KNOWLEDGE POTENTIAL: MAIN AGGREGATED ASSESSMENT PRINCIPLES

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Abstract

The growth of economic competitiveness as well as effective use of knowledge potential (KP) is of foremost importance for sustainable development of the newly EU countries. Though scientists have studied the country‘s KP assessing components, a single quantitative potential assessment technique has not been accepted.

The authors of the performed study provided a theoretical framework and empirical viewing for the complex evaluation of the KP determinants based on multiple criteria assessment methodology. The essence of the principal approach lies in quantitative measure of KP level, i.e. determination of general relative level index. The formulated main multiple criteria evaluation principles are focused on the formalization of an investigated system describing knowledge components independencies with adequate composite determinants and primary indicators, i.e. background evaluation models. Thus, the direct and indirect influence of primary criteria is taken into account; application of different significances of determinants is provided. The proposed technique is oriented towards incorporation into multicriteria decision making system and may be used for the reasoning of strategic decisions in the KP development. When applying the Simple Additive Weighting \method, which is especially applicable for the aggregate evaluation of substantially different criteria having both quantitative and qualitative expression, the general KP level index has been established.

The idiosyncratic components revealed with account of preliminary situation analysis in newly EU countries and classification of international institutions are as follows: innovative capacity, use of information technologies and quality of primary & secondary education. Those components may be described by adequate primary indicator system formulated in the study. The proposed methodology was approbated by evaluation of the KP level in Lithuania and by forecasting its prospective situation.

Keywords: knowledge potential; knowledge-based development; components; primary indicators; multiple criteria evaluation, Simple Additive Weighting method

1. Introduction

The KP is determined below as a totality of accumulated intangible (intellectual) assets and human resources with abilities & competencies to use them for generating value adding in knowledge based economies. The measurable components of the KP are detailed in the article with account of the international researches of country‘s competetiveness and its intellectual economy resources.

Over the past few decades, the intangible assets have been identified as fundamental sources of wealth and sustainable development in the newly EU countries. These assets represent a major concern not only for companies, but for global developed macroeconomies first of all for stimulating wise resource allocation, refining and re-orienting national development strategies for sustaining their competitive advantages. An integrated approach to understanding knowledge as a global resource facilitates the research of the growing

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competition for knowledge resources. That was stressed in some works investigating the nature of knowledge resources and their role in development, especially relevant to how these (knowledge) resources can be created, governed, distributed and exchanged (Millar, Choi, 2010). Therefore, the analytical studies must be focused on the knowledge-based growth of economic competitiveness, in particular, of innovation and technological adoption, ICT infrastructure and education, the economic and institutional regime as well as their idiosyncratic interdependencies that compiled the synergetic effect. This corresponds to integration of intangible assets into national accounts whereas the amount of investment in intangibles is increasingly significant (Berger, 2012).

The KP was widely attributed to the level of organizations as their intellectual or human capital, intellectual property, sometimes as a nonmaterial wealth (Lopes, 2010). Conceptually, the intellectual capital in its turn is often described traditionally as consisting of human capital, market capital, process capital, structural capital, relational capital, financial capital, etc. on the level of organizations (and including authors rights, patents, know-now, licences, franchising), amounting value management, strategic development, information products and innovations of finance management. So, the activities that form the backbone of a knowledge-based strategy are to be aimed at improving the capacity-to-act of KP in two directions - both inside and outside the organization - based on an epistemological approach to strategy formulation (Sveiby, 2001). On the state level, the importance of human resource development, education & IT systems, also country‘s and regional innovation systems development, can be more detailed when aiming to efficiency & competitivity (Buracas, 2007).

Last time, the new accents connected with priority of the knowledge economy, i.e. also with the KP, development can be revealed in the WB researches and publications including a wide approach both to the political issues and private initiatives as well, such as:

- to strengthen the business and public sector (including research and education institutions) cooperation;
- to support to reform state institutions,
- to promote innovation, learning and development of information society,
- to review the old and introducing new tax assistance measures for support of labour market development (to encourage people to retrain or gain a qualification to meet market requirements, while reducing unemployment over the medium term);
- to strengthen the legal framework.

So, the essential compound criteria of the knowledge economy (KE) could be defined as:
- economic & institutional surrounding;
- education and human resources;
- innovative systems;
- infrastructure of IT.

Thus, some of the KP examination areas are specified by development level of human resources (competencies & qualifications), innovation system (creativity), education system (new techniques, educational innovations, learning methods), IT as well as systemic development of knowledge and quality based management (QBM).

Mirghani Mohamed, Michael Stankosky and Mona Mohamed (2009) tested the importance of knowledge management for country’s sustainable economic development and growth of its competitiveness and shown its impact on the innovation implementation and efficient use of

resources. P. Cooke (2001, 2002) presented a systematic approach based on complexity of regional innovation systems, clusters and the KE. The author considered the criteria for examination of innovation activity, also emphasized that the future will require the widespread evolution of regional innovation systems along with stronger institutional and organizational support from the private sector. Other publications detailed the influence of human resource management on competitiveness, formation of individual competencies on strategic development (Chan, Lee, 2011), some of them - on problemic aspects of innovation efficiency evaluations (Geoff et al., 2009).

The common EU KE and innovation development program oriented to strengthen its competitiveness and sustainable development, on the one side, has impact on consecutive development of adequate national strategies (Grundey, 2008; Simmons et al., 2009). On the other side, the formulation of strategic intellectual potential trends as well as for knowledge control monitoring, taking into account many aspects of the problem, actually calls for an integrated application of adequate complex assessment systems (Marr, Moustaghfir, 2005; Shapira et al., 2006; Weziak, 2007; Meza, 2011).

The utilitarian *complex assessment* technique of the KE parameters leading to interstate rankings was fulfilled by the Knowledge for Development (K4D), affiliated with the World Bank experts. In order to facilitate the evaluations of the transition countries developing the KE, the *Knowledge Assessment Methodology* (KAM) was formulated. It is designed to provide a basic assessment of countries' readiness for the KE, and identifies sectors or specific areas which need more attention or future investments. The KAM is currently being widely applied for different World Bank research projects, and it frequently facilitates the discussions concerning the perspective priorities of the country's sustainable development. The KAM database measures variables that may be used to assess the readiness of countries for the KE based competitiveness and has many other policy uses. As was stressed, the main objective is to identify problems and opportunities as well as to quantify the factors for each country, and to do so in a way that allows the comparisons of factor scores.

A methodology for examination of the KP (aimed to measure the country's intellectual capital) based on activating the accountable expenses, assumed to generate knowledge, was presented by J. L. A. Navarro, V. R López Ruiz and D. Nevado Peña (Navarro et al., 2011). Some efficiency indicators are derived from a totality of structural, human and technological capital variables by means of factor analysis. Authors concluded, at the conceptual level, that this information should be used to design the convergence policies and balanced development strategies to ensure effective economic growth.

The models, composite indicators and indices for measuring KE are presented by many authors, between them the academic interest can be drawn to the reconciling of knowledge based development discourse with *happiness* studies (Meza, 2011). In contrast to the wide use of aggregate measures of innovation, some authors presented a *disaggregated* knowledge-based approach to decision-making processes as well as development strategies in a more knowledge-oriented direction (Shapira, Youtie, 2006). The authors discuss the methodology to develop sectoral knowledge content measures in manufacturing and services industries, vary in their emphasis on specific KE components, when levels of knowledge content are assessed by sectors (Shapira, et al., 2006). In addition to R&D, technology and ICT infrastructure, it is important to include access to large markets, international competition interconnected with FDI flows in context of knowledge-based growth.

This article proposes a conceptual approach to a comprehensive analysis of regional knowledge generation and its transfer in the perspective of innovation processes. Our approach emphasises the importance to take into compound account the multiple channels of knowledge transfer. This provides valuable insights into the spatial structure of innovation processes on the different levels. It is important to disentangle the innovation process and consider four different layers: 1) formal R&D collaboration projects; 2) patent applications; 3) publications in peer-reviewed journals; 4) localised innovative input-output relations. The relevance of the 'multi-layer approach' as a valuable tool is important by applying it to a knowledge-based regional development strategies.

As a result, the assessment of knowledge development level has become a common challenge however a single assessment technique has not been accepted (Ginevicius, Podvezko, 2004; Lopes, 2011). The review of research works shows that the attention given to complex evaluation is not adequate to its importance.

Thoroughly, the development trends as well as strategic decisions priorities may be identified in the developing economies as follows (compare also: Marr, Moustaghfir, 2005; Choong, 2008; Melnikas, 2008; Stam, Andriessen, 2009; Parada Daza, 2009; Chan, Lee, 2011):

- enhancement of innovations capabilities, manufacturing and export of high-tech production, organizational flexibility for innovations, entrance into new markets;
- advancement of life quality parameters according to human development index components, development of human resources;
- development of the KE, enhancement of economic competitiveness;
- ITT development in businesses and households, recent availability of IT;
- growth of businesses expenditure for R&D, QBM;
- growth of quality of primary and secondary education, development of staff training;
- technological transfer, foreign IT transfer, production sophistication;
- growth of the institutional environment favourability;
- government support for innovative technologies, investments into intellectual potential components;
- protection of the intellectual property, modernization of the legal basis.

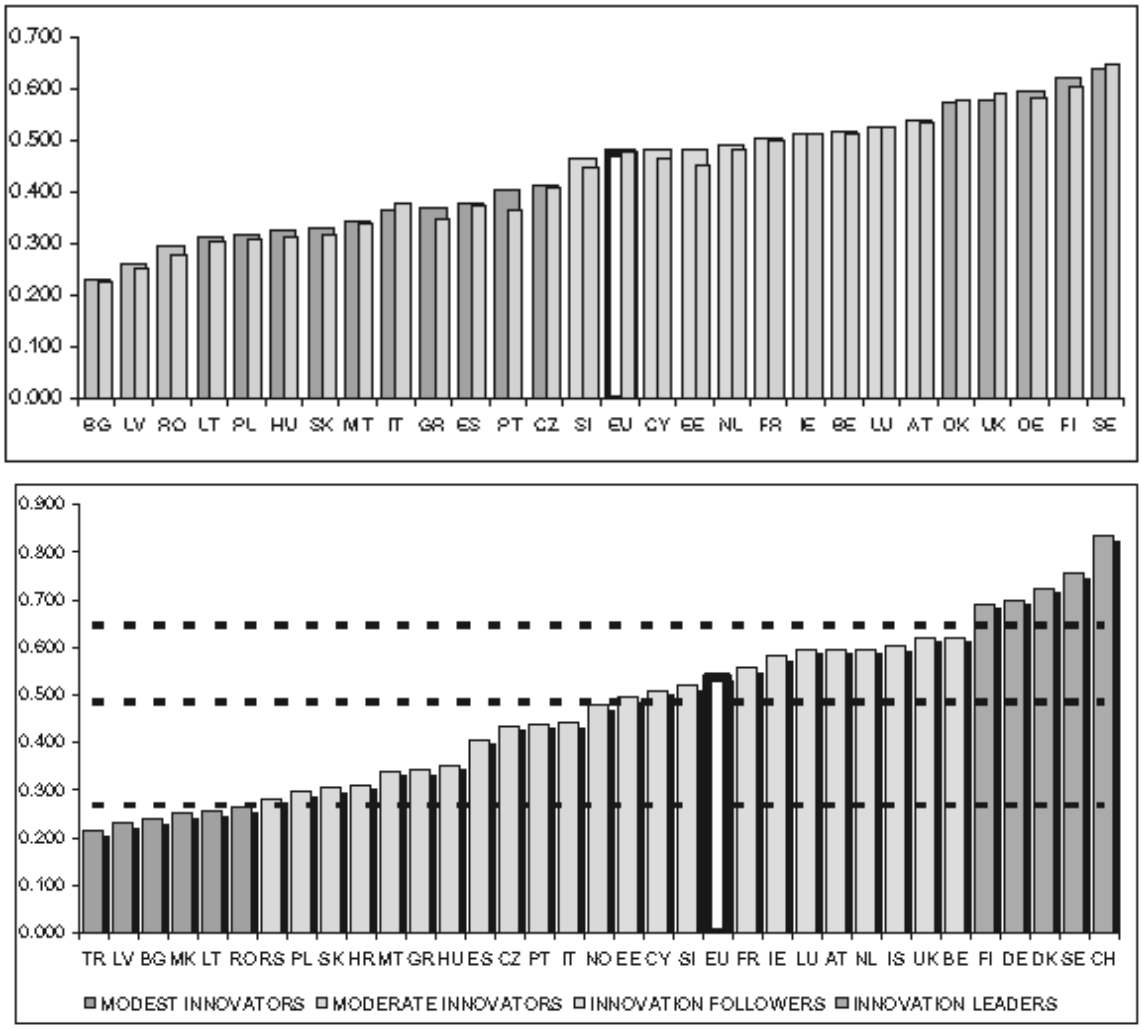
In the process of applying the multicriteria evaluation methods, the authors gave some attention to identification of intelectual potential determinants peculiar to newly EU countries (as for Baltic States - Zvirblis, Buracas, 2011; 2012) and below – to some applicants to the EU (as Turkey, Bulgaria). That required of detailed analysis of both primary indicators and those data as well as expert evaluations presented by the international institutions. However, the comparative data for the mentioned applicants to the EU are often not presented. The methods to be applied above are not oriented to *MCDM* (*Multiple Criteria Decision Making)* systems when validating the strategic decisions of KE development but more interconnected with universal alternative evaluations helping to choose the more efficient programmed variants.

The *aim* of the study is to identify the state KP determinants and present the aggregated evaluation construct. The o*bject* of the study includes the state KP components. The *methods of research*: critical review of expert evaluations, generalization of special literature & statistics concerning development analysis of the KP, multiple criteria evaluation by the *Simple Additive Weighting*. The *originality* of the study refers towards theoretical

backgrounds of the KP multicriteria evaluation and an attempt to apply them for the determination of general KP level index (case of Lithuania).

2. Main knowledge potential components analysis

The latest period of the economic development, the best rates of growth and competitiveness distinguished the OECD countries with more developed intellectual (knowledge) potential as a main priority of their strategic expansion (Fig. 1). According to the European Innovation Scoreboard, Scandinavian countries (SE, FI, DK) can be seen as innovation leaders; Latvia (LV), Lithuania (LT), Bulgaria (BG) and Turkey (TR) - as modest innovators which accounts for some special comparisons of their KP components below (unfortunately there is not always enough comparable statistics for Turkey).



Source: European Innovation Scoreboard. Retrieved from: http://i3s.ec.europa.eu/commitment/ 39.html; http://ec.europa.eu/enterprise/policies/innovation/files/ius-2011_en.pdf
Fig. 1. Comparisons of compound indices of innovation performance in EU countries:
(a) 2005-2009, (b) 2011

The comparative investments into components of intellectual capital are an important dimension of KP development determining its significance at value-adding production on the basis of new technologies and innovative decisions. Besides, it is possible to notice very different levels of innovative investments grouped by the Knowledge for Development (K4D)

systemic approach into human, organization & structural capital in various countries what also impact their productivity. Such components as replace of outdated products or processes, improving of goods or services quality & flexibility for their producing, organizational and productive adaptivity to innovations, reducing of labor costs per unit output - are revealed and measured. Some of the innovation objectives in Baltic and Nordic States compared with EU (as % of innovative enterprises) are presented in the Eurostat online data (inn_cis6_obj).

The data presented by the K4D also show the comparative progress made by various countries, the ratios among aggregate indicators of the KE: according to economic initiative and institutional environment Lithuania's situation in scores rose from 5.2 to nearly 8, similar to Latvia - from 5.64 to 8.03 and Poland - from 4.84 to 7.48; Estonia progress was not such significant (ranging from 7.94 to 8.76). Information technology development score rose from 5.7 to about 8 in Lithuania; similar progress was in other Baltic countries (in Estonia, the estimate has increased moderately - from around 8 to 9.05). The innovative activity indicators & their components published by Innobarometer, 2011, on impact and perception of the public sector innovation among companies fixed the comparative levels and sectors of retardation in the Baltic States comparing with the EU averages (data are based on a survey of 10,000 enterprises; in 2010 – only 4,000). They can be compared with the KP component evaluations for the selected Balkan, Baltic and Nordic countries, also Turkey, published by KAM 2012 (Table 1).

Table 1: Knowledge economy component evaluations: Turkey, the selected Balkan, Baltic and Nordic countries

Countries in 2009	Average KE index	Economic incentive and institutional regime	Innovation	Education	ICT
Turkey - 69	5.16	6.19	5.83	4.11	4.50
		Balkans			
Albania -82	4.53	4.69	3.37	4.81	5.26
Bulgaria - 45	6.80	7.35	6.94	6.25	6.66
Greece -36	7.51	6.80	7.83	8.96	6.43
Baltics					
Lithuania -32	7.80	8.15	6.82	8.64	7.59
Latvia - 37	7.41	8.21	6.56	7.73	7.16
Estonia -19	8.40	8.81	7.75	8.60	8.44
Nordics					
Sweden - 1	9.43	9.58	9.74	8. 92	9.49
Finland - 2	9.33	9.65	9.66	8.77	9.22
Norway - 5	9.11	9.47	9.01	9.43	8.53

Data are weighted by population, KAM 2012. All significances are calculated as average of normalized components. Numbers near countries – place between all of them evaluated by KE index.

Compiled by authors using the WB data: http://info.worldbank.org/etools/ kam2/ KAM_page5.asp.

If to compare the performance scores of countries by their knowledge potential dimensions, the substantial differences are observed in the stability and basic levels of their main parameters: for the selected Nordic countries about all of them are on high levels but they are unstables in Lithuania, Latvia, Bulgaria and Turkey. For those states all of the selected dimension parameters fluctuates and have especially low levels for innovators (except Turkey), research systems, firm investments, linkages of entrepreneurship, and Turkey – especially in human resources & intellectual assets (Table 2).

Table 2: Performance scores per knowledge dimensions in EU, Baltics, Nordics, Bulgaria and Turkey, 2011

Countries/ knowledge dimensions	Human resources	Research systems	Finance & support	Firm investments	Linkages entrepren.	Intellectual assets	Innovators	Economic effects
EU-27	0.563	0.530	0.584	0.440	0.487	0.551	0.506	0.585
Baltic countries								
Estonia	0.575	0.370	0.677	0.668	0.651	0.403	0.576	0.366
Latvia	0.451	0.053	0.250	0.369	0.061	0.309	0.035	0.262
Lithuania	0.646	0.168	0.438	0.240	0.195	0.133	0.170	0.209
Nordic countries								
Finland	0.858	0.630	0.833	0.639	0.768	0.662	0.523	0.638
Denmark	0.620	0.829	0.719	0.564	0.932	0.845	0.558	0.635
Sweden	0.893	0.820	0.895	0.691	0.793	0.799	0.562	0.622
Balkans & Turkey								
Turkey	0.066	0.208	0.385	0.084	0.216	0.099	0.562	0.273
Bulgaria	0.455	0.187	0.156	0.312	0.092	0.201	0.114	0.314

Source: Innovation Union Scoreboard 2011, EU. Retrieved from: http://www.proinno-europe.eu/metrics

The gap between advanced economies, on the one side, Turkey and some Balkan States KE levels, on the other side, remains deep. However, by *Innometrics* evaluations, in 2007-2011 Turkey summary innovation index increased from 0.181 to 0.213, in Bulgaria – from 0.173 to 0.239; in Latvia – from 0.191 to 0.230 (in Lithuania – diminished from 0.265 to 0.255;

Innovation Union Scoreboard 2011, EU, p. 53). The main prestigious targets set by the Supreme Council of Science and Technology in Turkey (BTYK) have to achieve within nearest years: (a) to increase GERD/GDP ratio from 0.53% in 2002 to 2% by 2013, half of this share being funded by the private sector; (b) to raise the number of full-time equivalent (FTE) researchers from 28,964 in 2002 to 150,000 by 2013.

Table 3: The competitive surrounding of knowledge potential in Baltic and Nordic countries, 2010

Indexes	Lithuania	Latvia	Estonia	Finland	Sweden	Norway
Market environment						
Financial market sophistication	4.1/77	3.9/82	5.2/34	6.1/12	6.4/7	6.1/9
Availability of latest technologies	5.6/37	5.1/65	5.8/31	6.6/4	6.8/1	6.7/3
State of cluster development	2.9/104	2.9/102	3.1/91	5.1/9	5.1/8	4.7/18
Burden of government regulation	2.7/114	3.1/87	4.4/6	4.3/9	4.0/15	3.4/58
Extent & effect of taxation	2.7/125	2.9/116	4.3/18	3.0/113	3.0/109	3.6/63
Total tax rate, % profits	38.7/64	38.5/63	49.6/101	44.6/85	54.6/110	41.6/74
Political and regulatory environment						
Laws relating to ICT	4.5/44	3.8/80	5.9/3	5.5/7	5.9/1	5.6/5
Judicial independence	3.6/72	3.7/70	5.5/24	6.3/6	6.6/2	6.2/13
Efficiency of legal system in settling disputes	3.5/76	2.9/116	4.3/40	5.5/7	6.1/2	5.8/4
Property rights	4.3/67	4.3/70	5.3/33	6.4/2	6.3/5	6.1/9
Intellectual property protection	3.5/68	3.6/63	4.6/34	6.2/2	6.2/1	5.6/16
Software piracy rate, % software installed	54/40	56/45	50/37	25/5	25/5	29/15
Internet & telephony competition, 0–6 (best)	5/62	6/1	5/62	6/1	6/1	6/1
Business readiness						
Expenditures, R&D	3.1/57	2.7/93	3.3/46	5.4/5	6.0/1	4.4/17
Government readiness						
Gov't prioritization of ICT	4.5/76	4.0/107	5.6/14	6.1/5	6.1/7	5.4/27
Gov't procurement of advanced technology	3.2/103	3.1/110	4.1/42	4.7/6	4.5/13	4.2/33
Importance of ICT to gov't vision	3.9/73	3.3/113	5.0/19	4.9/21	5.4/8	4.8/24
Individual usage						
Households w/ personal computer,%	57.3/40	60.1/38	65.1/33	80.1/16	87.5/5	87.6/4
Broadband Internet subscribers /per 100 pop	19.3/32	18.6/34	22.5/24	28.8/15	31.8/8	34.0/4
Internet users/100 pop	59.8/34	66.8/28	72.5/22	82.5/8	90.8/3	92.1/2
Internet access in schools	5.5/27	5.4/30	6.4/2	6.1/11	6.4/3	5.9/15
Use of virtual social networks	5.5/45	5.2/66	5.7/31	6.2/7	6.5/2	6.3/4
Impact of ICT on access to services	4.9/43	4.2/89	5.5/18	5.3/25	6.2/1	5.5/16

Business usage						
Firm-level technology absorption	5.0/55	4.5/88	5.3/42	6.0/12	6.4/2	6.2/6
Capacity for innovation	3.3/48	3.1/57	3.6/34	5.6/5	5.7/3	4.7/13
Extent of business Internet use	6.3/5	5.4/37	6.3/2	5.9/19	6.6/1	6.0/12
High-tech goods export, %	5.9/39	5.3/44	6.8/33	14.2/21	12.1/24	4.1/54

All evaluations are presented in points /place rating among 138 countries. Compiled by the authors using WEF data. Retrieved from: www.weforum.org/reports/global-information-technology-report-2010-2011-0.

More detailed evaluation of main surrounding factors influencing the status of KE determining its competitive development perspectives was presented in the *Global Information Technology Report* 2010–2011 (Table 3). Similar to World Economic Forum (WEF) criteria system, its experts presented the comparative impact of ICT on the development process and the competitiveness of 138 economies worldwide. The Networked Readiness Index (NRI) featured in the report examines how prepared countries are to use ICT effectively in the general business, regulatory and infrastructure environment. Below the comparative evaluation of main factors in the Baltic and Nordic countries according to main pillars reveal the premises, sources, perspective resources of the KP and some results of their interaction. It also reveals specifics of the KE development, in particular in the Baltic and Nordic countries, depending from market size, development level of finance and/or ICT sector and so on. Besides different traditions in the intellectual property protection in both groups of countries, there are many similar KE development features determined by more active penetration of the Baltic countries in some fields of ITC a/o determinants of countries' economic competitiveness.

The Networked Readiness Index (NRI), 2012, examines how well prepared countries are to use ICT effectively on three dimensions: the general business, regulatory and infrastructure environment for ICT; the readiness of the three key societal actors - individuals, businesses and governments - to use and benefit from ICT; and their actual usage of available ICT. According to the NRI rankings, Sweden scored 5.94, Norway – 5.59, Estonia – 5.09, Lithuania – 4.66, and Turkey – 4.07. The last financial crisis deepened the innovative backwardness of Latvia in 2008-2011; the release of new products or new markets in Estonia and Scandinavian countries is slightly behind by the EU average but the lag was significantly higher in Lithuania and Latvia (scored 4.35; some other data see in Table 4).

Table 4: Innovation objectives in the Baltic and Nordic States in 2008 (as % of innovative enterprises)

Nature of innovation	EU-27	Estonia	Latvia	Lithuania	Denmark	Finland	Norway	Sweden
Increase in range of goods or services	52.2	36.5	12.2	30.3	25.0	41.2	49.3	43.9
Replacement of outdated products or processes	34.5	35.8	9.3	26.4	27.7	29.3	39.1	32.0
Entering into new markets	39.6	24.1	11.3	26.5	23.8	29.6	36.6	28.3
Increase in market share	42.4	32.3	8.9	32.8	33.4	37.9	60.8	45.2
Improvement of quality of goods or services	56.6	50.8	12.6	42.8	30.3	43.0	71.6	45.2
Improvement of flexibility for producing goods or services	33.9	31.1	7.4	26.6	18.8	30.2	37.7	28.3
Increase in capacity for producing goods or services	31.7	33.9	10.3	27.7	18.5	23.7	34.5	25.5
Improvement of health and safety	24.9	18.7	8.0	17.6	11.1	13.1	49.2	16.1
Reduction of labour costs per unit output	28.1	21.3	6.9	28.3	30.0	30.2	37.6	34.1

Source : Eurostat online data code: inn_cis6_obj. Retrieved from: http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-31-11-118. Table 5.8.

Intellectual economic performance is closely linked with key human development index (HDI) components, so it's worth to compare its diversity in the Baltic and Scandinavian countries (Table 5). The largest of them is in GNP per capita (3-4 times) and life expectancy (7-8 years), but the selected countries (except Latvia) are attributed to high (Lithuania - in front of it) level of human development group. The HDI (with correction to net revenue impact) of Finland is higher than, for example, of Denmark when calculated in proportion to GDP per head. The Balkan countries & Turkey stands behind (except life expectancy; the lag is not so significant for average length of schooling in Bulgaria & Albania).

Table 5: Human development indices and their components between the upper middle income group in the selected Balkan, Baltic and Scandinavian countries & Turkey, 2011

State, its rank	HDI	Life expectancy at birth, years	Average length of schooling, years	GNP per capita*	HDI without income impact
Nordics					
Norway -1	0.943	81.1	12.6	47557	0.975
Sweden -10	0.904	81.4	11.7	35837	0.926
Finland - 22	0.882	80.0	10.3	32438	0.911
Baltics					
Estonia - 34	0.835	74.8	12.0	16799	0.890
Lithuania - 40	0.810	72.2	10.9	16234	0.853
Latvia - 43	0.805	73.3	11.5	14293	0.857
Balkans					
Turkey - 92	0.699	74.0	6.5	12246	0.704
Albania - 70	0.739	76.9	10.4	7803	0.804
Bulgaria - 55	0.771	73.4	10.6	11412	0.822

*Inequality- adjusted HDI. According to PPP at constant 2005 prices. Source: composed by authors on basis: Human Development Report, 2011. Retrieved from: http://hdr.undp.org/en/media/HDR_2011_EN_Table1.pdf

The detailed comparison of competitiveness indicators influenced by the components of the intellectual potential in the Baltic States (Table 6) shows why Estonia (33 place in the world) stands out among its neighbours, particularly comparing with Latvia (70 seats) in competitiveness.

Table 6: Indicators of competitiveness of the Baltic States interconnected with their intellectual potential (2009-2010)

Sectors & indicators	Lithuania	Latvia	Estonia
Cumulative Competitiveness Index	47	70	33
Intellectual property protection	69	64	34
Legal effectiveness of the system	91	118	40
Quality of infrastructure	41	51	28
Initial quality of education	44	46	16
Secondary education	29	32	26
Quality of the education system	70	64	42
Training for local access to services	38	68	33
Adequacy of staff training	64	76	48
Dominance in market	97	70	38
Customer orientation	34	73	40
Customer network complexity	105	86	78
Payment and productivity	18	42	8
Professional management application	54	76	29
Brain drain	110	93	57
Availability of risk capital	103	101	30
Access to latest technology	37	65	31
Technological renovation of firms	56	89	42
Foreign technology transfer	62	94	40
Mobile phone use	10	60	2
Internet use in business	36	29	25
Internet access in schools	27	30	2
Sophistication of production	51	72	41
Competitive advantages	43	49	53
Amount of marketing	46	69	61
The innovative capacity	48	57	34
Company spending on R & D	57	94	46
Government support for innovative technologies	104	111	43
Patents per 1 million people	55	41	40

Source: composed by the authors on basis of the WEF data.

First-of-all, the differences are in the impact of judicial system on business (Estonia - 40 place, and Lithuania - 91, Latvia - even 118 place), and they are substantial in levels of their infrastructure, education quality, professional management application, access to venture capital, foreign technology transfer, Internet use in schools (in Estonia is one of the best in the world) and others. The experts consider the support for innovative technologies of Latvia and Lithuania government to be considerably behind the EU average, more comparable to the situation in developing countries (Estonia – 43rd place, Lithuania – 104th, Latvia – 111th place). So, the improved efficiency in delivery and quality of public services also have a positive impact on a company's probability to innovate and on the company's turnover.

Over the past decade, the situation in the Baltic countries has improved by rapid development of the intellectual potential, especially in the field of ICT, but the global slowdown occurred in 2008-10, during the period of financial crisis. Some of the aggregated comparative levels of the ICT impact on economies under review are shown in the Tables 7-8. Current networked readiness indexes are based on expert evaluations of 53 indicators grouped into 4 subindexes and 10 pillars in 2012.

Table 7: Comparative networked readiness (CNR) indexes and their main pillars In the selected Nordic & Baltic countries

Country/Economy	Sweden	Finland	Denmark	Norway	Estonia	Lithuania	Latvia
Rank by index	1	3	4	7	24	31	41
State score	5.94	5.81	5.70	5.59	5.09	4.66	4.35
Business and innovation environment	5.15	5.32	5.24	5.12	4.54	4.39	4.42
Infrastructure and digital content	6.90	6.82	6.07	6.83	5.69	5.00	4.68
Affordability	6.38	6.17	6.13	6.04	5.48	6.40	6.23
Skills	6.03	6.51	5.93	5.65	5.83	5.67	5.40
Individual usage	6.39	6.15	6.22	6.23	5.17	4.76	4.51
Business usage	6.22	5.96	5.96	5.46	4.35	3.94	3.73
Government usage	5.21	4.88	5.15	5.08	4.89	4.13	3.70
Economic impacts	6.15	5.84	5.48	5.33	4.65	4.07	3.62
Social impacts	5.64	5.17	5.58	5.24	5.77	4.96	4.04

Compiled by the authors from: Global Information Technology Report 2012, p. 12-16. Retrieved from: http://www3.weforum.org/docs/Global_IT_Report_2012.pdf

Table 8: Comparative networked readiness (CNR) indexes and their main pillars / subindexes in Turkey and the selected Balkan countries

Country/Economy	Turkey	Albania	Bulgaria	Greece
Rank by index	52	68	70	59
State score	4.07	3.89	3.89	3.99
Business and innovation environment	4.33	3.92	4.27	4.21
Infrastructure and digital content	4.55	3.74	4.86	4.78
Affordability	5.48	5.43	4.12	5.54
Skills	4.54	5.18	4.98	5.19
Individual usage	3.45	3.58	3.79	3.96
Business usage	3.65	3.51	3.23	3.30
Government usage	3.98	3.90	3.60	3.39
Economic impacts	3.27	3.18	3.26	3.21
Social impacts	4.07	3.69	3.92	3.59

Compiled by the authors from: *Global Information Technology Report 2012*, p. XXIII, 12-16. Retrieved from: http://www3.weforum.org/docs/Global_IT_Report_2012.pdf

The tables of the pillars of CNR indexes revealed in detail the variety of backwardness fields in different compared countries and their groups what accents more clearly also different value adding results of their development over the last years.

3. Formalization and possibilities to apply multicriteria evaluation methods

Among the analysis of complex quantitative evaluation methods in general, the multicriterial methods are appropriate to be examined first of all (Park, Wu, 2000; Dombi, Zsiros, 2005). When quantifying the social processes, the SAW method is very frequently applied. The main advantage of this method is that, in principle, it enables researchers to combine different types of primary criteria (factors) according to their importance and the integrated parameters, but with all the criteria to be maximized. This method is applicable when all factors form an inter-dependent system, as well as in the case of interaction between the system and the factors when the influence of this interaction to integral parameter is not significant. Lately, experience has showed that the essential factors can be accepted as independent if only small number of identified factors are presented as shown, e.g., by Zapounidis and Doumpos (2002), and Podvezko (2007).

The adequate system of evaluation criteria has to be formulated and the significance of each criterion has to be determined by applying the SAW method. The joint influence of their sum of significances to integral parameter has to be equal 1 or 100 percent (Ginevicius, Podvezko, 2009).

The quantitative evaluation link with the SWOT analysis and scenario building is of particular importance. The possibilities of applying this method for evaluating the integrated financial system, and the level of entrepreneurship were disclosed by the authors in previous publications (Zvirblis, Buračas, 2010, 2011, 2012). It is calculated as the weighed sum of the normalized indicators values, and the best option is usually the largest integrated value of the criterion.

In such a case, the background model for quantitative evaluation of KP (*KP*) as a whole of components *I,,T,…,E* may be expressed as follows:

$$KP(I,T,...,E)=\begin{bmatrix} k_{11} & k_{12} & ... & k_{1n} \\ k_{21} & k_{22} & ... & k_{2n} \\ ... & ... & ... & ... \\ k_{n1} & k_{n2} & ... & k_{nn} \end{bmatrix}\begin{bmatrix} I \\ T \\ ... \\ E \end{bmatrix}, \qquad (1)$$

where c_{11}, c_{12}, ..., c_{nn} are the significance parameters of the component influence on the aggregated measure *KP*.

The basic model for the component evaluation (by setting the index of its level using a multicriteria SAW method and supposing that factors to identify are independent of each other), as a general case, can be expressed in such way:

$$K(I)=\sum_{i=1}^{i=n} a_i K_i; \sum_{i=1}^{i=n} a_i = 1, \qquad (2)$$

where: *K(I)* – the general index of component level; K_i – values of *n* primary indicators forming the component; a_i − significance coefficients of direct impact indicators on index *K(I)*.

As idiosyncratic KP components according to previous analysis and classification reglaments applied by international institutions may be emphasized the following (*Intellectual Capital for Communities* ..., 2005, 2006; Buracas, 2007):

- Innovative capacity and high-tech production (*I*);
- Use of information technologies (*T*);
- Quality of primary & secondary education and staff training (*E*).

Finally, the value of global KP index *KP(I)* may be determined by applying the additive proportional evaluation on the basis of previously established indexes *I*(*I*) of innovative capacity and high-tech production, *T*(*I*) of use of information technologies and *E*(*I*) of quality of primary & secondary education and staff training significances as follows:

$$KP(I)=k_f I(I)+k_e T(I)+k_s E(I); \sum_{i=1}^{i=3} k_i = 1; \qquad (3)$$

where k_f, k_e, k_s − the significances of components determining the value of level index *KP(I)*; values k determined by expert way.

When applying these basic models, the specific primary indicators according to the real state of transitional and newly EU member countries in every particular pillar can be taken into account.

The sets of typical indicators having essential influence on the KP level are presented in the table 9.

For the component (*I*) the following primary indicators may be emphasised: innovative capacity, innovativeness of development processes, product quality improvements, production flexibility for innovation. The component (*T*) firstly includes usage of E-government services, access to latest IT technologies, internet use in business, and foreign IT transfer. The component (*E*) focuses on the quality of primary & secondary education and staff training, internet access in schools, professional management application indicators.

Table 9: The underlying components and typical primary indicators

The idiosyncratic component	The typical indicators
Innovative capacity and high- tech production	The economic initiative
	Innovativeness of development processes
	New (high-tech) product release and export
	Product quality improvement
	Production (technology) flexibility for innovation
	Business expenditure for R&D
Use of information technologies	Recent availability of IT
	Internet use in business
	Usage of E-government services
	Foreign IT transfer
	Access to latest IT technologies
	Impact of ICT on access to basic services
Quality of primary & secondary education and staff training	Quality of primary education
	The average length of schooling
	Secondary education
	Training for local access to services
	Professional management application
	Internet access in schools
	Adequacy of staff training

Table composed by the authors

Most of these indicators are essentially composite determinants therefore their quantitative assessment requires an independent methodology. This is truing for the cross-country knowledge level assessment of the importance of setting an innovativeness of development processes, usage of e-government services, quality of primary education, etc.

Given the multicriteria evaluation methodology for enforcement, it is appropriate to use a solid framework for their evaluation, so the choice of indicators, as well as the general level of assessment of 100-point scale. The impact significance of primary indicators of can be determined by quantitative data-driven calculations, they can also be determined as well by

experts (Chu et al, 2007; Burinskienė, Rudzkienė, 2009). To achieve the reliability of expert assessments, the adequate examination technique must be subject to, for example, calculation of concordance coefficient *W* values and the significance parameter χ^2 for this factor. Thus, multicriteria evaluation methods (in other words, the existing theoretical multicriteria assessment potential) can be adapted and applied in the assessment of the KP, and may base the development of decision support system.

4. Case study: multicriteria evaluation of Lithuania's knowledge components

As the case study, the comprehensive assessment of the knowledge global index by 2012 situation and prospects for 2015 for Lithuania based on the SAW method were fulfilled below. Ready algorithmized process of multicriteria evaluation supposes that the first stage must be carried out describing the primary components of the factors (identification including the definition of assessment catered as a whole), the expert assessment (quantitative, by points), as well as the determining the significance of parameters. Taking into account the underlying components and results of the study authors, also the rating results, the primary indicators were assessed first of all (table 10).

The 100-point expert scoring system suggested by the authors was applied for determination of numerical values of identified factors: 100 points mark absolutely favourable (positive) influence of a factor, 70-80 points - highly favourable influence, 60-70 points - favourable influence, 50-60 points - medium favourable influence, 40-50 points - unfavourable influence, 30-40 points - highly unfavourable influence. In determining the impact significance parameters, the fact was taken into account that, the sum of following parameters must be equal to 1 by chosen approach. Authors carried out the results of assessing the primary indicators in Table10 (these estimates are reliable enough, since $W = 0.72$).

According to equation (2) adapted for each component (depending on the number of primary indicators *n*), the component indexes were established (Table 10). Determined on this basis ($k_f = 0.4$; $k_e = 0.3$ and $k_s = 0.3$) Lithuanian Knowledge Global Index *KP(I)* equals 51 points in 2012 and 56.5 in perspective for 2015. The lowest rated innovativeness of development processes, business expenditure for R & D, usage of e-government services, adequacy of staff training. It is possible to specify the number of possible features of the extended evaluation process. First, it is appropriate to develop a greater number of integrated criteria after identification of more primary criteria (in this case - the primary indicators) number in a given situation,. In this case, the total index is determined by the partially integrated criteria index values and the significance of these criteria by applying additive multicriteria evaluation method.

Table 10. Expert assessment of primary indicators and their significance parameters when determining the global KP index for Lithuania by the *SAW* method

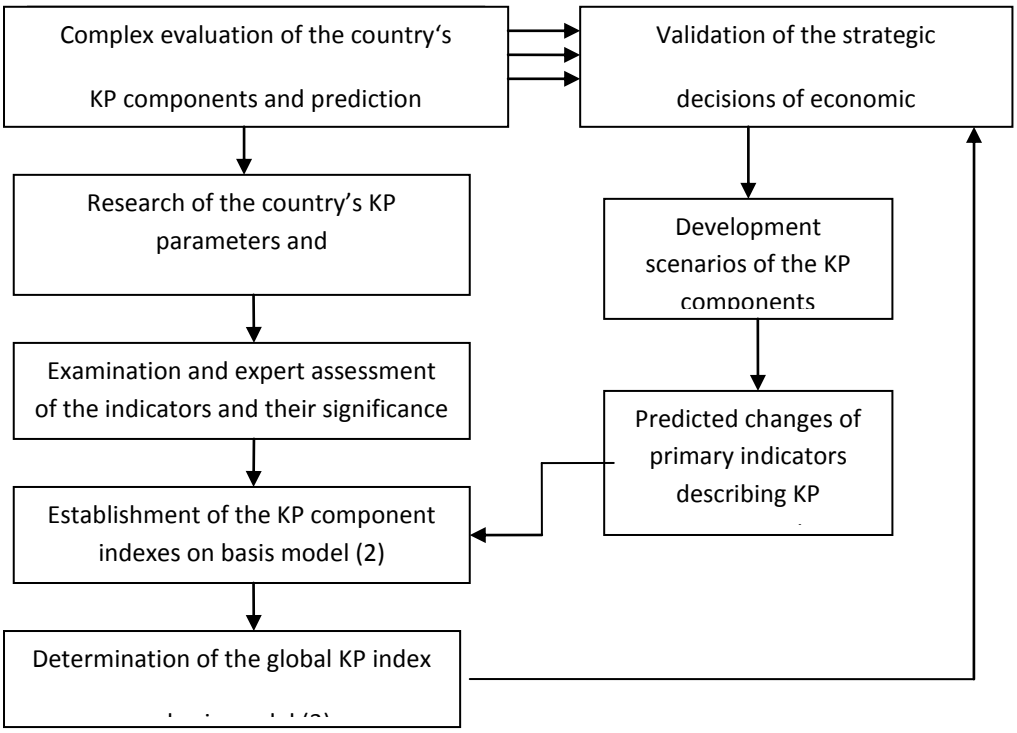
The idiosyncratic components and primary indicators	Score 2012	Forecasted score	Significance parameter
Innovative capacity and high- tech production:			
The economic initiative	54	59	0.20
Innovativeness of development processes	45	53	0.25
New (high-tech) product release and export	48	56	0.15
Product quality improvement	53	54	0.10
Production (technology) flexibility for innovation	51	56	0.15
Business expenditure for R&D	43	48	0.15
Component index I(I)	**48.6**	**55.4**	
Use of information technologies :			
Recent availability of IT	51	56	0.10
Internet use in business	57	70	0.15
Usage of E-government services	51	61	0.20
Foreign IT transfer	53	56	0.20
Access to latest IT technologies	49	55	0.20
Impact of ICT on access to basic services	51	57	0.15
Component indexT(I)	**51.9**	**59.0**	
Quality of primary & secondary education and staff training:			
Quality of primary education	54	56	0.15
The average length of schooling	56	56	0.15
Secondary education	52	52	0.20
Training for local access to services	50	54	0.15
Professional management application	49	51	0.10
Internet access in schools	56	63	0.15
Adequacy of staff training	48	53	0.10
*Component index **E(I)***	**52.5**	**55.1**	

Assessment by authors in 100 point system.

The next important forecasting procedure is the preparation of scenarios of every component (when evaluating the possible idiosyncratic impact of every primary indicator and their combinations) as well as composition of general knowledge development scenarios.

Principal scheme of multiple criteria assessment of KP components and prediction of the programmed changes is presented in fig. 2.

Figure 2: Principal scheme of multiple criteria assessment of knowledge components and prediction of the programmed changes



Source: composed by the authors.

The programmic development solutions may be based taking everything said before into the ground for modelling of alternatives according to the likely development scenarios for the individual components and taking into account their different impact on the significance of parameters (i. e., evaluated by multivariate calculations) when exercising the knowledge control (Peldschus, 2007). Prepared assessment process is also applicable to the revised ranking of newly EU countries and candidate countries under the KP criteria accepted internationally.

The strategic decisions can be based in principle (mostly on insight level) on a new approach to strategic management in general and especially to the multicriteria decision support (*DSS*) intended for economic development programs (their individual parts). They involve the multicriteria evaluation and substantiation of multipurpose solutions methods (including alternative modelling and optimization of programmed alternatives) and algorithmized procedures. The accent of a switch to computerized control systems is by algorithmic approach to this process.

Conceptually, the addressing of strategic decisions reasoning (by focusing on the alternative evaluation) may be performed on suggested appropriate global compatibility bases and partial compatibility levels (as components of the global compatibility level) dimensions. It is appropriate to present the compatibility expressions by the global compatibility vector $\{Lg\}$ and partial compatibility level vectors $\{L_P\}$. Thus, in accordance with the principal approach presented above, the general *n*-level determinants of relative compatibility can be identified for further consideration and their principal direct influence on the overall level can be described as follows:

$$\{L_g\} \rightarrow [\{L_{p1}\},\{L_{p2}\}, ..., \{L_{pn}\}] , \quad (4)$$

where $\{L_{p1}\} - \{L_{pn}\}$ – partial compatibility levels.
Moreover, it is appropriate to mention the utility function approach. Dealing with similar challenges, we believe, these (utility functions) methods can be applied effectively (in particular, given certain criteria of exceptional significance). First-of-all, the great diversity of the utility function approach permits bigger elasticity of examining and assessing of highly complex and diverse problems (of multiple attributes), including the country's current economic development, in particular. The formation of multiple attributed utility functions, of course, is a complex task. However, using an aggregate approach, is possible to compose the compound utility function of many features. This is possible only under certain evaluation conditions allowing simplification of the decision algorithm.

In general case of ranking programm alternatives, such additive utility function can be applied:

$$U_k = \prod_{k=1}^{K} w_k \prod u_h(x_{hk}), \qquad (5)$$

where w_k - the strength parameter for each character ($k = 1,2,...,K$ - identifying index, $h = 1,2,...,H$ - identifying index for considered alternative), $u_h(x_{hk})$ - one-dimensional partial utility function corresponding to the alternative h_n, as measured by character k_n.

So, the focus should be given (in the formation of a development program in the newly EU countries) to multiple criteria evaluation methodology and interactive expert *decision support system* that use knowledge-based procedures when formulating the strategic decisions.

Conclusions

The review of publications on knowledge and intellectual potential (resources) revealed insufficient attention to their complex evaluation; it is more dedicated to international scoring of the K4D. Most authors studied the analytical topics of assessing the country‘s intellectual (knowledge) potential components, however a single quantitative potential assessment technique has not been accepted. When solving this research problem, first of all, it is appropriate to consider comprehensive features of quantitative evaluation methods.

The examination of the knowledge potential (KP) in the Baltic a/o EU countries (based on the data and ranking assessments by international organizations) revealed the most important components and the factors affecting progress. Comparing the positions of Lithuania and Turkey with EU averages (particularly with neighbouring countries) show lower levels of their innovative business activity, technology updates. The analysis marked out the growth of intellectual capacity building and information provision preparing to expanded integration into the EU.

The strategic decisions are usually not based on a new approach to strategic public management (in principle mostly on insight level) in general and especially to the decision support by preparing economic development programs (their individual parts). They must involve the complex evaluation and substantiation of multipurpose solution (including alternative modelling and optimization of programmed indicators) methods and algorithmized procedures.

The proposed technique is based on the Simple Additive Weighting (SAW) method by forming a three-level system of assessment criteria, following the literature and analysis of the complex multicriteria evaluation methods on the given social processes. The knowledge assessment process by applying this approach highlights the country's KP components and appropriate identification of the primary indicators, their expert quantification (as proposed in points) and assessment of significances each of them. On this basis, the setting of general KP index can be performed. This corrected evaluation process is also applicable to specify more exact ranking according to the KP criteria for newly EU countries.

The idiosyncratic KP components were described as follows: innovative capacity and high-tech production, use of information technologies, quality of primary & secondary education and staff training; the adequate sets of typical primary indicators having essential influence on the KP level were composed. When formalizing the listed components, the evaluation models (oriented to using of SAW method) for components as well as for estimation of the global KP index values were created. The global knowledge index for Lithuania was determined on the basis of complex evaluation of most significant indicators according to the situation of 2012 (51 points) and forecasting the prospective situation (56.4 points) on the basis of proposed basic assessment models. The innovativeness of development processes, business expenditure for R&D and usage of E-government services were evaluated as most backward factors.

Conceptually, the reasoning of strategic decisions (by focusing on the alternative evaluations) may be performed by applying the suggested techniques based on appropriate global compatibility and partial compatibility levels (as components of the global compatibility level) dimensions. Besides, the application of utility function methods also is perspective analytical way.

The main focus in the formation of a knowledge development program (when exercising the KP components control) in the newly EU countries should be given to multiple criteria evaluation and decision-making methodology. The adequate interactive expert decision support systems must be developed by using the knowledge-based procedures for formulating strategic development decisions.

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