Frascotti Manual definition (OECD, 1993): *research and experimental development* mean the creative work carried out on a regular basis with the objective of widening knowledge including that about man, culture and society, and the use of this knowledge for elaborating new applications. The three fundamental types of R+D: basic research, applied research and experimental development.
Basic research is experimental and theoretical work with the primary objective of gaining new knowledge on the fundamental essence of phenomena and observable facts without any concrete application or utilisation objective. *Applied research* is also original investigation carried out for obtaining new knowledge. It is, however, carried out primarily for some concrete practical objective. *Experimental development* is regular work based on existing knowledge gained from research and practical experience with the objective of creating new materials, products and structures, introducing new processes, systems and services or substantially improving already existing and established ones.
The following cannot be regarded as R+D activities: education and training, other related scientific and technical activities (e.g. coding, translation, general-purpose data collection, routine testing, writing feasibility studies – if they rely on applying existing techniques or are directed at studying the social-economic characteristics of concrete situations), routine software development, administration and legal activities concerning patents and licences, production and related technical activities (OECD 1993.).

The concept of regional innovation potential

In the past two decades, new points of gravity appeared in the research into innovation (as proved by the large number of related publications). In addition to micro- and macro-economy, interest has been steadily growing in studying mezo-economic relations. As part of spatial investigations, more emphasis is granted to the examination of innovation potential, i.e. determining all the capabilities that can generate economic growth in a given region through new solutions (products, services, market segments, etc.).

Three levels of innovation potential (national, regional and corporate) can be differentiated (Figure 1).

Macro-economic innovation ability characterises the entirety of the national economy, while the regional level (sub-national) characterises a given, geographically well delineated region (forming part of the national economy) (e.g. a region, province, county, etc.). (National level data have been published since the early 1990s, regional ones since the late 1990s by researchers, statistics offices and research institutes.)

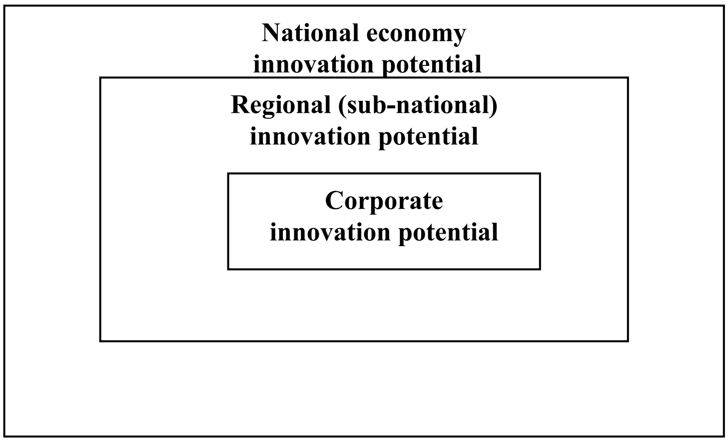

Figure : Possible levels of measuring innovation potential
Source: author's own work

Regional (mezo) level investigations demonstrate that there is a significant relation between the economic growth of a given region and its innovation potential. The outputs, added value, income relations of more innovative regions are better than those of regions lacking in innovation (WEIBERT, 1999). This assertion is true in a different way as well: regions with higher labour costs are only competitive if they can develop and market products and services with a high added value (CLAR/CORKAPIS/LANDABASO, 2001). It is evident today that innovation performance plays a decisive role also in the development of regional, social and economic disparities; and that regions that have drifted to the periphery can hardly change their positions without improving their innovation abilities (EVERS/BRENCK, 1992; WEIBER, 1999).

Thus the objective of measuring regional innovation potential is:

- to determine the given innovation performance of a given region, to measure its impact on the economic growth of the region,
- to analyse the individual factors determining its innovation potential, determine the possibilities for improving them, and to provide a foundation for the elaboration of regional innovation strategies.

2. Indicators determining the regional innovation potential

The innovation potential of a given region is determined by the national innovation policy (objectives, instruments and funds), the local potentials as well as the impact mechanism through which the results appear on the output side (Figure 2).

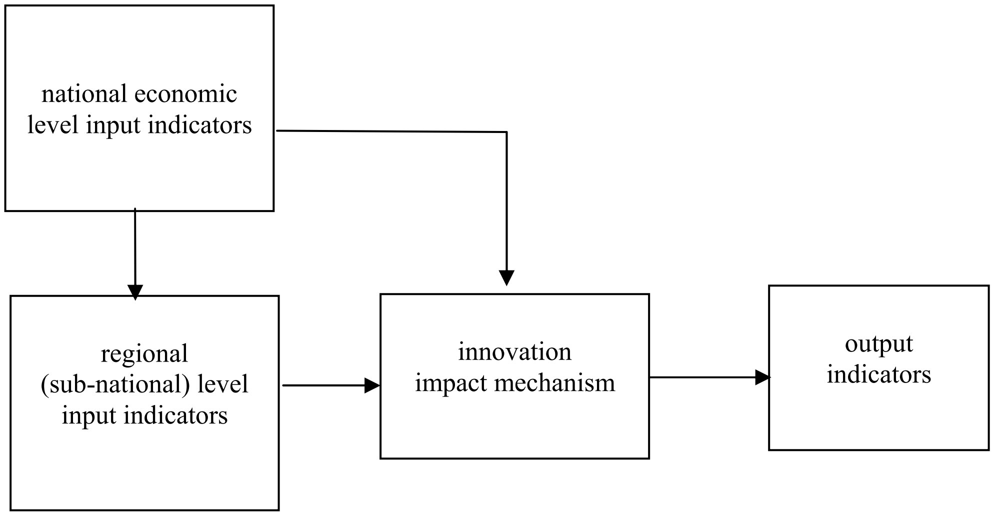

Figure 2: Relations of indicators determining regional innovation potentials
Source: author's own work

There exist correlation relations of differing extents and signs between the innovation potential and the innovations working in the region. Certain input side impacts strengthen, others reduce the resultant impact and/or the dimensions of the indicators measured on the output side.

Input side indicators

The regional innovation potential is thus influenced on the input side by the national innovation climate as well as by the regional potentials (the institutional background of innovation, its human conditions, site factors, further regional sources) (Figure 3).

It is obvious that all factors have an influence on all the components, but to differing extents. That is the final outcome (the region's innovation potential) is influenced by all of them, the extent of the impact depending on the combination of the factors exerting their influence. The lack of one or the other, or its low standard vitiates (may vitiate) the surplus emerging in another factor. Therefore it is not expedient to highlight any single factor (and to state that e.g. increasing the sources will certainly improve the innovation climate and thus the result appearing on the output side will also be greater).

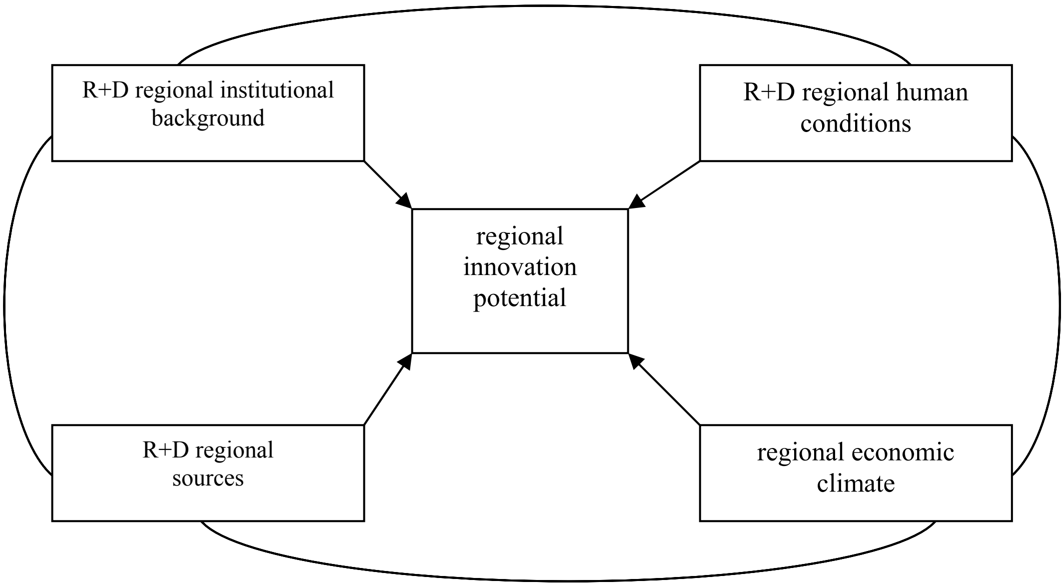

Figure 3: Factors influencing the regional innovation potential
Source: author's own work

Indicators of the macro-economic environment

The macro-economic environment exerts an influence on the innovators and knowledge transfer on the one hand, and, on the other, on the demand and supply of innovation (Figure 4).

Fundamental tasks of the state:

- defining the system of objectives of innovation (e.g. increasing added value, sector preference, etc.);
- creating the legal regulation conditions related to innovation (e.g. legal protection of intellectual property, regulation of procedures, etc.);
- regulating the cooperation between the state and the private sphere;
- supporting international R+D transfer;
- developing and innovation monitoring system;
- generating R+D commissions, operating a system of innovation project proposals, providing sources/funding,
- developing the regional system of innovation.

The macro-economic level exerts a decisive influence on the demand for and supply of innovation through the R+D sources and policy (1).

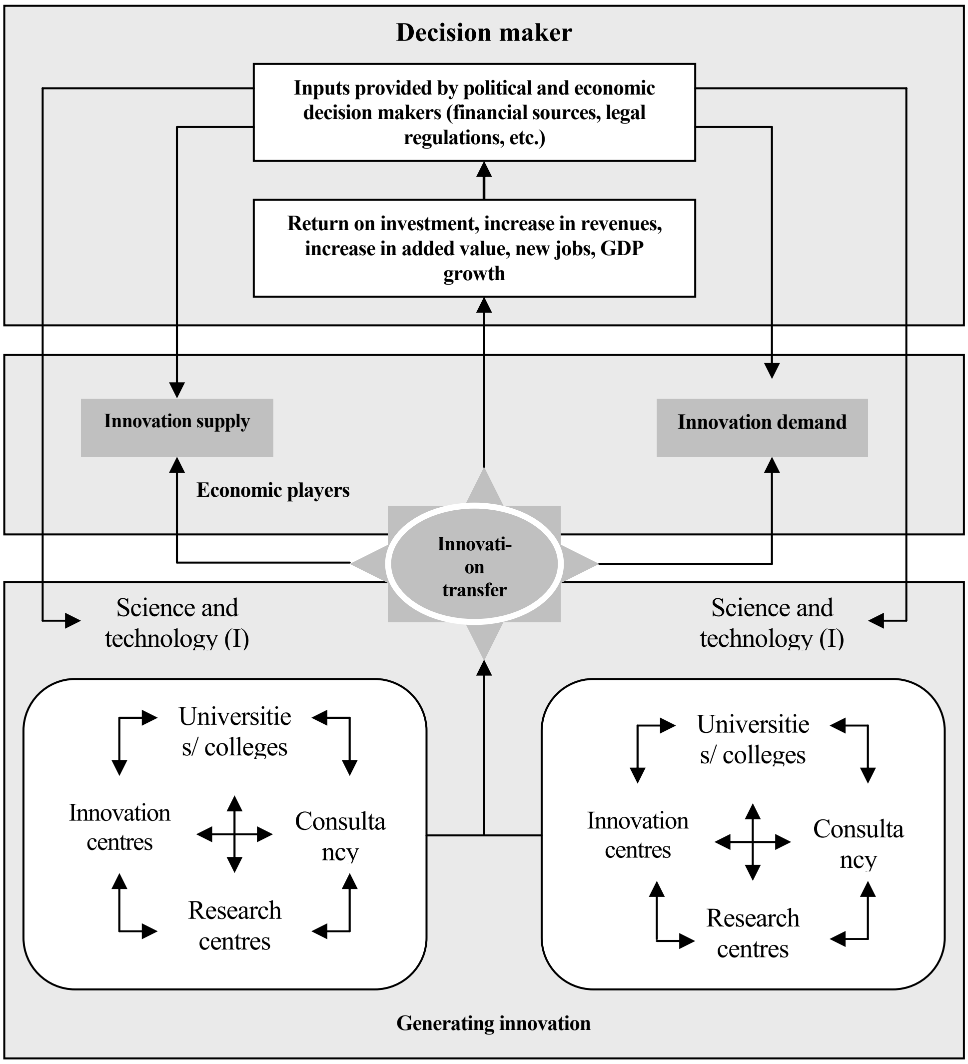

Figure 4: Relations between the players in innovation
Source: author's own work

Table 1: National economy level indicators

No	Indicators	Indices	
1.	R+D+I sources	1.1	Share of government R+D commissions in GDP percentage (%)
		1.2	Support of R+D activities within all government support (%)
		1.3	Tax benefits of those pursuing R+D activities as a share of total tax benefits (%)
		1.4	Annual growth rate of government R+D commissions (%)
		1.5	Tax benefits of R+D type enterprises as a share of total tax benefits (%)
2.	R+D+I policy	2.1	R+D share in driving sectors in GDP percentage (%)
		2.2	Annual growth rate of R+D in driving sectors (%)

Regional indicators

The regional innovation performance is primarily affected by the institutional background of innovation, its human conditions, the regional innovation climate and the regional sources.

<u>Regional institutional background of innovation</u>

The innovation process has multiple players with tasks going to (Figure 5):

- research and innovation institutions and organisations which generate innovation;
- higher education institutions which lay the foundations of knowledge and provide for the development of human conditions;
- financial institutions which are involved in creating the financing background;
- enterprises which utilise and commission innovation;
- regional innovation agencies which promote building relations between the players and are the transmissions of government sources.

Table 2: Indicators of the regional institutional conditions of the regional innovation potential

No.	Indicators	Indices	
1.	Number of R+D+I places	1.1	Number of higher education R+D places as a share in the region's all R+D+I places (%)
		1.2	Number of research institute R+D places as a share in the region's all R+D+I places (%)
		1.3	Number of corporate R+D places as a share in the region's all R+D+I places (%)
2.	Supply side of R+D+I	2.1	Product development supply as a share in sector revenue (%)
		2.2	Technology development supply as a share in sector revenue (%)
		2.3	Basic research supply as a share in sector revenue (%)
3.	Networking connections of R+D+I	3.1	Number of R+D+I tasks implemented in domestic cooperation as a share in total tasks (%)
		3.2	Number of R+D+I tasks implemented in international cooperation as a share in total tasks (%)
		3.3	Revenue of R+D+I tasks implemented in domestic cooperation as a share in total revenue (%)
		3.4	Revenue of R+D+I tasks implemented in international cooperation as a share in total revenue (%)

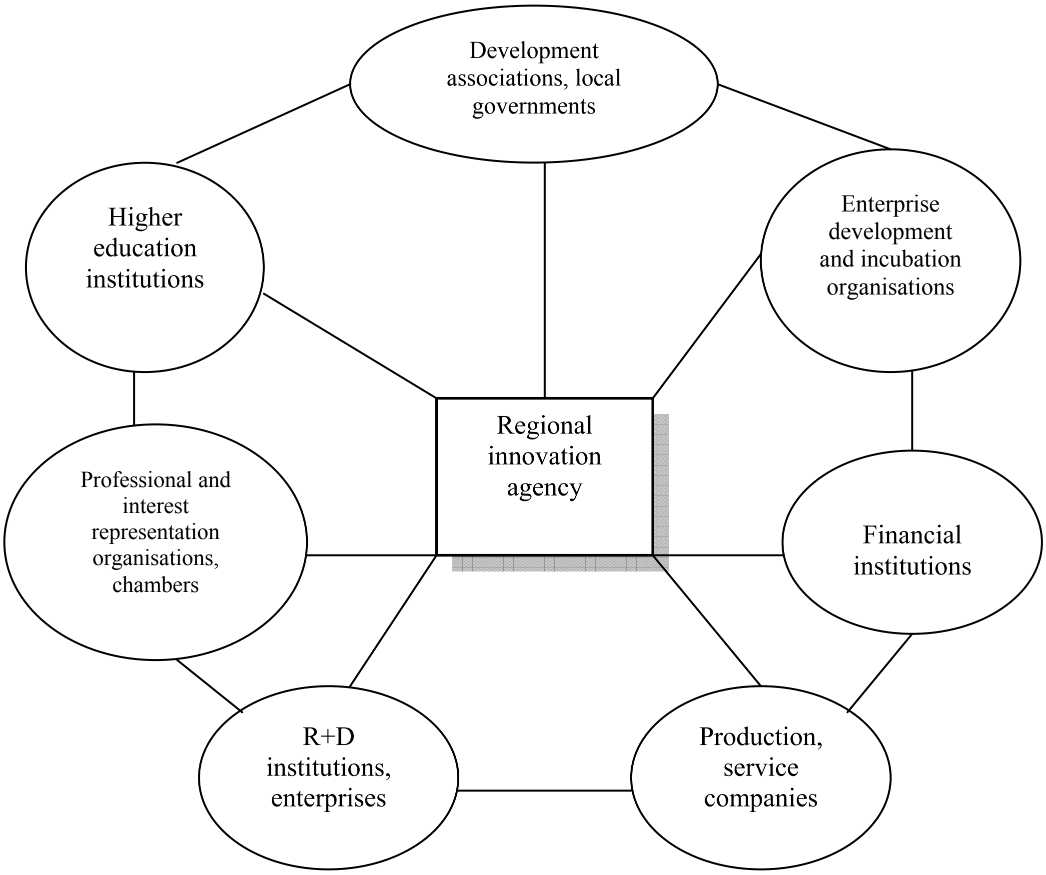

Figure 5: Regional innovation network model
Source: author's own workThe institutional background can first of all be expressed in terms of the number of R+D places, their offer and networking connections (Table 2).

Human conditions of innovation

In the decades to come, the positions of the regions will be determined by the knowledge surplus and results of the application of knowledge included in the products and services as opposed to the former competitive advantages (e.g. cheap labour, energy, raw materials, etc.). In this an important role is played by the human factor designed to introduce knowledge into the products and services.

Creating a new idea depends partly on the education, partly on the human conditions (Table 3). It is obvious that these two indicator groups are interrelated: in the vicinity of high standard higher education institutions the research centres are concentrated, and the efficiency of education increases close to high standard research centres.

Table 3: Regional indicators of the human conditions

No.	Indicators	Indices	
1.	Education conditions	1.1	Ratio of those involved in scientific (PhD) programmes (in percentage of the age-group 20-29)
		1.2	Number those in higher education within the age-group as a ratio of all employed (%)
		1.3	Number of those in life-long learning as a ratio of all employed (%)
2.	Personnel conditions	2.1	Innovation age ratio (ratio of the age-group of 18-59 within the regular population of the region (%)
		2.2	Ratio of those with higher education qualifications within the economically active population (%)
		2.3	Ratio of those speaking foreign languages within those with higher education qualifications (%)
		2.4	Number of those with higher education qualifications employed in R+D places within all those employed (%)
		2.5	Number of those with secondary education employed in R+D places within all those employed (%)

Regional economic climate

Through examining the relation between the economic situation (climate) of a particular region and its innovation potential, the literature highlights two relations: regions with considerable economic potentials (because the amount of added value and the resultant depreciation is higher) provide more favourable conditions for innovation (there are larger sources available, etc.); regions of a favourable economic situation also have a higher attraction for the human potential, which gives a further chance for innovators to get established.

This means that the 'snowball effect' prevails; the effect of mutual strengthening (inducing). (Obviously the opposite is also true; an unfavourable economic environment may render R+D areas lacking in sources, which vitiates the ability of the region to retain or attract professionals, reduces the demand for R+D and narrows the supply of this type of sources.

The economic climate is fundamentally determined by (4):

- the demand for R+D+I,
- the expenditure on R+D+I and
- the entrepreneurial climate.

Table 4: Regional indicators of the economic climate

No.	Indicators	Indices	
1.	Demand for R+D+I	1.1	Demand for developing new products as a ratio of the sector's revenue (%)
		1.2	Demand for developing new technologies as a ratio of the sector's revenue (%)
		1.3	Demand for basic research as a ratio of the sector's revenue (%)
2.	R+D+I expenditure	2.1	R+D expenditure as a ratio of regional GDP (%)
		2.2	R+D expenditure as a ratio of national GDP (%)
		2.3	R+D expenditure /costs of the business sphere as a ratio of total expenditure (%)
		2.4	R+D expenditure of the public sphere as a ratio of total expenditure (%)
3.	Entrepreneurial climate	3.1	Enterprise density (pcs/km^2)
		3.2	Ratio of migration of those employed in R+D against total migration of the region (%)
		3.3	Migration index of those with higher education qualifications
		3.4	Those employed as a ratio of the age-group 18-65 (%)
		3.5	Unemployed as a ratio of those employed (%)

Regional sources

The amount of sources available at regional level (K) may be made up of four components: from international sources (e.g. European Union, etc.) (K_{EU}), from support connected to sector-level R+D policy (K_A), from sources connected to regional innovation policy (K_R) and from the own sources of organisations (business, research institutes) pursuing R+D activities as well as foreign sources (K_S).

$$K = K_{EU} + K_N + K_A + K_S$$

The indices develop accordingly (Table 5).

Table 5: Indices of regional sources

No.	Indicators	Indices	
1.	R+D source	1.1	Ratio of R+D+I implemented from the sources of the sector against regional GDP (%)
		1.2	Ratio of R+D+I financed by the customer against regional GDP (%)
		1.3	Ratio of R+D+I financed by venture capital company against regional GDP (%)
		1.4	Ratio of regional R+D+I sources against regional GDP (%)
		1.5	Ratio of EU R+D+I sources (in a given sector) against total R+D (%)

The R+D+I source may be personnel (K_{SZ})-, real (K_D) and investment costs (K_B).

The personnel type expenditure (K_{SZ}) includes the wages costs of all the personnel involved in research activities, other personnel payments (e.g. bonuses, paid holidays, contributions to pension funds and other insurance-type payments), as well as the contributions and taxes imposed on wages and other payments (in determining the wages that can be accounted for as R+D+I costs, wages are usually corrected in proportion to the time spent on research, development and innovation tasks).

Real costs (K_D) cover the amounts spent on materials and supplies not coming under the heading investment for the R+D+I performed by the R+D+I organisation in the given year (e.g. water and fuel, gas and electricity, the costs of books, journals and other information material, library membership fees, membership fees in scientific societies, etc. Calculated or actual costs of smaller prototypes, models made outside the research centre, the costs of laboratory materials and supplies, chemicals, experimental animals, etc. belong here. The costs of indirect services have to be grouped here, irrespective of whether the service was provided within the given organisation, or bought or leased from an outside entity or supplier.).

The costs of scientific services include the costs of activities that the institute performs by commission for external entities and which are routine task not requiring scientific research (e.g. materials testing, instrumental measurements, data collection, calculations, processing, complex suitability and quality testing, expert opinions, studies, IT services, etc., as well as other technical development services such as standardisation, typifying, industrial design, production organisation).[2/]

R+D+I investment (accumulation expenditure) is the value of purchasing new and second-hand physical assets and computer software directly supporting research and experimental development and serving as its tool, incurred in the given year (K_B).
Purchasing, producing and implementing in own work of physical assets and computer software, the activities for the installation of the physical assets purchased until installation and delivery into the warehouse as well as all the activities connected directly or indirectly to the discrete physical assets, including the use of credit and insurance qualify as investment. The related costs incurred form part of the actual costs.

Construction investment includes the lands purchased for the purpose of R+D+I activities (experimental site, laboratory and pilot plant sites) and the purchasing or manufacturing costs of the buildings constructed or bought for this purpose, including substantial enlargements, re-construction and repairs. (*Machinery and instrument investment*: includes the costs of purchasing instruments and research equipment, new or second-hand equipment of substantial value for the purpose of performing R+D+I activities, including the software for operating the equipment).[3/]

Output side indicators
The results of regional innovation can be basically put into two indicator groups (6).
a) Indicators of scientific achievements

[2/] In European Union statements the costs of production activities and not those of scientific services include the costs connected with the production of single or small series products generally produced on commission or intended for marketing and requiring specialist knowledge and/or equipment as well as costs related to industrial and economic services. The costs of zero-series manufacturing, and the operation of pilot plants and experimental structures also belong here.

[3/] Computer software: the purchase of discrete identifiable computer software used in the R+D+I work, including program descriptions and other auxiliary materials, such as system and application programmes as well as the annual licence fees for the software necessary for using the computers purchased.

- The number of scientific publications written in the region (scientific publications is the umbrella term for the works publishing the new results of a discipline or discussing some knowledge in a scientific system).
- The number of patents born in a region (inventions and patents registered domestically and internationally).[4/]

Table 6: Output side regional indicators

No.	Indicators	Indices	
1.	Scientific indicators	1.1	Number of scientific publications per 100 thousand inhabitants in the region (pcs/person)
		1.2	Number of registered national patents per 100 thousand inhabitants in the region (pcs/person)
		1.3	Number of patents registered in the EU countries per 100 thousand inhabitants in the region (pcs/person)
		1.4	Number of patents registered in the USA per 100 thousand inhabitants in the region (pcs/person)
2.	Financial indicators	2.1	R+D+I revenue as a ratio of total revenues (%)
		2.2	R+D+I added value as a ratio of total added value (%)

The research topic, experimental development project is the basic unit of R+D+I activities.

A successfully completed research topic and experimental development project has the following conditions [5/]
- acceptance of the final report of the topic (project),
- recognition of the performance of a research or experimental development contract,
- in the case of applied research topics or experimental development projects verification of the possibility of implementation.

3. Quantification method of the regional innovation potential

The regional innovation potential (as can be seen from the above) can only be expressed through several, closely interrelated indices (Table 7). [6/]

[4/] Ongoing research topic and development project included in the programme for the given year and which incurred costs. All the research work and experimental development projects in progress are the aggregate of the research topics and experimental development projects registered at the research centres of the government (budgetary) and higher education and entrepreneurial sector. (This register may include smaller accumulations due to the division of labour between the research and development centres and the sectors (e.g. parts of a research topic or development project are performed by a different research-development centre or sector under contract or by commission.)

[5 /]According to EU statistics a research topic (project) cannot be regarded as successfully completed if it has been continuously worked on for two or more years and with only part tasks completed and the rest still to be done. Recognition of the completion of the contracts for the solution of the sub-tasks does not mean the successful completion of the entire work. Such projects do not count as successfully completed research topics or development projects in the statistics.

[6/] The numerous indices (42 pieces) can naturally be further extended and made more accurate.

Table 7: Regional indicators of innovation potential

No.	Indicators	Indices		Number of possible indices (pcs)
1.	National innovation climate	1.1	National level R+D+I sources	4
		1.2	National level R+D+I policy	2
2.	Regional institutional conditions of innovation potential	2.1	Number of R+D+I centres	3
		2.2	R+D+I supply side	3
		2.3	R+D+I networking relations	4
3.	Regional human conditions	3.1	Educational conditions	3
		3.2	Human conditions	5
4.	Regional economic climate	4.1	Demand for R+D+I	3
		4.2	R+D+I expenditure	4
		4.3	Entrepreneurial climate	5
5.	Output side regional indicators	5.1	Scientific indicators	4
		5.2	Financial indicators	2

Beyond the dimensions of the indicator groups and indices, an understanding of the interrelations of causal connections requires a computation method that [7/]

- does not differentiate between what are called result and explanatory variables;
- reflects not only the relations between the in advance and arbitrarily chosen causal variable and the factors influencing it, but expresses all the relations actually existing between the phenomena observed and (or the partial elements of a given phenomenon).

The method of factor analysis satisfies the dual criteria mentioned above.

The *objective of the procedure is* to express the variables described above as a linear combination of common factors which can explain the majority of the variance of the original variables. Then *the ranking order of the factors* can be established, which makes it possible to divide the variables into significant and insignificant ones.

The factor weights belonging to the variables can be used to interpret the factors (they can be identified with a group of variables or with individual variables). [8/]

The innovation potential is a complex concept, which is compound and cannot be directly measured. Although a great number of factors (criteria, variables, characteristics, active components, etc.) can be given that are more or less closely related to it (and at the same time these can be measured), none of them can be fully identified with it.

[7/] Naturally it is possible to use a simpler method (e.g. the use of weighted arithmetical mean), but then the impact of the individual factors cannot be assumed.

[8/] The basis of calculating factor weights is the matrix of simple correlation coefficients, on the basis of whose own values and vectors the factor weights are to be determined.

Thus the model has been expanded with a new variable, the factors [9/], as compared to the regression models. The variables observed in the factor scheme can be used to conclude on the variable observed, the factors transmitting the relations between them; therefore they have an information carrier role. (They do not have a meaning of their own, but, on the other hand, densify the information contents of the original variables with which they are in connection. Naturally a single factor is not necessarily in connection with all the variables, and then the corresponding c_{ij} values in the factor scheme – called factor weights – are equal to 0.)

The essence of factor analysis

The method consisting of probability calculus and mathematics-statistics relations is essentially a procedure for reducing dimensions, the essence of which can be readily illustrated in a two-dimension case (Figure 6).

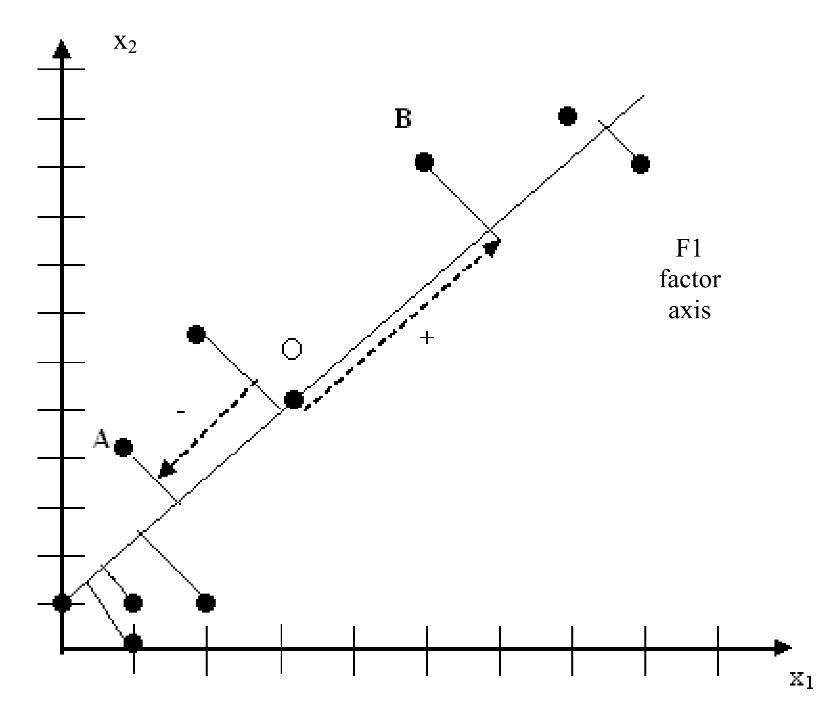

Figure 6: The logics of dimension reduction

Let us assume that we wish to measure the innovation potential with two series of data (x_1 and x_2) in a given spatial observation system. Since both series of data are connected to the same phenomenon, they will probably correlate with each other. If they are plotted in a coordinate system, it is possible not only to determine the correlation between the two variables, but it is

[9/] A traditional regression equation has the following form:

$$y = b_1 x_1 + b_2 x_2 + b_3 x_2 + b_0.$$

By contrast, the factor analytical way of writing it is as follows:

$$y = c_{01} f_1 + c_{02} f_2 + c_{00}.$$
$$x_1 = c_{11} f_1 + c_{12} f_2 + c_{10}.$$
$$x_2 = c_{21} f_1 + c_{22} f_2 + c_{20}.$$
$$x_3 = c_{31} f_1 + c_{32} f_2 + c_{30}.$$

possible to draw the regression line. This goes through point ‘O’ corresponding to the mean of the data series x_1 and x_2. This straight line will be the new dimension axis, along which the situations of each original unit area (in the Figure points A and B are the examples) can be measured with the length of the signed projection of the points to the new axis giving the new values.

The negative projection length (marked with an arrow in the Figure) to the left side of point O on the factor axis belongs to point A, while the positive axis projection (this is what is called factor value) belongs to the more favourable B area unit [10/]

The calculation based on the above principle can be performed in practically five steps (Figure 7).

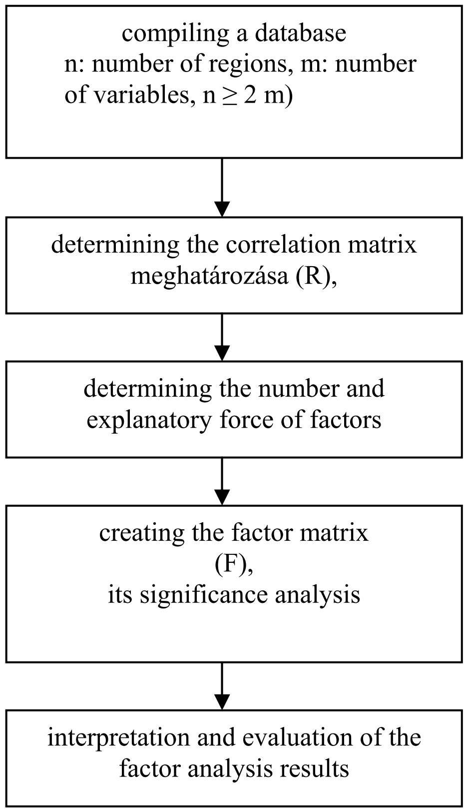

Figure 7: Logical process of factor analysis

[10/] Since the relative positions of variables x_1 and x_2 cannot be evaluated accurately with one data, a loss of information occurs, which can be shown in the Figure by the sections indicating the distances of the two points from the factor axes. This loss of information is the ’price’ of a simpler measurement using one data instead of two. It is also easy to see in the Figure that the numerical values corresponding to the positions measured along the new axis also definitely correlate with the values of both x_1 and x_2 (if x_1 or x_2 increases, the factor value belonging to them also increases). This relation verifies the fact that the new data series (the factor) is related with the level of development, for it correlates with the two indices chosen as its initial values.

a)The first task is to compile the data matrix describing the innovation potential. In doing so, it is a requirement that the number of observation units – in our case regional – should be higher than the number of variables (Table 8).

Table 8: Data matrix structure

Individual variables	Regions			
	1	2	…	n
1	x_{11}	x_{12}	…	S_{1n}
2	x_{21}	x_{22}	…	x_{2n}
.	.	.		.
.	.	.		.
.	.	.		.
I	x_{i1}	i2	…	x_{in}
.	.	.		.
.	.	.		.
..	.	.		.
N	x_{N1}	x_{N2}	…	x_{Nn}

The measurement results are denoted by x_{ij}, where points 'i', 'j' of the variables are the numbers of the regions. The Table can be written as the (N_{xn}) matrix of X, where each region corresponds to one column. The (stochastic) interdependence of the variables can be explained by the fact that each of the variables (or part of them) depends on a common generating active components unknown to us yet, which are from now on called common factors (and denoted by f_1, f_2, …, f_n). The common factors are therefore hypothetical variables that can be quantified only indirectly (after analysing the observations on the variables under examination) and their presence can only be concluded from the interdependence of the variables studied.

b) Determining the correlation matrix (R)

The interdependence of the variables can be expressed and measured by the (total or complete) correlation coefficients.

In a multi-variable relation naturally we can talk about correlation in several senses. The closeness of the correlation can be examined for each pair, on the one hand between the 'result variable' and the individual factor variables, and, on the other, between any two factor variables.

In this examination the multi-variable relation per se does not play a role, and the pair-wise correlation coefficients can be calculated by the well-known method. That is:

$$r = \frac{\frac{1}{N}\sum(x - \bar{\ } \cdot (y - \bar{y})}{\delta_x \cdot \delta_y},$$

where $\bar{x}$ and $\bar{y}$ are the empirical means of all the (observed) x and y values, respectively, and $\delta_x \cdot \delta_y$ are equal to their empirical variance. (The product in the numerator is the covariance of x and y, the arithmetical average of the product sums of the deviations d_x, d_y, with the approximate meaning of 'joint variance'.) It shows whether in the whole of the population the value pairs typical of a positive or a negative relation dominate or not. (Thus it is characteristic of the direction of the relation.) It is generally not used in the analyses, but is an important component of other indices. Using it, the above formula of the product momentum correlation coefficient can be written as:

$$r = \frac{\text{covariance of x and y}}{\sqrt{[\text{variance (x)}]\cdot[\text{variance (y)}]}} = \frac{C}{\delta_x \cdot \delta_y}$$

The correlation coefficients r can be arranged in a matrix R, where r_{ii} are diagonal elements (showing self-correlation) with a value of 1 (Table 9).

c) The correlation matrix can be used to determine the new variables and factors.[11/] The factors gather those of the basic data that are in close correlation with each other (the factors are the linear combinations of the original standardised variables). The factors are uncorrelated with each other, but are in correlation with the original basic data they have gathered (these correlations are the factor weights), and these can be used to identify their contents and name them. In the calculations it can be determined what proportion of the information gathered in the original data matrix the new variables (factors) cover (this is indicated by the eigenvalues of the factors and the variance expounded by them (Figure 8).

[11/] Three types of factors can be differentiated:

a) Factors in which several features observed appear, common factors ($F_1, \ldots, F_m$). These factors assume that Z is in correlation with other probability variables.
b) Factors which emerge only for one variable (special factors, s_j).
c) Factors which do not contain determinant components (Ej).

Table 8: An example for a correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	■																										
2	X	■																									
3		X	■																								
4				■																							
5					■																						
6				X		■																					
7							■																				
8	●			X				■																			
9	●			●					■																		
10				○		●		●		■																	
11					●						■																
12	●	●		●				X		●		■															
13				◆		●		X	●	X		●	■														
14				○				X	●	x		X	○	■													
15				X	●			X	●	●	●	●	X	●	■												
16				●				●				●	●	●	X	■											
17	●							●	●		●						■										
18				●				X				X		●	X	●		■									
19		●		●				●					●	●	●	●		●	■								
20				X				X				●	X	X	X	X		X	●	■							
21	●			●		●		●					●	●	●			●			■						
22				○		●		X		X		●	X	X	X	X		X	●		●	■					
23				●	●			●				●	●			●		○	●	○	●	●	■				
24				●	●					●			●	●	●					●		●		■			
25	●		●		●								●							●			●		■		
26				X	●	●		●	●	●		●	X	●		●		●		●		●		●		■	
27				○		●		○		●		●	◆	○	X	X		X		○	●	○	●	●	●	X	■

●= 0.20-0.39; X= 0.40-0.59; ○= 0.60-0.79; ◆= 0.80-0.99; ■= 1.00

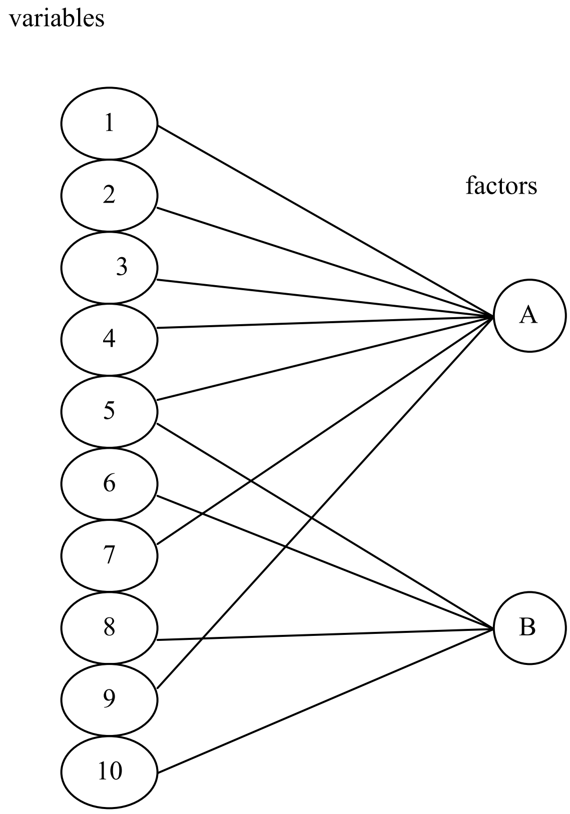

Figure 8: An example for the relation between the original variables and factors

d) Each observation unit carries as the result of the computation k pieces of factor value, these are the data that can be interpreted, mapped and explained in the regional investigations.
e) Assigning the variables to different factors results in different factor weights (Table 9).

Table 9: An example for a factor element and its three versions

Factor	Version 1	Factor weight	Version 2	Factor weight	Version 3	Factor weight
F_1	21.	0.84	1.	0.84	1.4.	0.86
	1.	0.83	4.	0.82	21.	0.83
	27.	0.78	21.	0.81	15.	0.80
	15.	0.78	27.	0.78	27.	0.77
	4.	0.78	15.	0.73	17.	0.75
	8.	0.70	8.	0.71	26.	0.69
	26.	0.68	26.	0.67	8.	0.65
			17.	0.63		0.63
F_2	24.	- 0.85	24.	0.84	19.	0.77
	22.	- 0.62	22.	0.71	23.	0.57
					13.	- 0.75
F_3			19.	0.79		
	19.	- 0.83	13.	0.74	22.	- 0.78
	13.	0.66	23.	0.57	24.	- 0.75
F_4	14.	0.79	14.	0.81	14.	0.81
					10.	0.78
	10.	0.74	10.	0.75	5.	0.56
					6.	0.52
					16.	0.49
F_5	2.	0.91	2.	0.89	2.	0.77
					12.	- 0.59
F_6	3.	- 0.85	9.	0.81	3.	- 0.80
			18.	0.63		
F_7	20.	-0.90	20.	- 0.89	20.	- 0,79
	18.	- 0.49	18.	- 0.44	18.	0.71
F_8	20.	- 0.89	7.	- 0.84	7.	0.93
F_9	9.	- 0.89	3.	- 0.84	20.	0.90
F_{10}			25.	- 0.56	11.	0.55
	25.	0.85	11.	- 0.46	25.	0.51
F_{11}	12.	0.91	6.	- 0.73	-	-
			5.	- 0.56		
F_{12}	6.	0.75				
	5.	0.56	12.	0.90	-	-
F_{13}	16.	0.80	-	-	-	-
F_{14}	23.	0.85	-	-	-	-

To choose the optimum version is the task for the analyst.

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