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INTEGRATED EVALUATION OF THE SUSTAINABLE DEVELOPMENT OF KNOWLEDGE BASED ECONOMY IN BALTIC COUNTRIES

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Baltic countries are faced with a variety of challenges, determined by globalization, economic competition, technological changes, promotion of innovation, protection of environment and other factors. They are discussed in conferences, publications of social researches as well as declared in strategic documents. Sustainable development and promotion of knowledge based economy being perspective directions in socio-economic development are still problematic areas in Lithuania taking into account the context of other European Union (EU) countries. For example, Estonia, which joined EU in 2004, like Lithuania and Latvia, demonstrates better results. Understanding of this discrepancy is one of the objectives of this article.

Our viewpoint is that not enough has been done to evaluate results in development of knowledge based economy by taking into account leading parameters of environmental sustainability (energy intensity in the economy, level of sustainable consumption and production, correlations between climate change and energy, prevalence of sustainable transport, consideration of natural resources). On the other hand, it is not perspective to evaluate the level of sustainable development without the analysis of the intensification of the main pillars of knowledge based economy like level of innovations and education. It seems that it is important to look at local, national and global context as well as research in private and public sectors. The progress in both – socio-economic and environmental sectors is likely as a holistic result. Not occasionally main documents of EU fixating the principles of the sustainable development and the knowledge based economy are written in close correlation: the priority of the Strategy of Europe 2020 is to develop smart, sustainable and inclusive economy. Eco-friendly environment is promoted in Innovation Union (the strategy of EU) too. In the Communication from the Commission to the European Parliament, the Council declared that knowledge is the currency of the new economy and that sustained and greater investment can increase the competition level within national borders.

The purpose of the study is to evaluate the level of sustainable development and knowledge based economy in Baltic countries by using the original integrated multi-criteria Sustainable knowledge based economy index. The following tasks were used: 1) to reveal the importance of sustainable development and knowledge based economy for Baltic countries in the context of the countries of EU, 2) to analyse indicators of sustainable development and knowledge based economy in Baltic countries in 2008–2012 year period, demonstrating contemporary situation and possibilities for improvement.

The research was made, using quantitative and qualitative methods: literature analysis, statistical classification, systematization, synthesis, comparison and generalization. The aim of the study was reached using the original integrated multi-criteria Sustainable knowledge based economy index. It consists of the following sub-indices: socioeconomic development, environment, human resources, innovation and information communication technologies. Determined index is useful because of its flexibility (on demand there can be changed indicators, periods and sub-indices). It could help to evaluate any interdisciplinary things (objects of low, socioeconomic, knowledge, environmental, technologies). Creating and using new methodologies for evaluating different aspects of countries development could help in fostering their competitiveness.

Keywords: *Knowledge based economy, Sustainable development, Sustainable knowledge based economy index, Integrated evaluation, Multi-criteria index.*

Introduction

Development processes in the Baltic region could be defined as an important factor of complex societal modernization in the Baltic countries as well as in Central and Eastern Europe (Melnikas, B., 2008). Lithuania, Estonia and Latvia, like other countries in Europe, are facing many challenges and need to: create job opportunities for everybody, especially the young, get the economy back on track, make companies more competitive in the global market, solve the challenges for an ageing population, secure resources like food and fuel, fight global warming, improve smart and green transport (European Commission, 2013). All those challenges are interdisciplinary (objects of law, socio-economy, knowledge, environmental, technologies) and have a strong correlation with the competitiveness of the economies of the Baltic countries. The principles of sustainable development and aspirational knowledge based economy are mentioned in strategic documents of EU as well as in documents at national, regional and local levels.

Modernization of countries' economies and issues pertaining to the formation and implementation of mentioned policy are widely discussed in academic and practical environments. Sustainable development and knowledge

based economy like complementary principles and processes for competitive and modern economy are analysed in the publications: Krisciunas (2010), Melnikas (2008, 2010, 2011), Ciegis, Kareivaite (2012), Sirbu, Doinea, Mangra (2009), Nguyen (2010), Sabau (2010), Ivancheva (2013), Wang, Ma, Weng, Wang (2004), Grizans, Vanags (2010) and others. The sustainable development and the knowledge based economy are especially important in long-term approach and they have to have a methodology of the evaluating of the processes. Nevertheless, till now a suitable aggregated indicator has yet to be created.

The ***aim*** of the study is to estimate the level of sustainable development and knowledge based economy in Baltic countries by using the original integrated multi-criteria *Sustainable knowledge based economy index.* The following *tasks* are defined: 1) to reveal the importance and coherence of sustainable development and knowledge based economy for Baltic countries in the context of EU, 2) to analyze indicators of sustainable development and knowledge based economy in Baltic countries in 2008-2012 period, analyzing the contemporary situation and improvement possibilities.

The research was made, using quantitative and qualitative *methods*: literature analysis, statistical classification and systematization, synthesis, comparison and generalization. The aim of the study has been reached using the original integrated multi-criteria *Sustainable knowledge based economy index*. It consists of the following sub-indices: socioeconomic development, environment, human resources, innovation and information communication technologies. Determined index is quite universal because of its flexibility (on demand there can be changed indicators, periods and sub-indices). It could help to estimate any interdisciplinary things (as objects of law, socio-economy, knowledge, environmental, technologies, etc.). Creating and using new methodologies for estimating different and correlated aspects of countries' development could help in fostering their global competitiveness.

Theoretical approach to the estimating of sustainable development and knowledge based economy in the countries

Sustainable development is a concept which was introduced and become popular after 1987 when the World Committee for Environment and Development report "Our common future" also known as the Brundtland report was distributed. Here the concept is defined as being "that development that satisfies the needs of the present without compromising the future generations` possibility of satisfying their own needs" (United Nations Documents, 1987).

The scientific theories of sustainable development are based on three key development principles:

- the principle of stability means time long enough for reproduction of the development potential. However, development is not a linear process; declines and rises are possible as well as periods of accumulation and use of the accumulated development resources,
- the principle of balance means an optimal proportion among the constituent parts of development,
- the most important and up until recently the least appreciated development principle is social orientation, which means, that evaluation of situations has to be first of all carried out depending on their impact on the standards and the quality of life of the population (Tamosiunas, T., Butkaliuk, R., 2013).

Sustainable development is a long-term strategy, ensuring clean and healthy environment as well as an increasing standard of living for the present and future generations (Kareivaite, R., 2012).

Sustainable development concept in 1987 highlighted only two domains – economic and environmental. At present scientists are counting economic, environmental, social, political-organizational and ethical domains (Cepinskis, J. et al., 2002). Grizans, Vanags (2010) are pointing, that the sustainable development is the interaction of economic, social, demographical, political, cultural, technological, scientific, and environmental processes. That interaction has to penetrate all levels: society, business, and authorities. The number of connected interdisciplinary things (objects of law, socio-economy, environment, technologies) is increasing. It means that necessity to create an innovative, flexible method for estimating the progress of sustainable development exists.

In the EU's Sustainable Development Strategy (Council of the European Union, 2006) it's declared, that the key objectives of the strategy are: Environmental protection, Social equity and Cohesion and Economic prosperity.

Also, it seems that it is not perspective to evaluate the level of sustainable development without the analysis of the intensification of the main pillars of knowledge based economy like level of innovations and education.

According to Janez Potočnik, former European Commissioner responsible for Science and Research (2004 – 2009), and currently serving as European Commissioner for Environment, the development of modern science undergoes three major periods, associated with concrete human values: (I) the age of truth**:** from the Renaissance to the Enlightenment, i.e. the 16th–18th centuries; (II) the age of progress**:** during the industrial revolution, i.e. the 19th century; (III) the age of responsibility: since the emergence of „knowledge-based society, i.e. the second half of the 20th century until nowadays (as cited in Ivancheva, L., 2013).

The term "knowledge industry" was extended to "the knowledge economy" by Peter Drucker. As he stated almost four decades ago, "knowledge has become the central factor of production in an advanced, developed society" (as cited in Ivancheva, L., 2013). In 1996, the term of knowledge based economy first appeared in the international organization documents used by the Organization of Economic Cooperation and Development. Knowledge based economy was understood as the economy that is based on the producing, distributing and using of knowledge and information. Currently, knowledge has been considered wider as the driving force of improving productivity and realizing the economic growth (Wang, Z. et al., 2004).

Knowledge based economy and sustainable development are evolving concepts that describe complex, dynamic social and environmental realities mostly, by means of the imperfect analytical framework provided by neo-classical economics (Sabau, G., L., 2010). Krisciunas (2010) cites economists as Colander, Holt, Rosser (2004), that in the vein of ecological economics, believe that the neoclassical "holy trinity" of rationality, greed, and equilibrium, is being replaced by the holy trinity of purposeful behaviour, enlightened self-interest,

and sustainability, considerably broadening the scope of what is the mainstream.

Numerous theories and indicators have been developed in the attempt to show that knowledge based economy can promote sustainable development through more innovation sustained by economic growth (Sabau, G., L., 2010). Wang et al. (2004) points that both concepts are related with economic growth. However, they relate to the physical and economical geographical factors respectively, and hence display different spatial diffusion process.

The EU's strategy, adopted at the Lisbon Summit in 2000, whose strategic objective proclaims that by the year 2010 EU economic should become the most competitive knowledge based economy in the world, capable to maintain sustainable development and create new generation workforce, and to be consensual with the concerns of the world's developing countries (Sirbu, M. et al., 2009). Regrettably that written target in the EU's Sustainable Development Strategy has not been achieved. The EU is still facing the challenges, which are more qualitative, than quantitative. Melnikas (2011) notes these factors:

- transformation of society, opportunities and perspectives of modernization, contemporary challenges in the field of improving the quality of life,
- globalization and global transformations, their impact on societal being,
- knowledge-based society and knowledge economy: challenges of creation, trends and controversial phenomena,
- sustainable development as a key challenge of society development,
- innovations in various areas of life, scientific and technological progress fostering, development of higher technologies sector,
- networking, new forms of organizations and effective management,
- interaction processes and convergence of business and public sector,
- national economies and their problems, perspectives of international business.

In the document Europe 2020 (a strategy to help Europe emerge stronger from the crisis and prepare the EU economy for the next decade) the European Commission has identified three key drivers for growth, which will be supported through actions at both EU and national levels:

- smart growth (fostering knowledge, innovation, education and digital society),
- sustainable growth (making EU production greener and more resource efficient while boosting competitiveness),
- and inclusive growth (enhancing labour market participation, skills acquisition, and the fight against poverty) (European Commission, 2014a).

Ones again we can see, that all challenges are about the principles of sustainable development and the processes of knowledge based economy.

Sustainable development and knowledge economy creation processes are complicated and interconnected. Specific and adequate theoretical attitudes has to be developed. The attitudes are characterized by orientations to exceptionally wide and deep scientific cognition and suitability to apply them under the conditions of great uncertainty (Melnikas, B., 2010).

In this research an attempt was made to create the method for the estimation of the Sustainable knowledge based economy index – which could help researching those interconnected aspects.

Methodology of Sustainable knowledge based economy index

The methodology of integrated multi-criteria indices, such as presented in the article, was used by Simanskiene, Ciegis, Ramanauskiene (2011), Tamosiunas, Butkaliuk (2013) and Kareivaite (2012). The authors used the estimation method when evaluating the sustainable development. Considering growing challenges for modern and competitive economies the importance of assessing knowledge based economy combined with sustainable development is increasing.

Using specific indicators allows for the evaluating of economic, social, and environmental objectives of national development. If environmental, social, economic, innovation, human resources, information and communication technologies indicators are integrated into one, they could form one index reflecting a wide context. Integrated indices display various important qualitative aspects of the researched phenomena and at the same time demonstrate how the changes of those indicators influence the dynamics of common integrated index change. Understanding of sustainable development and knowledge based economy versatility and searching for necessary compatibility of ecological, economic and social, innovation, human resources, information and communication technologies sphere policies require innovative methodologies based on the newest statistical data. The challenge is to create an instrument for the measurement of the level of sustainable development and knowledge based economy based on known indicators.

The aim of the study was to determine and to use the original integrated multi-criteria Sustainable knowledge based economy index (ISKE). The construct of this research is presented in Fig. 1.

<table>
<tr><th>DETERMINATION OF SUB-INDICES</th><th>ESTIMATION OF THE SUB-INDICES OF EACH BALTIC COUNTRY</th><th>ESTIMATION OF THE COUNTRIE'S INDEXES</th></tr>
<tr><td>Socioeconomic Development sub-index</td><td rowspan="2">The sub-indices of Lithuania</td><td rowspan="5">The change of the I_{SKE} in Baltic countries</td></tr>
<tr><td>Environmental sub-index</td></tr>
<tr><td>Human Resources sub-index</td><td>The sub-indices of Estonia</td></tr>
<tr><td>Innovation sub-index</td><td rowspan="2">The sub-indices of Latvia</td></tr>
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Figure 1. The construct of the research

Firstly, there were determined sub-indices, which are the most important for knowledge based economy (Socioeconomic, Human resources, Innovation and Information Communication Technology sub-indices) and sustainable development (Socioeconomic development and

Environmental sub-indices) of Lithuania, Estonia and Latvia in the period 2008–2012. It helps to evaluate the differences between them according to their sub-indexes.

Using results of the first step of research, as next step there is presented the evaluation of every sub-index of Lithuania, Estonia and Latvia. It enabled to determine the strongest and the weakest aspects of the countries' objectives.

Using results of the second part of the research, differences of the Sustainable knowledge based economy index I_{SKE} of the Baltic countries could be estimated. Integrated index is estimated by the formula:

$$I_{SKE} = \Sigma_i a_i S_i, \quad (1)$$

were S_i – separate sub-indices of sustainable knowledge based economy index, a_i – the weight of sub-indices (on condition that Σa_i=100). The I_{SKE} includes five sub-indices: Socioeconomic Development sub-index (S_{SED}), Environment sub-index (S_E), Human Resources sub-index (S_{HR}), Innovation sub-index (S_I) and Information and Communication Technologies sub-index (S_{ICT}). Therefore:

$$I_{SKE} = a_1 S_{SED} + a_2 S_E + a_3 S_{HR} + a_4 S_I + a_5 S_{ICT}, \quad (2)$$

were $a_{1\text{-}5}$ are the weight of S_{SED}, S_E, S_{HR}, S_I, S_{ICT} indices (on condition that Σa_i =100).

Each of the sub-indices in its turn consists of indicators. The estimation formula is:

$$S_x = \Sigma_i a_i i_i, \quad (3)$$

were i_i are the indicators of sub-indices, a_i are the weight of indicators (in this case Σa_i=20), S_x – any separate sub-index.

If, while forming an integrated indicator, the growth of the value of certain constituent indicators is assessed as a positive and desirable process, change of the index of such indicator from 0 to any greater figure should signify a favourable process, while indices of the indicators, decrease of which is a desirable process, i_i is recalculated according to the formula:

$$i_i = 1/i_i. \quad (4)$$

The indicators, used in this research, have been taken from the database of the Eurostat (European Commission, 2014b) and from the Innovation Union Scoreboard 2014 (European Commission, 2014d).

The indicators were analysed in the period between 2008 and 2012. The processes as sustainable development or knowledge based economy, according to Tamosiunas, Butkaliuk (2013), are important in the long run, that's why they have to be analysed in retrospective point-of-view so that essential changes during 5 years could be visible.

Estimation of Sustainable knowledge based economy index of the Baltic countries

In the World Economic Forum's (2013) report "Rebuilding Europe's Competitiveness it's noted, that Europe is currently facing important economic and social challenges. Recent years have seen stagnating economic growth, rising unemployment leading to social tensions, and sovereign debt crises, exacerbated by the fact that the future outlook remains uncertain. These challenges should not be regarded as signs of "the inevitable decline" of Europe in a globalized world economy, but rather as drivers of a transformational action to better adapt Europe to a new competitive environment.

The following indicators were selected to determine *Socioeconomic Development sub-index (S_{SED})*:

- Real GDP per capita (Euro per inhabitant),
- Market Integration – Foreign Direct Investment intensity (% of GDP),
- Labour productivity per hour worked (Euro per hour worked),
- People at risk of poverty or social exclusion (percentage of total population).

The highest values of those indicators in 2012 were in Estonia, and lowest – in Latvia. For example, Real GDP per capita in Estonia were 9500 Euro per inhabitant, in Lithuania – 8100 Euro per inhabitant and in Latvia – 6800 Euro per inhabitant; Labour productivity per hour worked in Estonia were 11,20 Euro, in Lithuania – 10,30 Euro and in Latvia – 8,20 Euro. Nevertheless analysis of sub-index S_{SED} showed different tendencies (Fig. 2):

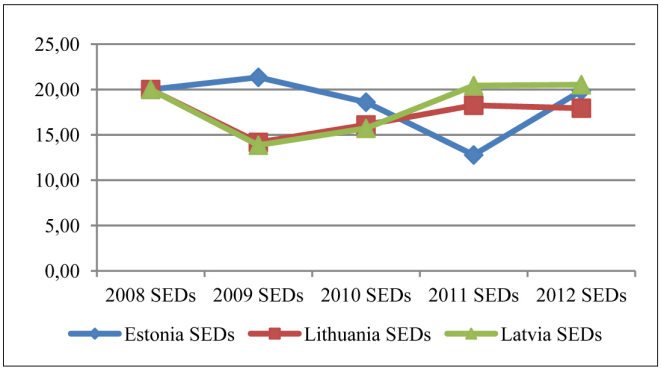

Figure 2. The evolvement of sub-index S_{SED} in the Baltic countries during 2008–2012

In the analysed period the sub-index decreased in all countries. As it was mentioned in the methodology, the weight of the sub-index in the first year (2008) was 20. The sub-index values of Lithuania and Estonia fell during 2009 and didn't increase until 2012. Latvia's sub-index slightly derives in the period 2009–2011. The main reason for it could be positive changes in market integration. In Latvia's case the average value of inward Foreign Direct Investment flows were higher than outward. In Estonia this indicator was negative. The number of people at risk of poverty or social exclusion increased. In the same time labour productivity per hour in all countries had been increasing.

The level of sustainable development of knowledge based economy is impossible without evaluating the Environment sub-index (S_E). As the world's population grows, the demand for non-renewable resources rises. They also argued that the consumption of materials per capita also increases with the increase of living standards. Between 1960 and 1984 the world's total consumption of energy had increased by 46 percent due to population growth and 54 percent through increased per capita consumption levels (Nguyen, T., T., 2010). The indicators evaluating the S_E were:

- For greenhouse gas emissions base have been taken emission in the year 1990 (This indicator shows trends in total man-made emissions of the 'Kyoto basket' of greenhouse gases. The 'Kyoto basket' of greenhouse

gases includes: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and the so-called F-gases (SF6). These gases are aggregated into a single unit using gas-specific global warming potential (GWP) factors). The EU as a whole is committed to achieve at least a 20% reduction of its greenhouse gas emissions by 2020 compared to 1990. This objective implies: -a 21 % reduction in emissions from sectors covered by the EU ETS (emission trading scheme) compared to 2005 by 2020; – a reduction of 10 % in emissions for sectors outside the EU ETS. To achieve this 10% overall target each Member State has agreed country-specific greenhouse gas emission limits for 2020 compared to 2005 (Council Decision 2009/406/EC),

- share of renewable energy in gross final energy consumption (%) (This indicator is determined on the basis of data covered by Regulation (EC) No 1099/2008 on energy statistics),
- resource productivity (Index, 2000 = 100) (Resource productivity is gross domestic product (GDP) divided by domestic material consumption (DMC). DMC measures the total amount of materials directly used by economy. It is defined as the annual quantity of raw materials extracted from the domestic territory of the focal economy, plus all physical imports minus all physical exports),
- energy consumption of transport relative to GDP (Index, 2000 = 100) (This indicator is defined as the ratio between the energy consumption of transport and GDP (chain-linked volumes, at 2000 exchange rates). The energy consumed by all types of transport (road, rail, inland navigation and aviation) is covered, including commercial, individual and public transport, with the exception of maritime and pipeline transport).

Evolvement of Environment sub-index is presented in Fig. 3:

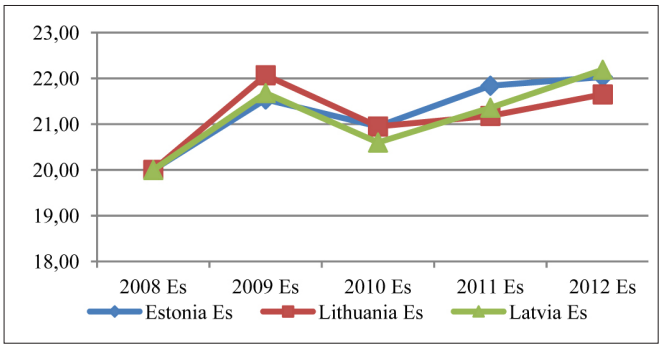

Figure 3. The evolvement of sub-index S_E in the Baltic countries during 2008–2012

In Estonia the level of Greenhouse gas emissions in 2012 was lower than in 2008. The biggest positive development of this indicator was in Lithuania (from 5 in 2008 up to 5,75 in 2012). The biggest percent of Share of renewable energy in gross final energy consumption in 2012 is in Latvia (35,8%), and minimal in Lithuania 21,7 %. The fastest growth of this indicator is in Estonia (from 5 in 2008 to 6,63 in 2012). In Latvia and Estonia the level of Resource productivity was growing, but in Lithuania in 2010 and 2011 the growth was negative. In energy consumption case Lithuania demonstrates the best results. The friendly-environment is maintained in all Baltic countries in a stable manner in that period.

The rising role of science for the modern society is indicated as well by the wide spread of new concepts as "knowledge society", "knowledge-based economy" or "sustainable development" (Ivancheva, L., 2013). According to Nguyen (2010), many authors believe that knowledge, in the form of both – appropriate education and development of human resources, does not only contribute to current economic growth but in the long term, is also likely to contribute solutions to the global problems relating to sustainability. For determination of the *Human Resource sub-index (S_{HR})*, the following indicators were chosen:

- Percentage of population aged 30–34 having completed tertiary education,
- Mathematics, science and technology enrolments and graduates (ISCED 5–6),
- Participation rate in education and training (last 4 weeks, age from 25 to 74 years) (%),
- Employment rates of young people not in education and training by sex and educational attainment level (ISCED 3–6).

These indicators might illustrate development of the sub-index, including the level and subject of education, the situation in long-life learning, employment rates of youth depending on education level. The best results of not normalized data of the indicators are as follows: the indicators for population having completed tertiary education, and Employment rates of young people were best in Lithuania; the indicators for Mathematics, science and technology enrolments and graduates, as well as Participation rate in life-long learning were best in Estonia. Evolvement of sub-index S_{HR} is presented in Fig. 4:

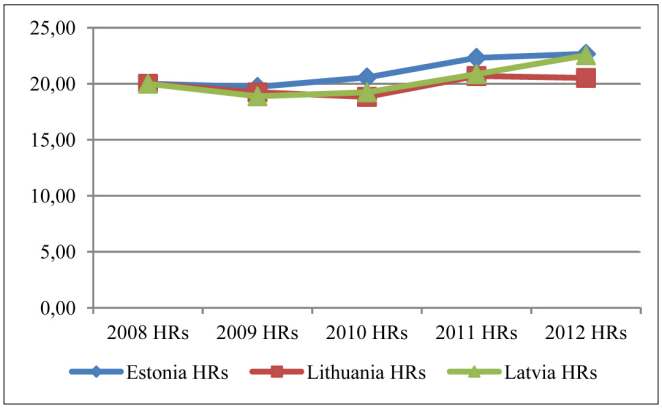

Figure 4. The evolvement of sub-index S_{HR} in the Baltic countries during 2008–2012

Human Resources in Baltic countries are developing slowly but steady. If countries search to boost knowledge based economy as well as strengthen sustainable development, in the context of other EU countries, they have to be more agonistic. It's very important for competitiveness, creativity and responsibility in general.

In description of the Research and Innovation performance in EU member states it's pointed (European Commission, 2013b), that Estonia need to enhance the quality of the higher education system and to address the non-absorption of highly-skilled graduates in firms. Estonia has improved its scientific quality and production but still faces the challenge of increasing the excellence and internationalization of its research institutions. Estonia has improved its performance

in public-private cooperation although it still performs well below the EU average.

One important aspect of the Latvian Research and Innovation system is the lack of highly qualified scientists and engineers, a lack which is correlated to the low numbers of new doctorates awarded and graduates in science and engineering. Moreover, it can be seen from the above graph that the share of researchers in business enterprise is extremely low and employment in knowledge-intensive activities is still below the EU average. In fact, Latvia suffers an important outflow of graduates and researchers to the United States and other countries, many scientists preferring to pursue their careers abroad (European Commission, 2013b).

The Lithuanian science base is insufficiently competitive and is not well connected to European science networks. Due to unattractive research careers, the science support is also threatened by an insufficient supply of human resources. Links between education, research and the private sector are very weak. The reform of the science support is expected to make the Lithuanian research and innovation system more efficient and better performing in the years to come (European Commission, 2013b).

Intan-Soraya, Kok-Wai (2010) points, that existing literature recognizes the positive influence of a firm's intellectual capital on innovative capability and on various other financial and non-financial performance measures such as profitability, revenue growth, return on assets, return on equity, customer satisfaction, and product and service quality. Different components of intellectual capital, which are human, social, and organizational in nature, both individually and jointly influence a country innovative capability.

For the analysis of the *Innovation sub-index* (S_I) the successive indicators have been taken:

- Employment in technology and knowledge-intensive sectors (% of total employment),
- Public R&D expenditures (% of GDP),
- Number of enterprises in high-tech industries and Knowledge Intensive Services,
- Exports of high technology products as a share of total exports.

The level of data for Lithuania in 2012 was lower, than in other Baltic countries. The changes of sub-index S_I are presented in Fig. 5:

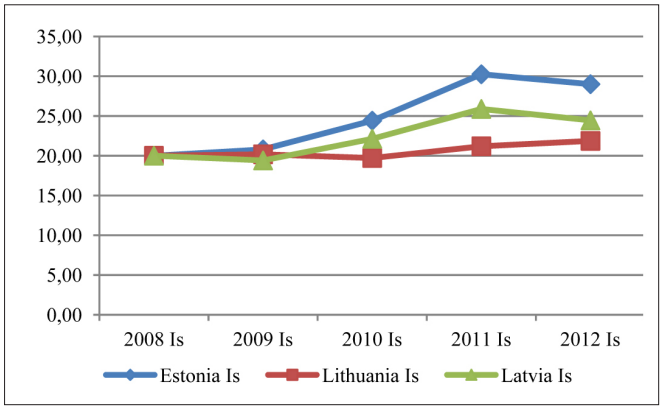

Figure 5. The evolvement of sub-index S_I in the Baltic countries during 2008–2012

The biggest positive progress in Innovations have been estimated in Estonia which might be because of the biggest growth of exports of high technology products and of the number of enterprises in high-tech industries and Knowledge Intensive Services. In all indicators of Baltic states the developments were positive (normalized values were more then 5) except Exports of high technology products in Lithuania (normalized value was 4,46).

In Innovation Union Scoreboard, 2013 Lithuania ascended from modest to moderate level, only because of the number of new doctorate graduates. In Lithuania's profile of Research and Innovation performance (European Commission, 2013b), it's noted, that the main strengths of it are the size of its public research sector and the good supply of new graduates. Human resources and innovations are complementary, but the instrument, measures for the implementation of the targets are necessary too.

All analysed countries have opportunity to use EU's financial instruments (for example Horizon 2020) and implement Europe's 2020 flagship initiative aimed at securing Europe's global competitiveness. By coupling research and innovation, Horizon 2020 helps to achieve this with its emphasis on excellent science, industrial leadership and tackling societal challenges. The goals for the countries are world-class science, removing barriers to innovation and making it easier for the public and private sectors to work together in delivering innovation. One of the Horizon 2020 programme sections is Information and Communication Technologies, which underpins innovation and competitiveness across a broad range of private and public markets and sectors (European Commission, 2014c).

For determination of the development of *Information Communication Technology sub-index* (S_{ICT}) (Fig. 6) the following indicators were chosen:

- Individuals' 5 or 6 level of computer skills (% of the total number of individuals aged 16 to 74),
- Individuals' 5 or 6 level of internet skills (% of the total number of individuals aged 16 to 74),
- Individuals using the Internet for interacting with public authorities (% of individuals),
- Share of enterprises' turnover on e-commerce (%).

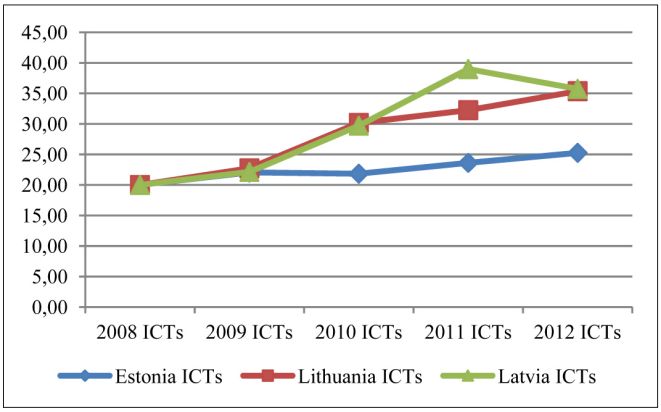

Figure 6. The evolvement of sub-index S_{ICT} in the Baltic countries during 2008–2012

The best results seem to be in Lithuania and Latvia. In these countries the main positive changes started in 2009. In Lithuania development was stable, but in 2012 the share of enterprises' turnover on e-commerce ceased its upward growth. Positive enterprises' receipts from sales through

electronic networks are very important in the countries' ICT development, because of the close correlation with the development of the information literacy of human resources, with promotion of other e-skills (like e-government).

In 2012, the World Bank Group (2012) adopted ICT sector strategy. 3 Regional Priorities for Europe and Central Asia were presented: deepening reforms for improved competitiveness, social sector reforms for inclusive growth and climate action for sustainable growth.

Baltic countries show positive results in ICT's sector, but because of the dynamic environment, they always have to renew their own targets. In the World Bank Group ICT sector strategy were mentioned three pillars, so the Baltic states can pay attention to them: 1. Transform: making development more open and accountable, and improving service delivery for instance, education, health, and financial services; 2. Innovate: developing competitive IT-based service industries and fostering ICT innovation across the economy with a focus on job creation, especially for women and youth; 3. Connect: scaling up affordable access to broadband including for women, disabled citizens, disadvantaged communities, and people living in remote and rural areas.

European Grid Infrastructure's Position Paper in Common Strategic Framework for future EU Research and Innovation Funding points, that accelerating the development of e-Infrastructures in Europe will enable them to get a key enabling factor in making the Europe 2020 Strategy for Europe a reality. These innovations will help the European research community to derive the knowledge it needs from the data deluge to tackle the societal challenges facing Europe both now and in the future (European Grid Infrastructure, 2011).

Using results of determined sub-indices, estimation of the results in Lithuania (Fig. 7), Estonia (Fig. 8) and Latvia (Fig. 9) are presented. Figures reflect the strongest and the weakest aspects of the sustainable knowledge based economies development.

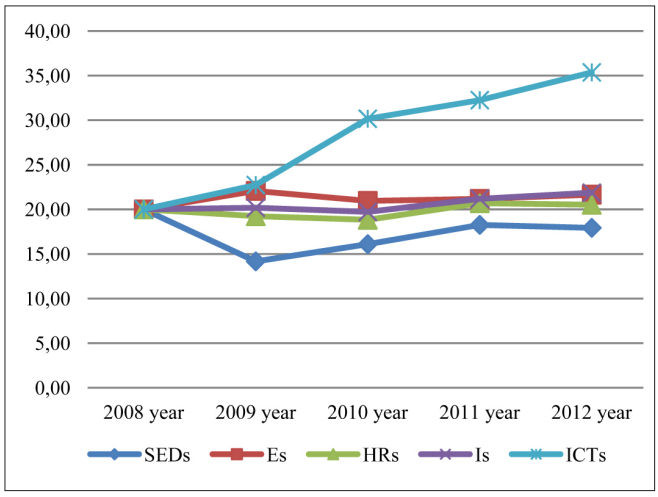

Figure 7. The evolvements of sub-indices I_{SKE} in Lithuania during 2008–2012

Level of sub-indices of Lithuania is not steady. Strongest indicator of sustainable knowledge based economy is in ICT sector. In Environmental, Human Resources and Innovation sectors, the development is very slow and not steady. It might be the reason why the dynamics of socioeconomic development in the country is negative (in the year 2008 the value was 20, and in the year 2012 was 17, 93).

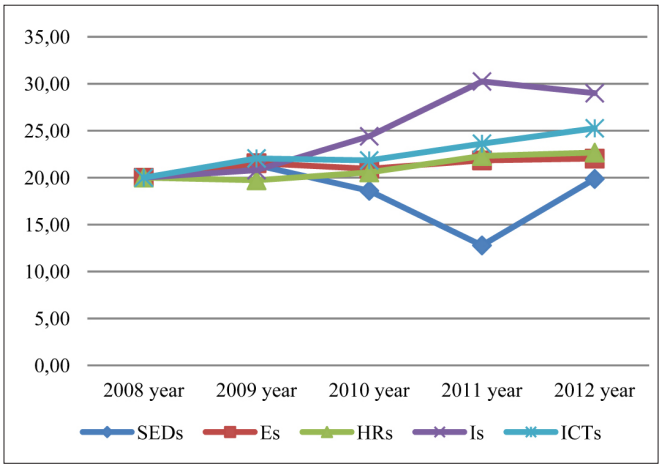

Figure 8. The evolvements of sub-indices I_{SKE} in Estonia during 2008–2012

In Estonia Socioeconomic development sub-index increased only in 2012 and almost reached the level of the 2008 year. The highest competitiveness indicator in Estonia might be because of the best results achieved in the Innovation sector. In Estonia employment in technology and knowledge-intensive sectors, public R&D expenditures as well as in exports of high technology products in the context of EU countries is quite high. Estonia needs to accelerate development of Human resources and Environment protection. It might help to strengthen development of the sustainable knowledge based economy level in the country.

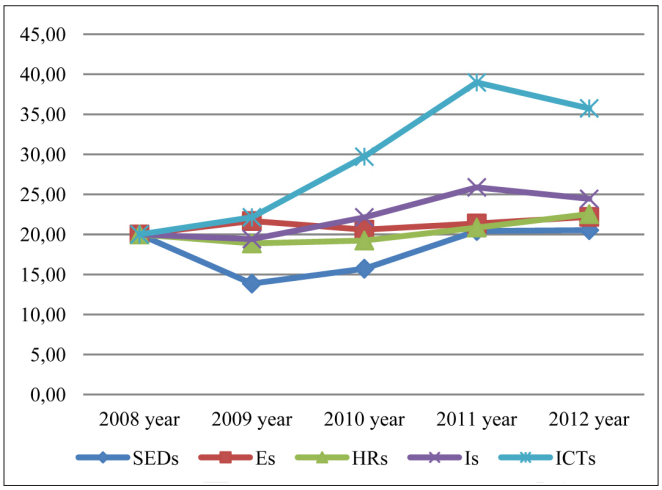

Figure 9. The evolvements of sub-indices I_{SKE} in Latvia during 2008–2012

The best results Latvia demonstrates in ICT's and Innovation's sectors. The implementation of the policy in those sectors in 2012 helped the country to reach the same level of Socio-economic development, as it was in 2008 year.

It's important to mention, that as reasonable level of sustainable development could be accepted the level when all used sub-indices are quite equal. In that context the biggest problem still seems in Lithuania, and the lowest – in Estonia.

Using the results of the second part of the research, following will be evaluated the development of the I_{SKE} in the Baltic countries (Fig. 10).

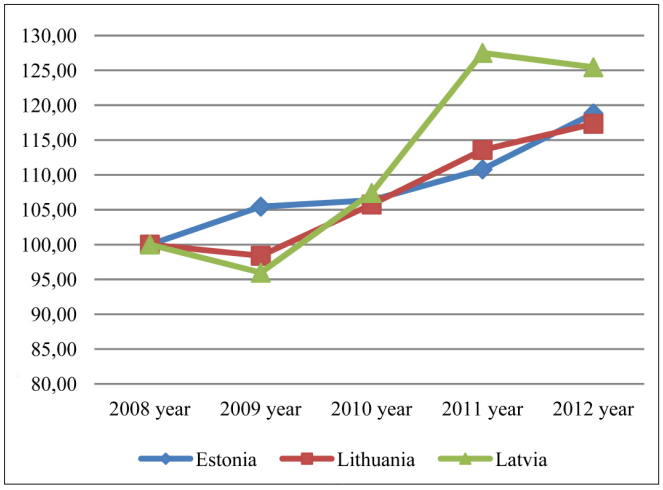

Figure 10. The evolvement of I_{SKE} in Baltic countries during 2008–2012

The leader in the development of Sustainable knowledge based economy according proposed methodology is Latvia. Although, as it was mentioned earlier, the separate indicators have the biggest values in Estonia, but in the long term point of view, the best development is in Latvia.

Conclusions

- Sustainable development and knowledge based economy aspects in estimation of countries development are complimentary and reflects their welfare and competitiveness. Both of them are often analysed and discussed in theoretical works as well as in the strategic documents at global, EU or national level.
- New methodologies for estimating different but correlated aspects of countries' development could help in fostering their global competitiveness. The methodology of creating and utilising of Sustainable knowledge based economy index is proposed in the article. This index is quite universal because of its flexibility (on demand there can be changed indicators, periods and sub-indices). It could help to estimate any interdisciplinary aspects in countries' development.
- Development dynamics and level of the sustainable knowledge based economies in Lithuania, Latvia and Estonia have been researched by evaluating the interdisciplinary sectors: socio-economic development, situation in environment protection, innovations, human resources as well as information and communication technologies. Authors take the position that countries' economic sustainability is possible, if all of these objectives are developed equally.
- Using the proposed Sustainable knowledge based economy index a methodology estimation of different development aspects in Baltic countries has been made. Estonia's seems the strongest in innovation, in contrary, this aspect in Lithuania seems to be its weakness. Although separate researched indicators have the biggest values in Estonia, in long run view, dynamics is the best in Latvia.

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