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COMPARATIVE EVALUATION OF NATIONAL INTELLECTUAL CAPITAL MEASUREMENT MODELS

Irena MAČERINSKIENĖ[1], Rasa ALEKNAVIČIŪTĖ[2]

Mykolas Romeris University, Ateities g. 20, LT-08303 Vilnius, Lithuania
E-mails: [1]irena.macerinskiene@mruni.eu; [2]aleknaviciuterasa@gmail.com (corresponding author)

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Abstract. National intellectual capital is regarded as an important factor of a country's ability to perform high value added functions including the ability to create innovations. Measuring national intellectual capital is still a complicated task. In this article national intellectual capital concept and measurement models are analysed in order to show how national intellectual capital could be measured. The findings show that there are several weaknesses of measurement models validity. Those weaknesses in more recent measurement models are minimized by introducing advanced national intellectual capital structural models and more complex value approximation methods. Analysis of selected national intellectual capital measurement models has shown that there are not many similar indicators used (from 21% to 60% of matching indicators), though results obtained by using these evaluation models have high significant correlation.

Keywords: national intellectual capital, knowledge capital, national intellectual capital measurement models, intangibles, human capital, structural capital.

JEL Classification: O34, O15.

VALSTYBĖS INTELEKTINIO KAPITALO VERTINIMO MODELIŲ LYGINAMOJI ANALIZĖ

Irena MAČERINSKIENĖ[1], Rasa ALEKNAVIČIŪTĖ[2]

Mykolo Romerio universitetas, Ateities g. 20, LT-08303 Vilnius, Lietuva
El. paštas: [1]irena.macerinskiene@mruni.eu; [2]aleknaviciuterasa@gmail.com

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Santrauka. Valstybės gebėjimas kurti inovacijas ir atlikti aukštos pridėtinės vertės funkcijas priklauso nuo valstybės intelektinio kapitalo. Nustatyti valstybės intelektinio kapitalo vertę – vis dar sudėtinga užduotis. Šiame straipsnyje analizuojama valstybės intelektinio kapitalo koncepcija ir vertinimo metodai, siekiant parodyti būdus, kaip valstybės intelektinis kapitalas gali būti įvertintas. Tyrimo rezultatai atskleidžia taikomų vertinimo modelių validumo trūkumą. Šie trūkumai naujausiuose vertinimo modeliuose minimizuojami taikant sudėtingas valstybės intelektinio kapitalo klasifikacijos sistemas ir pažangius valstybės intelektinio kapitalo vertės apibendrinimo metodus. Pasirinktų valstybės intelektinio kapitalo modelių analizė atskleidė, kad jų vertinimo sistemoje tapačių rodiklių naudojama nedaug (nuo 21 iki 60 proc.), tačiau valstybės intelektinio kapitalo vertė, nustatyta taikant skirtingus vertinimo modelius, yra panaši (rezultatai yra aukšto statistiškai reikšmingo koreliacijos lygio).

Reikšminiai žodžiai: valstybės intelektinis kapitalas, žinių kapitalas, valstybės intelektinio kapitalo vertinimo modeliai, nematerialusis turtas, žmogiškasis kapitalas, struktūrinis kapitalas.

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Introduction

A country's wealth is more and more dependent on its ability to perform high value added functions including the ability to create innovations. NIC creates value through innovation, where large or small changes done for processes, services or products results in creation of new value, so contributing to the growth of the wealth of nation (Chew *et al.* 2014). Intangible investment influences establishment and improvement of global value chains driving fragmentation of production through outsourcing and off-shoring. Specialization on high value added functions is possible only if a country fosters a high level of intellectual capital. The World Bank (2006, 2011) capital structure analysis performed in over 100 countries over a 10-year period from 1995 to 2005 shows that intangible capital (human capital, social capital, and the quality of institutions) makes up to 60–80 percent of total wealth. In advanced economies of OECD countries intangible capital is the only significant factor of production (World Bank 2011: 120). Findings also suggest that investments in human capital, strengthening institutions and developing the capacity to generate and use knowledge leads to wealth creation. Many researches investigating the influence of national intellectual capital (NIC) on economic growth also confirm a positive effect of NIC on countries' wealth. Bontis (2004) performed an analysis of NIC in Arab states (21 countries), which showed that NIC accounted for nearly one-fifth of the explanatory power for financial wealth of the Arab region. Lin and Edvinsson (2011) performed a NIC analysis covering 14 years (1995–2008) for 40 countries, which showed that there was a strong correlation of 0.88 between intellectual capital and GDP per capita (PPP) in real dollars in these countries. Ruiz, Navarro and Pena (2011a) analysed NIC and GDP relations in the years 2000, 2005 and 2008 for 72 countries. The results confirm the existence of a positive relationship between GDP and the measure of intellectual capital, which shows non visible wealth of a country. Weziak (2007) confirms the fact that there are important connections between intellectual capital and GDP per capita in the European countries. These researches show that intangible factors are very important for national wealth creation and highlight the need for their better measurement and management models.

Recent NIC research shifts the focus of intellectual capital within a firm to a longitudinal focus of how intellectual capital is utilised to navigate the knowledge created by countries, cities and communities (Dumay, Garanina 2013). Serenko and Bontis (2013) identify that intellectual capital research is at the theoretical consolidation stage of prescience and is progressing toward becoming a reference discipline. Intellectual capital research has already overcome the first stage of development and its concepts and importance to economy is recognized (Dumay, Garanina 2013). There is an increasing part of literature in the field which develops second stage research with a focus on developing models how NIC is measured and reported, and there is only a small number of papers in the third stage, which examine NIC in practice and its management questions. Obstacles of NIC measurement are still one of the most important questions to be solved. It is believed that an ability to measure NIC could help to improve management practices of NIC (Koch 2011). On the country level it means a more effective distribution of investments in intangibles in order to create the well-being. Salonius and Lönnqvist (2012) identify that policy makers in Finland would appreciate a more conceptualized model of NIC, which could help them to make decisions. Even though NIC is very difficult to capture and measure (Weziak 2007), its value could serve as an extension of GDP that may predict future national wealth.

Still the basic methodological problems of intellectual capital research have not been solved. Three types of problems are identified in intellectual capital research (Jeschke *et al.* 2011: 323): the problem of definition, the problem of content, and the problem of measurement. The problem of measurement refers to the objects of measurement (inputs, process variables, outputs); to their selection and to the corresponding definitions of indicators, to the intervals and methods of measurement; to comparability; and to the cost and benefits of the measurement task (Jeschke *et al.* 2011). There are no measurable metric parameters, and thus there is no measure of knowledge; knowledge assets are described in terms of intellectual capacities, competencies and complexities of structure and relationships, etc., which can be approximately represented by indicators and can be quantified in this way (Koch 2011). Various NIC measurement models could be found in scientific literature. An analysis of these models helps to give a more comprehensive picture of what NIC is, what aspects of NIC are considered in NIC research, and how the value of these aspects is reflected. Hence, *the aim* of this article is to analyse NIC concept and measurement models in order to show how NIC could be measured.

The objectives are as follows: to analyse the conceptual framework of NIC, to define the most significant NIC measurement models, to investigate the main obstacles of validity faced by NIC measurement models, and to compare the selected NIC measurement models in order to verify their similarity and results' correlation.

Research methods used include scientific literature and documents analysis and comparative analysis of NIC indexes.

1. NIC conceptual framework

The definition of intellectual capital is related to the definition of knowledge (Pawlowsky 2011). Intellectual capital is defined as knowledge that can be applied to yield value (Edvinsson, Sullivan 1996). Accordingly, the semantics of what is meant by knowledge is developed differently

in different disciplinary, cultural and temporal contexts (Koch 2011). The concept of value is also constantly under debate discussion and is, time and again, redefined in the democratic political process (Kapyla *et al.* 2012). It is not surprising that NIC models are specific to each society and can change through time. The creation of NIC models is based on subjective choices influenced by environmental factors. Nevertheless subjectivity should not be seen as a problem – it is indispensable (Kapyla *et al.* 2012).

NIC content is based on the value-laden character of the underlying assumptions coming from broadening theories. The main idea of NIC research is based on long-established bordering theories emphasising the importance of knowledge for the development of society. Knowledge base in the region is shaped partly through innovation processes, which were investigated by frameworks on three research areas: ideas driven endogenous growth (Romer 1990), national innovation systems (Nelson 1993) and the cluster-based theory (Porter 1990; Hervas-Oliver, Dalmau-Porta 2007). The understanding NIC performance is reached by constructing a comprehensive, multidimensional measurement framework that completes and combines the viewpoints provided by different knowledge society frameworks and acknowledges the contextual and strategic nature of NIC (Kapyla *et al.* 2012). NIC measurement models derive from theoretical assumptions on knowledge economy and also from specific strategic goals of a nation.

The essence of the NIC concept could be defined in different ways. Three approaches how NIC is defined are identified: by defining its outcomes, by defining its application level, and by defining its structure.

1.1. Defining NIC outcomes

Usually, when defining NIC, its outcomes for the society are stressed. It is stated that "IC is not valuable as such – it should lead to outcomes" (Salonius, Lönnqvist 2012). NIC is defined as being "all intangible assets of a nation, which provide a comparative advantage and enhance wealth creation" (Lazuka 2012). NIC definitions give reference to outcomes of NIC, which are described as "competitive advantage" (Lin, Edvinsson 2011), "future growth potential" (Lin, Edvinsson 2011), wealth creation (Lazuka 2012; Bontis 2004), "society's value creation" (Kapyla *et al.* 2012), and "economic, social and environmental development" (Salonius, Lönnqvist 2012). Such definitions are related to the main idea of IC, which is limited with only valuable knowledge analysis. Defining what dimensions are taken into account as valuable makes the NIC concept definite. Though it does not mean that this relation is presumed and a deeper investigation of such relations is not needed. The majority of NIC measurements were directed to the interest towards finding the economic value of NIC. The main focus is on confirming the influence of NIC on GDP. But currently broader outcomes are investigated. The role of NIC in the society is investigated through different perspectives. NIC is often analysed as one of the most important factors of innovations (Aizcorbe *et al.* 2009), competitiveness (Barkauskas 2009; Bronisz *et al.* 2012; Crass *et al.* 2010; Cristelli *et al.* 2013), productivity (Barnes 2010; Barnes, McClure 2009; Capello *et al.* 2011; Edquist 2011; Ferreira, Hamilton 2010; Haskel, Pesole 2011), sustainable development (Abdullaeva, Warden 2011; Allee 2000), and creativity (Cabrita, M. R., Cabrita, C. 2010). Close relations of NIC with these strategic processes show that NIC as a resource is valuable and fosters the development of the society.

1.2. Defining NIC application level

The concept of NIC integrates different layers of society and various types of economical actors. Intellectual capital could be analysed in separate sectors or layers of economy on the national level or it could encompass all sectors and layers. Both these research approaches are developed. When defining NIC its component sectors and layers are conveyed: "the intellectual capital of a nation includes the hidden values of individuals, enterprises, institutions, communities and regions that are the current and potential sources for wealth creation" (Edvinsson, Stenfelt 1999; Bontis 2004; Cabrita, M. R., Cabrita, C. 2010). Defined levels start with individuals, which are the primary source of NIC. Communities and regions, which form a nation, also could be characterized by their unique IC. Intellectual capital of all these levels is integrated into a specific national-state structure.

IC analysis very often is performed in separate sectors. Results of such researches are generalized to describe intellectual capital in a nation, though these results describe intellectual capital value of only one sector in a country and should not be mixed with NIC measurements as NIC integrates intellectual capital of all sectors of a nation. Kapyla, Kujansivu, and Lönnqvist (2012) show that NIC involves four sectors of a society (see Fig. 1).

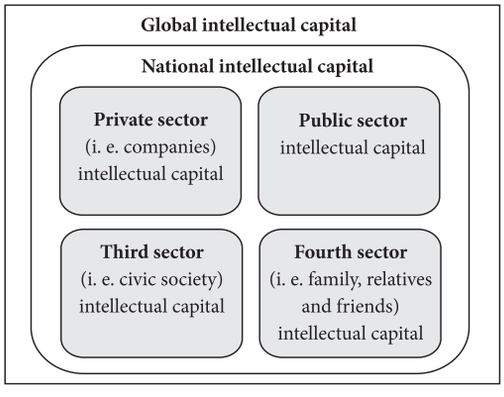

Fig. 1. Elements of knowledge society (Source: Kapyla *et al.* 2012)

The sectorial structure of NIC involves intellectual capital of the private sector, the public sector, the third sector, and the fourth sector. This structure enriches the understanding of NIC by showing the essence of the third and fourth sectors in forming NIC. Distinguishing of the third sector is associated with a rising popularity of the theory of social economy. Social economy, including cooperatives, mutual societies, non-profit associations, foundations and social enterprises, provides a wide range of products and services across Europe. It is estimated that there are more that 11 million paid jobs in the social economy across Europe (the equivalent of 6% of the working population in the EU) and membership in social economy enterprises ranges as high as to 160 million people (European Commission 2014). This type of social organization created with an explicit aim to benefit community fosters NIC development as well as could be characterised by its individual level of IC. The fourth sector represents informal social organizations such as family, relatives, and friends. These informal forms of organizations are based on shared trust, norms, values, customs and traditions and generate positive externalities for members of a group. Such organizational structures may contribute to the development of social capital and thus generate beneficial outcomes for the society. There is a lack of research of intellectual capital in the fourth sector. Intellectual capital evaluation in the third sector is performed in separate social enterprises. Some scholars (Bronisz *et al.* 2012; Guthrie *et al.* 2009; Najafbagy *et al.* 2014; Kong 2007) have investigated intellectual capital in non-profit organizations and ways how it could be measured and managed. Nevertheless in NIC research the perspective of the third sector (e.g. associations) and the fourth sector (e.g. families) is usually ignored (Kapyla *et al.* 2012). Measurement of the influence of the third and fourth sectors on the creation of NIC could be a perspective place of NIC theory development.

Currently the most attention is given to the research of private sector intellectual capital. Currently companies' intellectual capital measurement methodologies are in the stage of standardization. The most influential approach of measuring private sectors' intangible capital on the national level is proposed by Corrado, Hulten, and Sichel (2005). This measurement approach provides a financial intangible capital investments measurement model, which could integrate intangible capital investments value with GDP. Scientific research shows that intangible resources are becoming an important factor of production and should be treated as capital (Nakamura 1999, 2010; Hall 2000; Webster 2000; Hulten 2000; Corrado *et al.* 2005, 2006, 2009, 2012; Nakamura, Philadelphia 2008; Corrado, Hulten 2012; Stachowicz-Stanusch 2013). But this perspective involves only private sector intangible capital measure, as the NIC approach employs a broader perspective and seeks to reveal NIC value, which integrates all sectors operating in the territory of a specific country. Public sector intellectual capital is an important component of NIC, though these relations are not well understood. Public sector intellectual capital measurements (Ramírez 2010; Kamaruddin 2013; Bueno Campos *et al.* 2006) seek to improve the efficiency of the public sector, which leads to benefits for the whole society. The influence of public sector intellectual capital on NIC is not explicitly investigated.

All these sectors hold their unique intellectual capital, which is formed from national and global resources. Intellectual capital of each sector interacts with intellectual capital of other sectors and interacts also with national intellectual capital and global IC. Identity is an important aspect of NIC, which could change with the movement of intellectual capital resources. Migration flows influence human capital level, transfer of intellectual property, offshoring and outsourcing activities may change NIC value. This process may have positive as well as negative effects on the level of NIC, but these processes are rarely discussed in current NIC literature. Increased movement and interdependency between countries does not decrease differences between them. It is discussed that some tacit knowledge aspects are grounded and could not be separable and transferable to others.

NIC is a specific characteristic of a nation, which integrates intellectual capital of various sectors. It could be measured as a characteristic, which is accumulated in a particular territory and merges intellectual capital of smaller territorial units. Or NIC could be analysed as a specific characteristic of a collectively organized society, which could be represented by an analysis of interactions, forming that society. These approaches do not conflict, but they are based on a different theoretical basis.

1.3. Defining NIC structure

Defining NIC structure is a popular way of thinking about this object. Various NIC classification systems are used, which differ by terms used to define components, the level of elaboration and indicators used. The basic conceptual classification of NIC was transformed from the organizational level of research. Firstly, the general intellectual capital model of Scandia Navigator, proposed by Edvinsson and Malone (1997), was applied to define NIC (Malhotra 2000, 2003; Bontis 2004; Lin, Edvinsson 2011). In this model NIC consists of five types of component capitals, see Figure 2.

On the first level of this model IC is divided in only two components: human capital and structural capital. This feature allows to analyse classification systems that divide intellectual capital into two components in parallel to this model. The concept of structural capital describes

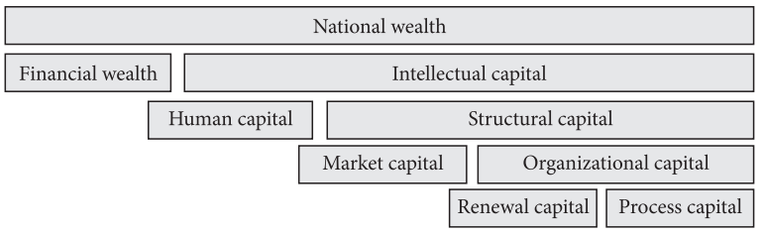

Fig. 2. NIC model based on Skandia navigator (Source: Bontis 2004)

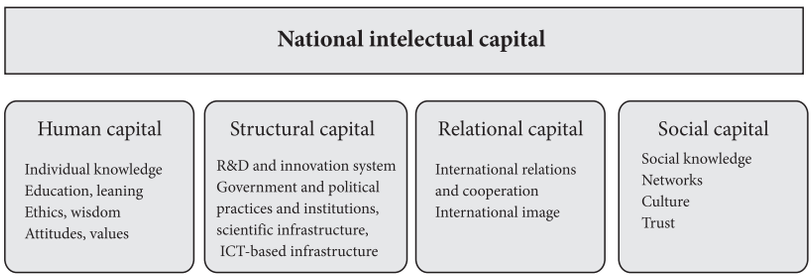

Fig. 3. NIC structural model of four elements (Source: Kapyla *et al.* 2012)

the supportive environment of human capital, formed both with internal interrelationships and the country's external relationships. Market capital shows a country's competitiveness in the external market, which is achieved by investments in foreign relations and exports of quality products and services (Bontis 2004). It is created by elements such as laws, market institutions, and social networks. And broader concepts such as social capital could be treated, as it includes systemic qualities that enable social capital creation. Organizational capital describes an internal environment formed by renewal capital and process capital. Renewal capital includes capabilities and actual investments in renewal and development for sustaining a competitive advantage (Bontis 2004). Process capital is described as "the non-human storehouses of knowledge in a nation which are embedded in its technological, information and communications systems as represented by its hardware, software, databases, laboratories and organizational structures which sustain and externalize the output of human capital" (Bontis 2004). This model categorizes NIC components into a hierarchical structure with different levels of elaboration. Researchers could select the level of their interest. A NIC measurement model could be identified, which stresses the importance of only the first two NIC components: human capital and structural capital (Navarro *et al*. 2011b; Ruiz *et al*. 2011b). This model interprets intellectual capital as the value of ideas generated by the union between human and structural capital, which allows knowledge to be produced and shared.

The intellectual capital classification system of Stewart (1997) is also applied on a macroeconomic level (Andriessen, Stam 2005; Stam, Andriessen 2009); this system defines three intellectual capital components: human capital, structural capital, and relational capital. The term of structural capital has the same meaning as organizational capital in the model of Edvinsson and Malone (1997). It describes the internal environment of a country. Relational capital represents the intellectual capital embedded in national intra-relationships. It represents a country's capability in providing an attractive, competitive environment.

Recently the NIC structural model of three components was extended by adding one new component – social capital. This element is added either as a component relating to other components, or as a component equal to other NIC components. The model where structural capital is added as an additional component equal to others is shown in Figure 3.

NIC is divided into four parts: human capital, social capital, relational capital, and structural capital. Human capital consists of individual knowledge, education, learning, ethics, wisdom, attitudes and values. The importance of wisdom and ethics is stressed when describing human capital, as the value of human capital for finding the solutions but also for finding the problems and asking the right questions. Social capital represents social knowledge that can be derived from social relations and networks (Kapyla *et al*. 2012). Relational capital represents intellectual capital related to a country's international relations and cooperation and international image. It shows how NIC is related to global intellectual capital, how a country succeeds in attracting and using global intellectual capital for its own national development. Structural capital refers to intellectual capital embedded in national organisational and technological structures. Renewal capital is not excluded because its elements can be found in these four factors mainly in the scope of structural capital.

Salonius and Lönnqvist (2012) show social capital as a connector of NIC components describing trust and communication. The concept of social capital refers to "the institutions, relationships, and norms that shape the quality and quantity of a society's social interaction" (Jianbin *et al*. 2014). It is an essential component enabling a society to prosper. In the NIC model the scope of social capital is attributed to other components: the characteristics of norms and institutions are included in the scope of structural capital, social interactions are partly described by the use of the term of relational capital. The model of key NIC elements is shown in Figure 4.

Human capital in this model represents individual competence. A competence is a whole of knowledge, insights, skills and attitudes which a professional is setting in when critically intelligent ripe handling in different professional situations (Agten 2007). Relational capital describes not only external relations as declared in previously analysed models (Andriessen, Stam 2005; Stam, Andriessen 2009; Kapyla *et al.* 2012), but all relations between stakeholder groups and other interest groups. Structural capital describes data and process structures. Interaction between NIC components shows that they are closely related.

To sum up, human capital is excluded in all classification systems; other component capitals describe non-human based resources. An analysis of NIC structure shows that the concept of NIC characterizes not only intangible but also tangible factors. These tangible factors describe an environment, which fosters the use of human capital and creating value added. They include infrastructure factors, which support knowledge creation and sharing, factors reflecting relations, policy variables and a country's image. All these factors help to create value added for the society.

2. Sample selection and the method of analysis

The analysed NIC measurement models include only academic measurement models, which, in order to report the value of NIC, use a system of variables (indicators) that helps to uncover and manage NIC. The NIC evaluation methods, which treat NIC as a residual (World Bank 2006, 2011; Pucar 2013; Hall 2000; Webster 2000) are not analysed in this paper. Also the general competitiveness frameworks and innovation measurement models, which include numerous elements similar to those in the NIC frameworks, are not analysed.

In order to understand how the value gained using different measurement models correlates, a deeper analysis of already published NIC measurement models and their results is performed. Four different intangibles' assessment methodologies, empirically applied in order to assess intellectual capital in EU countries, are analysed. Indicators used in these measurement models are matched in order to define similarities of used NIC measurement model index matrix. The analysed methodologies were

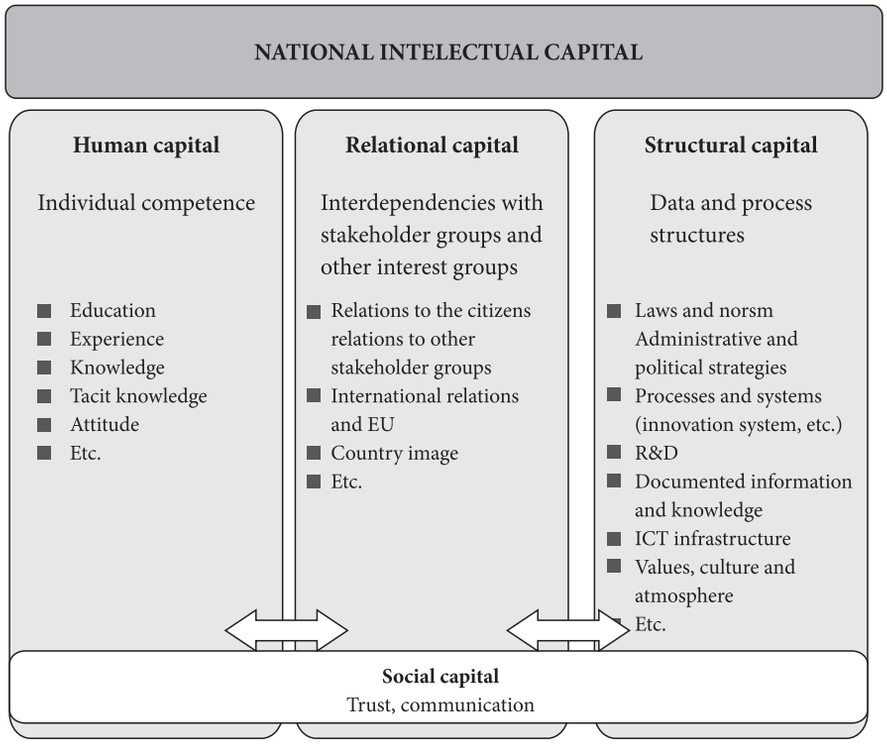

Fig. 4. Key elements of NIC (Source: Salonius, Lönnqvist 2012)

used to evaluate NIC in 12 EU countries. It was chosen to compare the results of these countries in order to find out if there was agreement among the ranks given to countries using different NIC measurement models. There was a need to unify measurement scales and re-rank these assessments in the analysed group of 12 EU countries. The index value of each EU country was taken, and then the countries were ranged from 1 (with the highest value of national intellectual capital) to 12 (with the lowest value of national intellectual capital). This simple procedure allowed making comparisons of results of different indexes. The Spearman's correlation coefficient was calculated for comparing the results.

3. Characteristics of NIC measurement models

NIC measurement models show how to define NIC, what components constitute its content, and how it could be reflected. They don't just give tools to get the value of NIC, but they also compose specific economic, managerial and econometric models based on taxonomically arranged hierarchies of intangible resources. These models differ by a chosen approach to the NIC structure, applied NIC value aggregation methods, and by selected indicators, used in the models. In this paper it was decided to divide NIC models into the ones that analyse NIC using one layer, and the ones that use two layers to analyse NIC. Selected measurement models and their main characteristics are given in Table 1.

Table 1. NIC measurement models (source: created by the authors)

NIC measurement models using one layer				
Author	Measurement model name	NIC structural approach	Purpose	NIC value approximation function used
(Bontis 2004)	National Intellectual Capital Index	– Human capital – Market capital – Process capital – Renewal capital – Financial capital	NIC analysis of Arab states	The Simple Additive Weighting (SAW) method is used for the calculation of cumulative indices and NIC index
(Užienė 2014)	National Intellectual Capital Index		NIC analysis in Baltic states	The Simple Additive Weighting (SAW) method is used for the calculation of cumulative indices and NIC index
(Lin, Edvinsson 2011)	National Intellectual Capital Index		General model of NIC applied to 40 countries	Mean scores of the five types of capital and the total score of national intellectual capital for each country
(Hervas-Oliver, Dalmau-Porta 2007)	The Intellectual Capital Regional Index (ICRI)	– the technological base – the human and educational base – the business policy base – the social aspect – the market block – the economic performance (financial) base – Firms' strategies – Clusters – Linkages	IC analysis in OECD countries	Index calculation method
(López Ruiz *et al.* 2010; Ruiz *et al.* 2011)	National Intellectual Capital per capita	– Human capital – Structural/non-human capital - Process capital - Relation capital - Image of the country - Innovation and development capital - Social and Environmental capital – Non explicit capital	General model of NIC applied to 82 countries	The additive model of NIC value approximation from component capital values. Component capital is assessed by a group of absolute indicators, filtered by efficiency indicators.
(Ruiz *et al.* 2011a; López Ruiz *et al.* 2011)	Scorecard for national intangibles		General model of NIC applied to 72 countries	
(Navarro *et al.* 2011a, 2011b)	National or regional knowledge competitiveness (INANK) model		NIC analysis in EU	The multiplying model of NIC value approximation from component capital values. Component capital is assessed by a group of absolute indicators, filtered by efficiency indicators.

Continued Table 1

NIC measurement models using one layer					
Author	Measurement model name	NIC structural approach	Purpose	NIC value approximation function used	
(Mačerinskas, Aleknavičiūtė 2012)	National intellectual capital scorecard	– Human capital – Structural capital - Relational capital - Innovation capital - Technological environment - Institutional environment	NIC analysis in EU	The Simple Additive Weighting (SAW) method is used for the calculation of cumulative indices and NIC index	
Two layers NIC measurement models					
Author	Measurement model name	NIC structural approach	Logic model of NIC performance	Purpose	NIC value approximation function used
(Malhotra 2000)	National intellectual assets	– Human capital – Market capital – Process capital – Renewal capital	– Inputs – Processes – Outputs – Performance	NIC analysis in Israel	NIC components evaluation without one NIC index calculation
(Andriessen, Stam 2005; Stam, Andriessen 2009)	Intellectual Capital Monitor	– Human capital – Structural capital – Relational capital	– Assets (present) – Investments (future) – Effects (past)	NIC analysis in EU	The value hierarchy defines combinatory rules.
(Kapyla *et al.* 2012)	Measurement system for national intellectual capital performance	– Human capital – Structural capital – Relational capital – Social capital	– Investments – NIC – National performance	NIC analysis in Finland	NIC components evaluation without one NIC index calculation
(Salonius, Lönnqvist 2012)	Key elements of national intellectual capital performance				
(Buracas *et al.* 2012; Buracas 2007)	The System of Indicators for Measuring Intellectual Assets by main Components	– Human capital – Organizational/ Structural capital – Relational capital	– Intellectual assets – Investments into KE & intellectual assets – Effects of intellectual resources	NIC analysis in EU	Multiple criteria evaluation model

The use of two layers is based on a logic model of performance measurement, which uses various variations of inputs-processes-outputs-outcomes measurement matrix. One layer NIC measurement models do not define this layer and integrate indicators with different nature into one NIC value measured by the index.

3.1. NIC measurement models using one layer

This group of measurement models uses complex structural models with different hierarchical levels for NIC analysis. Primarily the focus is on inputs and structural variables with lesser attention to process, outputs and outcomes (Malhotra 2003). Perspectives of investments, state and performance are merged. NIC value is analysed by calculating NIC index value and performing benchmarking studies. The main purpose of the country benchmarking studies is the operationalization of the NIC concept and the international comparison of the status of certain NIC elements (Salonius, Lönnqvist 2012). Benchmarking studies are also performed to evaluate NIC value changes in time. Even if the measurement unit is not available, this method allows to monitor the changes of value in different time periods as well as differences between countries. In order to perform a benchmarking study the same indicators should be available in a specific group of countries. This could be an obstacle for including more specific indicators into the NIC measurement model.

NIC index approximation functions are mainly based on the Simple Additive Weighting (SAW) procedure. Before applying the approximation function indicators are

normalized. This allows to keep value differences of measures and enables to combine NIC value. This innovative NIC approximation method was suggested and used in the works of López Ruiz *et al*. (2010, 2011), Ruiz *et al*. (2011a, 2011b), Navarro *et al*. (2011a, 2011b). This method allows gaining the financial value of NIC. It uses absolute indicators, which are measured on the financial scale and reflect investments into NIC elements, and efficiency indicators, which reflect efficiency of those investments. The calculated value is later weighted in accordance with the subjective weight and synthesised into a sole indicator (Navarro *et al*. 2011a, 2011b). Such measurement approach is in a transition between one layer measurement models and two layer measurement models.

3.2. Two layer NIC measurement models

One of NIC research approaches investigates NIC in the process of value creation. This approach separates NIC investment, NIC stock, and NIC outcomes. This is the main improvement of the static NIC measurement approach, which mixes indicators of different nature. The knowledge management model created by (Malhotra 2003) suggests adding the four component layer of inputs-processes-outputs-outcomes. The model of Andriessen and Stam (2005) shows how to compose the NIC measurement model taking into account different structural components and at the same time separating assets, investments, and effects:

- *Assets* (present) give an indication of the present power of a nation. It provides an overview of the current main assets if NIC.
- *Investments* (future) give insights into the future power of a nation. Investments should be continuously made to maintain or strengthen the current level of NIC.
- *Effects* (past) show the extent to which a nation has made its NIC productive during the past period.

This logic structure of indicators is used together with the structural NIC model of three components. NIC measurement is completed by calculating index values, though more complex findings are received. The present NIC value of a country, investments and effects could be analysed separately. This logic structure of indicators was used by other researchers (Buracas 2007; Buracas *et al*. 2012; Molodchik *et al*. 2012).

This measurement layer system stresses the dynamic nature of NIC. It does not measure the static state of NIC. More attention is given to evaluate NIC as a process of knowledge management in a country. In this measurement approach effects are described as outputs and outcomes. Outputs are a more direct reflection of NIC results, as outcomes are more related to achievements complementing strategic goals.

3.3. Measurement structure validity

Validation of research methods determines how precisely and accurately these measures represent the theory's concepts and how correctly these particular measures test the theory's hypothesis. The validity of the instrument of NIC measurement models is defined as "the extent to which differences in scores on it reflect true differences among nations on the characteristic we seek to measure, rather than constant or random errors" (Malhotra 2003). In order to measure NIC theoretical concepts are operationalized due to a phenomenon that could not be directly measured. The concept of NIC is analysed by defining its component factors. These factors define characteristics of NIC, which could be measured by indirect indicators, so their generalized values form the index value of NIC. Currently there are several weak points of the validity of NIC measurement models:

- Measurement models using one classification layer are missing the focus on the inputs-process-outputs-outcomes.
- NIC theory is still developing and the selection of indicators lacks theory (a framework of justifiable assumptions) (Malhotra 2003). It is sometimes not clear if the selection of indicators was derived from theory or from policy about knowledge economy.
- An additional concern is that the focus of most indices on NIC inputs may not be valid "proxies" for outcomes (Malhotra 2003). This issue is in every NIC measurement model using one classification layer. This means a lack of construct validity, which is directly concerned with the question of what the instrument is, in fact, measuring.
- Input measures, which are based on indicators of the investment level to NIC elements, often do not account for the quality factor of investments. Investment level indicators do not in themselves represent the "production of knowledge". The quality of investments is also very important. It was suggested to solve this issue by introducing absolute and efficient indicators, though there is a very limited number of indicators measured, which could reflect the quality of NIC.
- Existing indices use multiple constructs and variables that overlap and interact with each other. Empirical results show high correlation between measures of different capital types. It could be noticed that the same or similar indicators are used to describe multiple capital types. This shows that the measurement system could be optimized by reducing overlapping capital types and eliminating indicators, which have the same variance and do not provide additional explanatory power to the model (Malhotra 2003). Measurement model indicators must be necessary

and sufficient with respect to the objective. This implies: completeness (they cover the full meaning of the objective as understood by the stakeholder), distinctness (each attribute must carry one meaning only), and minimality (the attributes should be minimal sets) (Andriessen, Stam 2005). It is suggested that regression and factor analysis could help to improve current NIC models.

– Indicators used to measure NIC do not reflect that economies could be characterised by extreme variances of indicators. Average value is used, evaluated in scale, comparable between countries. Usually normalized measures are used. These extreme variances could have influence on the general level of NIC and its improvement perspective.
– Predictive or criterion related validity that the test or measurement predicts an outcome or correctly identifies group membership. It is determined by the correlation between two measures, if the correlation is high, the measure has predictive validity (Malhotra 2003). The critical issue here is if what we are trying to measure as "effect" may in fact be the "cause" (Malhotra 2003). This means that it's not NIC that influences a higher wealth level in a country, but a country with a higher wealth level could afford to have higher levels of human and social capital.

There are several ways how the validity of NIC measurement models could be analysed. The multi-method approach to instrumentation states that using more than one indicator to evaluate each concept could minimize the risk of overlapping methodological biases if selected indicators point to the same social phenomenon but use different data-collection techniques. The general rule of validation is that if two measures really point to the same phenomenon then their findings should correspond. The results obtained in the same countries by using different NIC measurement models are compared in the next section.

4. Comparative evaluation results

A comparative analysis of national intellectual capital evaluation models was prepared by matching indicators in the selected evaluation methodologies (Lin, Edvinsson 2011; Navarro *et al.* 2011b; Mačerinskas, Aleknavičiūtė 2012; Užienė 2014). A total of 105 indicators were used to assess the value of the national intellectual capital index in the defined national intellectual capital models (Lin, Edvinsson 2011; Navarro *et al.* 2011b; Mačerinskas, Aleknavičiūtė 2012; Užienė 2014). The number of unique indicators used was 41. About 61% of indicators were used in more than one national intellectual capital measurement model.

The number of indicators in analysed models varies from 20 in the measurement model of Mačerinskas and Aleknavičiūtė (2012) to 29 indicators in the model of Lin and Edvinsson. The most similar indicators (60% indicators were similar) were between the measurement models of Mačerinskas and Aleknavičiūtė (2012) and Užienė (2014). The highest level of uniqueness was between the measurement models of Lin and Edvinsson (2011) and Navarro *et al.* (2011b); here only 21% of used indicators were similar.

Table 2. Number of homogenous used indicators (source: created by the authors)

	Lin, Edvinsson (2011)	Navarro *et al.* (2011b)	Mačerinskas, Aleknavičiūtė (2012)	Užienė (2014)
Lin, Edvinsson (2011)	29			
Navarro *et al.* (2011b)	6	27		
Mačerinskas, Aleknavičiūtė (2012)	10	10	20	
Užienė (2014)	12	7	12	24

The following indicators were used in each model: R&D expenditures, exports of goods and Internet users. One of the main components of renewal capital is R&D expenditures. Exports of goods represent a part of market capital. Internet subscribers are one of the indicators of human capital in the model of Lin and Edvinsson (2011), while in the model of Navarro *et al.* (2011b) this indicator reflects Research, Development and Innovation Capital, in the assessment by Užienė (2014) this indicator was one of the components of process capital, and in the model of Mačerinskas and Aleknavičiūtė (2012) Internet usage represents the technological environment of a country.

Countries' ranks by their intellectual capital gained using different NIC measurement models are given in Figure 5. Countries are sorted from having the highest value of business sector intangible capital to the lowest value.

It may be seen that business intangible capital is the highest in the counties, which have the highest value of national intellectual capital index (Sweden and Denmark). The lowest value of intangible capital is in Italy and Spain; this value is received by all measurement methodologies. Other countries' national intellectual capital rankings are more diverse. The calculated Spearman's rho coefficient shows that there is a high positive correlation between variables. The highest correlation is between the measurements of Lin, Edvinsson (2011) and Mačerinskas, Aleknavičiūtė (2012) (the correlation coefficient is 0.89). The lowest correlation is between the measurements of Lin and Edvinsson (2011) and Navarro *et al.* (2011b) (the correlation coefficient is 0.64). Correlation coefficients between all pairs are significant at the level of 0.05. A high significant correlation between

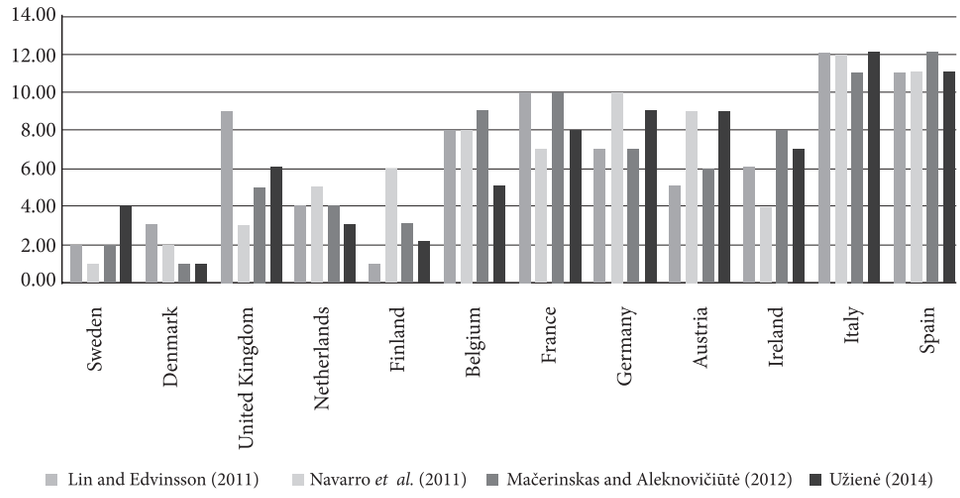

Fig. 5. National intellectual capital rankings using different methodologies (source: own calculation using data from Lin and Edvinsson (2011), Navarro *et al.* (2011b), Mačerinskas and Aleknavičiūtė (2012), Užienė (2014), European Central Bank (2005), World Bank (2011))

the results gained with different methodologies could be interpreted as an indicator of representativeness of the used evaluation methodologies.

Conclusions

The NIC approach provides a new way of analysing knowledge and its influence on the development of the society. The essence on NIC is difficult to define, as the meaning of the concept is developed differently in different disciplinary, cultural and temporal contexts. Its essence could be explained by defining outcomes, by defining the level of NIC application, and by defining NIC structure.

NIC outcomes help to identify what intellectual capital dimensions are valuable in a specific society. Identification of outcomes is declared in strategic documents of country. Often outcomes are defined as a competitive advantage and wealth creation. Currently the indicators of the quality of life are introduced to evaluate outcomes. NIC outcomes are extended and include more aspects such as social and environmental development.

Intellectual capital is measured in various units of a collectively organized society. Also intellectual capital is measured as a characteristic specific for a particular territorial unit. The NIC approach could be interpreted from both of these perspectives as a specific category of territory or as a category of collectively organized actions.

Four sectors (private, public, the third and the fourth) of the society which compose NIC have been identified. The results of sectorial analyses are often generalized to a national level, but these researches should not be mixed with NIC measurements. Currently intellectual capital researches focus on the analysis of private sector intellectual capital, and there is little research done in the public sector, the third sector, and the fourth sector. As the scope of intellectual capital outcomes is broadening, these sectors may receive more attention in the nearest future.

NIC is a component of global intellectual capital. The interaction of NIC with global intellectual capital is not well understood. Cross border movement of resources may have positive as well as negative effects on the level of NIC. Some tacit NIC aspects, which are grounded in the culture and traditions, form the identity of a nation.

Structural models of corporate level intellectual capital measurement were transformed to measure NIC. Such models are the hierarchical model of Skandia, and the classification system of three parts (human capital, structural capital, and relational capital), proposed by Stewart (1997). NIC structural models now are extended by adding social capital to the NIC structure. The analysis of the NIC structure has shown that the concept of NIC characterizes intangible as well as tangible factors. These tangible factors describe an environment, which fosters the use of human capital and formalized knowledge resources.

The value of NIC is received using multiple criteria evaluation methods. These methods allow to integrate indicators measured on a different scale and approximate their values to one NIC index. Such evaluation enables to perform a benchmarking analysis between countries and time periods. The Simple Additive Weighting method is the most popular for the approximation of NIC value. Currently there is a proposed method, which allows filtering absolute indicators by quality indicators and performing components weighting procedures when composing the final NIC value.

NIC measurement models used to be based on a one layer structural model, but a more dynamic approach is

becoming more and more popular. A logic structure model of performance management added as a second layer of a measurement structure allows to separate investments-assets and outcomes of NIC.

A comparative evaluation of four NIC measurement models has shown that the indicators used in the empirical measurements match vary from 21 to 60 percent even between models, based on similar NIC classification systems. This shows that there are differences between measurement model indicator matrixes. Nevertheless results gained using these different measurement models strongly correlate. Such strong correlation can show a representativeness of the used measurement models. The analysis of measurement models has shown that there are still many places where the validity of the NIC measurement structure could be improved.

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Irena MAČERINSKIENĖ, Prof. Dr, is head of department of Banking and Investments at the faculty of Economics and Finance Management of Mykolas Romeris University, Lithuania. Scientific interest covers intellectual capital, social capital, banks, finance and small and middle business.

Rasa ALEKNAVIČIŪTĖ is PhD student at the department of Banking and Investments at the faculty of Economics and Finance Management of Mykolas Romeris University, Lithuania. Scientific interest covers intellectual capital, innovativeness, national development.