The Role of National Intellectual Capital in the Digital Transformation of EU Countries. Another Digital Divide?

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Abstract:	

MANUSCRIPT DETAILS

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:exploratory study empirically investigates the association of national intellectual capital (NIC) with the national digital transformation readiness of the European Unionâ€™s (EU) member states. Apart from building the conceptual model of NIC, this study explores the role of NIC dimensions in the digital divide between European countries.on the literature review and the available EU statistical data and indexes the theoretical framework and conceptual model for national intellectual capital were developed. The model explores the relation of NIC and its dimensions (human, social, structural, relational, and renewable/development capital) on the readiness of European countries for digital transformation and the digital divide. Significant differences between EU countries in NIC and digital readiness were tested. Multiple linear regression was used to explore the association of each NIC dimension with digital transformation and digital divide within the EU.positive association between all dimensions of NIC and digital transformation readiness the proposed model of NIC wasnâ€™t confirmed in full. Regression analysis proved Social capital and working skills, a dimension of Human capital, to be the predictors of digital transformation at a national level, able to detect certain elements of digital divide between EU member states. Structural capital, knowledge, and education, as dimensions of Human capital, were predictors of the digital divide in terms of the integration of digital media in companies.research has a limited propensity for generalisation due to the lack of common measurement models in the field of NIC exploration.research offers policy makers an indication of the relationships between NIC and digital transformation, pointing out which dimensions of NIC should be strengthened in order to allow the EU to meet the challenges of digital economy and to overcome the digital divide between EU member states.study provides an original theoretical framework and conceptual model through which to analyse the relationship between NIC and digital transformation, which has thus far not been explored at the level of the European Union. This research makes an original contribution to the empirical exploration of NIC and produces new insights in the fields of digital transformation and intellectual capital.

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Abstract

Purpose: This exploratory study empirically investigates the association of national intellectual capital (NIC) with the national digital transformation readiness of the European Union's (EU) member states. Apart from building the conceptual model of NIC, this study explores the role of NIC dimensions in the digital divide between European countries.
Design/methodology/approach: Based on literature review and the available EU statistical data and indexes the theoretical framework and conceptual model for national intellectual capital were developed. The model explores the relation of NIC and its dimensions (human, social, structural, relational, and renewable/development capital) on the readiness of European countries for digital transformation and digital divide. Significant differences between EU countries in NIC and the digital readiness were tested. Multiple linear regression was used to explore association of each NIC dimension with digital transformation and digital divide within EU.
Findings: Despite positive association between all dimensions of NIC and digital transformation readiness the proposed model of NIC wasn't confirmed in full. Regression analysis proved Social capital and working skills, dimension of Human capital, to be the predictors of digital transformation at a national level, able to detect certain elements of digital divide between EU member states. Structural capital, knowledge, and education, as dimensions of Human capital, were predictors of digital divide in terms of the integration of digital media in companies.
Research limitations/implications: This research has a limited propensity for generalisation due to the lack of common measurement models in the field of NIC exploration.
Practical implications: This research offers policy makers an indication of the relationships between NIC and digital transformation, pointing out which dimensions of NIC should be strengthened in order to allow the EU to meet the challenges of digital economy and to overcome the digital divide between EU member states.
Originality/value: This study provides an original theoretical framework and conceptual model through which to analyse the relationship between NIC and digital transformation, which has thus far not been explored at the level of the European Union. This research makes an original contribution to the empirical exploration of NIC and produces new insights in the fields of digital transformation and intellectual capital.

1. Introduction

Since the beginning of the twenty-first century, two revolutions within global and national economic systems have occurred. The first revolution was linked to the rise of intangible economy, as the developed economies of the United States and Europe began to invest, for the first time after 2010, in more intangible assets than tangible ones (Haskel and Westlake, 2018, 2018a). Investments in innovation, design, research and development (R&D), human resources, and software were becoming the main source of companies' market success, while tangible assets such as buildings, land, and machinery or hardware became less necessary for long term economic growth. This reinforced the role of intellectual capital as a subset of intangible assets (Petty and Guthrie, 2000), able to drive competition and progress. For example, the national

intellectual capital (NIC), according to Stahle et al. (2015, p. 9), accounts roughly for 50% of the EU's GDP formation, with Nordic countries in the lead. The role of NIC is rather important as the intangible economy is fundamentally different from the tangible one (Andriessen, 2004) and requires different behaviours, rules, knowledge, and intangible assets in order to work properly and to avoid the recently recognized threats of secular stagnation and social inequality (Haskel and Westlake, 2018a, p. 7).

The second revolution marks the rise of the digital economy - a phenomenon resulting from online connections between people, businesses, and devices, as well as changes in conventional notions of businesses and social interactions. This usually refers to the concept of "Industry 4.0" and advanced manufacturing (OECD, 2017), but it can also encompass semantically different concepts of platform economies, sharing economies, gig economies, etc. (ILO, 2018). Digital economy marks the increasing digitalisation of businesses giving intangibles more of a prominent role in their income generation (Mayer, 2018) (e.g. Airbnb, Uber, or Netflix, which do not possess much physical capital) and forces not only companies but also regions and whole countries to invest considerable efforts into digital transformation. Although digital transformation (DT) manly challenges companies to radically redesign their business models to draw on information technologies (Del Giudice and Straub, 2011; Scuotto et al., 2017; Ardito et al., 2019; Solima et al., 2016) and on digital innovation embracing their intangible and non-rivalry character (Yoo et al., 2012; Nambisan et al., 2019; 2016; Smit et al., 2016) it also requires dramatic social and cultural changes at broader levels. The perceptions of societal changes vary from techno-optimistic view of revolutionary power of digitalisation which will advance all aspects of society, to the opposite believes by which digitalisation threaten public values, democracy and social equality (Betancourt, 2015; Srnicek, 2016; van Dijck et al., 2018). In any case, digital transformation is a global process and no economy or society can avoid this transformation if it is to achieve prosperity.

The successful realisation of these two revolutions was highly dependent on intellectual capital as an economic value of intangible assets of businesses, regions, or nations (Bounfour and Edvinsson, 2005, Malhotra, 2000, Stahle and al., 2015, Nambisan et al., 2019; Scuotto et al., 2017).

Some key international studies have shown that digitalisation contributes towards economic growth, increases in productivity, and employment (OECD 2017a, p. 13, WEF, 2017). The scope and speed of the digital transformation varies across countries. While some parts of the world are better prepared for digital transformation, others are lagging. According to UNCTAD (2019, p. 3), Europe, Africa, and Latin America are trailing considerably behind the

United States and China in terms of digital technological developments. For example, Europe's share in the market capitalisation value of the world's 70 largest digital platforms is only 4%, while the United States and China account for 90% as a result of giants such as Microsoft, Apple, Amazon, Google, Facebook, Tencent, and Alibaba. Despite some European countries' success in industrial digitalisation (e.g. Germany) (WEF, 2018), the regions outside of Europe dominate so many fields of the digital economy that technological dependency has become a real risk (Schweer and Sahl, 2017). For example, European companies account for only around 10% of global sales revenues in information and communication technology (ICT) and its ICT market is growing at a mere 1.3% per year (Schweer and Sahl, 2017).

There is therefore a growing recognition of the fact that digital technologies are not being used to their full potential in European countries (Smit et al., 2016). Although, according to the 2019 digital competitiveness ranking (WDCR, 2019), West Europe maintains its leading position alongside Eastern Asia and North America, it is increasingly acknowledged that the EU faces a huge challenge in its attempt to mobilise its intangible assets and intellectual capital for effective digital transformation, in order to keep up with competitors and remain one of the world's leaders. There is a digital divide between EU member states on both the first level (infrastructure) and the second level (use of digital technologies) of the digital divide (Evangelista et al., 2014; Mondekar, 2017) which weakens the competitiveness of Europe in its entirety.

NIC can be understood as the set of intangible assets or the abilities of a country used to put the country's resources in action for successful digital transformation. The relationship between NIC and digital transformation, to the best of our knowledge, has not been explored so far. With a focus on this under-investigated subject, the following research questions were formulated:

RQ1. What is the relationship between the national intellectual capital (NIC) and national digital transformation readiness (DTR) of European countries? Do countries with lower levels of intellectual capital lag behind in terms of digitalisation?

RQ2. What is the relationship between the first and second levels of the digital divide and the level of NIC and its components across EU countries? Do countries experiencing first or second digital divides also have lower levels of certain components of NIC?

Therefore, the aim of this research is twofold: firstly, it seeks to explore whether or not the digital divide between EU countries is related to their levels of NIC and any of its components and, secondly, it will assess the relationship between NIC and national capacities for digital transformation.

This article is structured as follows. The concepts of NIC and digital transformation are outlined in Section 2. Section 3 presents the research concepts and hypotheses. The methodology of the empirical research, including the construction of the NIC index and its relationship to digital transformation readiness, is given in Section 4. Results are discussed in Section 5. Section 6 concludes, and Section 7 describes the implications and limitations of the research.

2. Theoretical backgrounds

2.1. The concept of the national intellectual capital (NIC)

The origin and development of the intellectual capital (IC), as a scientific and managerial discipline, has been well documented in contemporary academic literature (Serenko and Bontis, 2014; Labra and Sanchez, 2013; Pedro, Leitao, and Alves, 2018; Petty and Guthrie, 2000) which usually emphasises the contributions of visionaries who either pioneered IC research, such as Sveiby (1997), Stewart (1991, 1997), and Edvinsson and Malone (1997), or gave inputs to its consolidation, such as Malhotra (2000, 2003), Bontis (2004, 2005), Lin and Edvinsson (2008, 2010, 2011), Bounfour and Edvinsson (2005), Andriessen (2004), Kapyla et al. (2012), and many others.

The focus of intellectual capital was originally oriented towards the intangible assets of companies (Stewart 1991, 1997) and has been extensively developed and modified, shifting the focus from companies to countries, cities, and communities (Bounfour and Edvinsson, 2005). The shift to these more aggregate levels, including nations, is driven by the idea that intellectual assets are as important for the competitiveness of countries as they are for firms (Mačerinskiene, et al., 2016; Labra and Sanchez, 2013; Malhotra 2003). A lot of empirical research validates this idea and shows, as summarised by Stahle et al. (2015) and Seleim and Bontis (2013), a positive relationship between gross domestic product (GDP), productivity, and NIC. Overall, NIC is seen as an essential element of wealth creation (Bontis, 2004), a factor linked to the competitive advantage of a country (Lin and Edvinsson, 2011), and a source of national economic growth (Stahle and al., 2015).

Stem and Andriessen (2009, p. 490) defined NIC as the "all intangible resources available to a country or region, that give relative advantage, and which in combination are able to produce future benefits". Bontis (2004, p. 14) holds that "NIC includes the hidden values of individuals, enterprises, institutions, communities and regions that are the current and potential sources for wealth creation". However, there are many definitions of NIC - almost as many as there are authors - which suggests that the concept of NIC is still under-developed and suffers from a lack of coherent theory and consistent measurement models. Michalczuk and Fiedorczuk (2017) identified over 15 different definitions of NIC, concluding that existing definitions are divergent in terminology and taxonomy, which is undoubtedly result of the individual approaches of individual authors to the topic. Despite their diversity, they all emphasise the intangible or knowledge-based nature of NIC (Kapyla et al., 2012).

The most recent studies of the evolution of IC point out a taxonomy based on four stages of IC development (Roos and O'Connor, 2015; Pedro, Leitao, and Alves 2018; Borin and Donato, 2015; Secundo et al., 2018; Stahle and Bounfour, 2008) and converge to the conclusion that the concept of NIC begins in the last stage of evolution of IC research - after 2000. This stage marks the extension of the IC model from a micro level of companies to a national, regional, and communal macro level. The topic of national IC has attracted global attention and has brought a new structural dimension into the NIC model – the social capital dimension - advocating the need to go beyond the traditional boundaries of IC measurements to catch the "larger holistic perspective, as well as new softer dimensions of Mind set, Culture and Values of Nations" (Lin and Edvinsson, 2011, p.x). The basic idea is that social capital influence the creation of intellectual capital and consequently new economic values through various social relationships. The seminal article of Nahapiet and Ghoshal's (1998) explained how social capital can generate intellectual capital for the organization through social relationships, networking and social bonds and inspired similar research at the national level (e.g. Kapyla et al., 2012; Salonius and Lönnqvist, 2012; Mačerinskienė and Aleknavičiute, 2017; Michalczuk et al. (2019; Borin and Donato, 2015).

Social capital in digital society is challenged by the specific societal changes brought by digital technologies which differ from previous industrial-type of technological change (D'Ippolito et al., 2019). For example, social interactions are dependent on and shaped by digital communication infrastructures that promote them into the most important component of digital transformation readiness (DTR) of nations. Furthermore, digitalisation which relies on data as raw material and allows for decoupling of physical from intangible components of objects generate new products and services at a marginally negligible cost. This digital non-rivalry (Yoo

et al., 2012) enables massive economies of scale and initiates new business models, competition strategies, and organisational forms (e.g. digital platforms) (Warner and Wäger, 2019; Nambisan at al., 2019). In entrepreneurship literature this is mostly celebrated for facilitating entrepreneurial opportunity, new business models, innovations and value creation (Nambisan at al., 2019) but also receive many critics for "platformisation" of society with many negative consequences (van Dijck et al., 2018; Srnicek, 2016). Changes in the business models and social interactions shape the way we live and how society is organised (van Dijck, 2018) and have a huge influence on societal changes captured in many different forms such as status of employment and work (Bounfour, 2016), distribution of income and wealth, social inequality, education attainment, competition regimes, government settings etc. (Betancourt, 2015; Srnicek, 2016; van Dijck et al., 2018). The efforts of companies to deal with these societal challenges and new business model to remain competitive will often results in redesign of the firm's strategies and knowledge management which will influence the structure of firm's IC and NIC, as well.

Despite the widely recognised importance of NIC, its assessment and measurement is rather challenging, as the concept is fairly fuzzy (Salonius and Lönnqvist, 2012), difficult to describe (Mačerinskiene et al., 2016), and still in its infancy (Bontis 2004). As Michalczuk et al. (2019) warn, NIC is a complex, multi-dimensional category, impossible to observe directly and without widely accepted measurement methods. Therefore, various authors have attempted to develop their own frameworks for the measurement and evaluation of NIC, which makes NIC research subject to a variety of arbitrary interpretations, which have subsequently been criticised for their abstract nature which receive little or no support in practice (Dumay and Garanina, 2013), and their haphazard construction (Kapyla et al., 2012). Despite the fact that the concept of NIC is mainly an extrapolation of pre-existing IC concepts, such as Scandia navigator (Edvinsson and Malone 1997) or of the classic three types of capital – human, organisational, and relational - introduced by Sveiby (1997), a range of various NIC structural models have been established, which differ in both their IC component as well as the variables used to define these components.

Following previous literature resources, primarily systemic literature reviews from 1960 to 2016 (Pedro, Leitao, and Alves, 2018) and 2000 to 2012 (Labra and Sanchez, 2013), an overview of selected models of IC at a national level (NIC) can be deduced (Table 1). Aside from the literature presented in Table 1, there are a number of studies of IC at other aggregate levels, such as regions (Schiuma and Lerro, 2008) or cities (López-Ruiz, Alfaro-Navarro, and Nevado-

Peña, 2014; Nevado-Peña, Alfaro-Navarro, López-Ruiz, 2017), which are well-summarised by authors such as Stahle et al. (2015), Labra and Sanchez (2013), and others.

Insert table 1 about here

The most frequent model for the evaluation of NIC (marked by two asterisks in Table 1) involves four dimensions: 1. Human capital; 2. Relational capital; 3. Structural capital; 4. Social capital. These dimensions including the newest dimension of Development/Renewal capital will be analysed in this research.

Exploration of IC and NIC at an EU level does not make the mainstream research field and only a few studies have been identified in this area. Among the first of these studies is the research of Bounfour (2003) who developed an IC-dVAL approach to measuring intellectual capital in a dynamic way, concluding that Nordic countries are the best in the EU in terms of adaptation to the knowledge economy.

The study of Stam and Andriessen (2009) measured the progress of EU countries towards the Lisbon Agenda and confirmed the three conclusions of their previous research: a.) Leading economies have a greater value of both Human and Structural capital; b.) Investments in intellectual capital pay off as there is a significant correlation between investments and assets and c.) High values of IC assets are no guarantee of high productivity. They also concluded that the EU is geographically divided regarding IC assets. The old north-south division regarding IC is complemented with the new east-west division following the enlargement of the EU with the countries of Eastern Europe. Mertins et al. (2009) explored the role of IC in different sectors of Europe - industry and service - concluding that these sectors differ in terms of their IC components. For example, employee motivation and leadership are much more important in the service sector than in the industrial sector, which seeks explicit knowledge and formal qualifications.

The most recent studies are mainly interested in the influence of NIC on the economic growth of EU countries, and have concluded that NIC converges between EU countries (Mačerinskienė and Aleknavičiute, 2017) and that NIC, dominated by human capital, has had a statistically significant impact on economic growth rate (Mačerinskiene et al., 2016). Finally, the study of Michalczuk et al. (2019) found strong disparities between EU countries regarding NIC

resources. There is clear division between the north and the south of the EU, while the highest intellectual capital resources are in the countries of Northern Europe.

2.2. **Digital transformation in Europe**

Digital transformation has come to the centre of scientific research, with growing de-industrialisation, the rise of Industry 4.0, and the rapid development of artificial intelligence, which together signal radical changes in the global economy. Industry 4.0 is, broadly speaking, a production system in which machines can perform or optimise the production process themselves using cyber-physical systems of communication between the real and the virtual world (Hirsch-Kreinsen, 2016; Smit et al., 2016, p. 22). In contrast, within Industry 3.0, such operations required the assistance of a human being. Industry 4.0 is the current stage of evolution of industrial production that can be traced back to the first industrial revolution around the 1780s (Industry 1.0) launched by steam-powered mechanical production equipment. The second industrial revolution (Industry 2.0) was marked by the advent of electrically powered mass production (around 1870s) and was followed by the third industrial revolution (Industry 3.0) based on electronics and automatisation (Smit et al., 2016; OECD, 2017).

Digital transformation is a great challenge for both national economies and individual companies and it assumes the basic processes at three levels: technological, business, and social (Smit et al., 2016). Firstly, it assumes the technological transformation of companies through the use of digital innovations such as the Internet of Things (IoT), cloud computing, big data, RFID (radio frequency identification), augmented/virtual reality, which are expected to be further upgraded through robotics, artificial intelligence, machine (deep) learning, etc. (Ardito et al., 2019; Solima et al., 2016) Secondly, it includes the transformation of traditional business models into new management paradigms in order to integrate all processes into one connected and networked value chain. Finally, it implies social and cultural transformation in terms of companies and societies in order to embrace technological advances and digital transformation.

Since digital transformation is indispensable for economic progress, the major challenge for contemporary economies, including Europe, is the preparation and the maximisation of digital transformation benefits (Berger, 2014; Smit et al., 2016). However, many studies and benchmarking analyses reveal that Europe is lagging behind its competitors, not only in terms of digital transformation (Schweer and Sahl, 2017; UNCTAD, 2019), but also in terms of productivity (Smit et al., 2016). Although insights into global readiness for future production (WEF, 2018) reveal that the European industry remains competitive globally, its productivity

increases have been slowing in comparison to the United States, and it is increasingly exposed to competition with emerging economies, such as China and India. Europe has struggled to achieve the 20% re-industrialisation target set by the European Commission due to widespread deindustrialisation (Smit et al., 2016, p. 65).

It is thus reasonable to assume that rise of productivity through digitalisation and Industry 4.0 is important in allowing Europe to catch up and to escape digital marginalisation (Degryse, 2017). It was relatively late, in 2010, when the Digital Agenda for Europe became one of the seven pillar initiatives of the Europe 2020 strategy, followed by the Digital Single Market Strategy in 2015 (European Commission, 2015), which developed a number of policy initiatives to facilitate a boost in digital economy across Europe to this day (Mondekar, 2017).

The EU continuously evaluates its progress towards digital economy. Along with periodical reports on the digital market (European Commission, 2017), it has developed different monitoring tools, such as the Digital Transformation Monitor[1] which, among other analyses, includes the Digital Transformation Scoreboard (European Commission, 2018). For three consecutive years, it has run a statistical analysis of the adoption of digital technologies in businesses across the EU. This is closely related to the Digital Economy and Society Index (DESI) launched by the Europe 2020 strategy as a composite indicator to track the evolution of EU member states in terms of digital transformation (Kotarba, 2017). DESI and the Digital Transformation Scoreboard share one common dimension: the "Integration of Digital Technology", which refers to the absorption of digital innovation in companies.

However, different benchmarks reveal that there is a gap between European member states, especially between Northern and Southern Europe, in terms of both their readiness for Industry 4.0 (Berger, 2014) and digital transformation (Mondekar, 2017). According to Roland Berger's Industry 4.0 Readiness Index (Berger, 2014), there is an obvious gap between northern EU countries. These belong to "Front runners" and "Potentialists" who are better prepared for Industry 4.0 than southern countries, who are considered to be "Traditionalists" and "Hesitators" and have not yet introduced initiatives to shift themselves into the new industry era.

Insert Figure 1 about here

Figure 1. DESI index, 2019

[1] Available at: https://ec.europa.eu/growth/tools-databases/dem/monitor/

With regards to the national indicators for digital transformation of EU member states, the DESI index reveals the same pattern of north/south and west/east digital divide. Finland, Sweden, the Netherlands, and Denmark scored the highest ratings in DESI 2019, and are also among the global leaders in digitalisation. These countries are followed by the United Kingdom, Luxembourg, Ireland, Estonia, and Belgium. However, many eastern Europe countries belonging to new member states, such as Romania, Bulgaria, Slovakia, Croatia, and southern countries such as Italy, Greece, and Portugal, still require serious improvements if they are to compete with their northern neighbours or on the global stage (Figure 1).

3. Research concept and hypotheses

The purpose of this research is to explore the relationship between national intellectual capital and national digital transformation readiness (RQ1). It is motivated by the growing recognition that company's competitiveness depends today on digital transformation that radically modify company's business models, strategies and knowledge management (Stahle et al. 2015; Bounfour, 2016; D'Ippolito et al., 2019; Warner and Wäger, 2019; Nambisan at al., 2019) and consequently strongly influences economic success of a nation (Smit et al., 2016; OECD, 2017; OECD 2017a; WEF, 2019). This initiates the idea that successful digital transformation is highly dependent on the intellectual capital as a hidden intangible asset of a nation that puts overall resources in action. Therefore, this research stems from the assumption that NIC has an impact on national digital transformation readiness (NDR) and influences, as well on the digital divide between EU member states. The NDR and the digital divide are measured by the set of indicators covered by the DESI index (Figure 2).

Insert Figure 2 about here

Figure 2. Concept of research

Despite the rapid spread and uptake of digital technologies the European countries are lagging behind its competitors in digital transformation (Schweer and Sahl, 2017; UNCTAD, 2019; Degryse, 2017) while the national pace of adoption and use of digital technologies (digital transformation readiness-DTR) vary significantly across the European countries (RQ2). The relationship between DTR and IC on regional and national level is yet poorly explored. However, the comparison between the level of DTR and level of NIC, which are both assessed by the

numerous international rankings and studies and in their relevant field of research (as detailed in the sections 2.1. and 2.2), suggest that intellectual capital can be instrumental for DTR.

While the positive impact of NIC is expected to benefit the whole DTR, some NIC components may prove more important for upgrading the level of DTR. For example, upgrading the quality of human resources (Human capital) and establishing a good business environment (Strucutural capital) can result in better readiness of the country for adoption and use of digital technologies. As result the following hypotheses have been established:

H1. Countries with higher NIC score have higher level of digital transformation readiness (DTR);

H2. Dimensions of NIC are positively associated with the readiness for digital transformation;

Various international benchmarks reveal that this digital divide is worldwide (Pick and Sarkar, 2015), but that it is also evident between EU member states (Evangelista et al., 2014; Mondekar, 2017; Cruz-Jesus, 2016) and even exists within particular countries. Different rankings, such as the IMD World digital competiveness ranking (WDCR, 2019) and the Digital Transformation Scoreboard (European Commission, 2018), have revealed that there is a digital divide between EU countries. The strong disparities between EU countries regarding NIC resources are found (Michalczuk et al., 2019) pointing to the clear division between the north and the south of the EU. Scandinavian and western European economies are on the top of the rankings, while the eastern and southern Member States lag behind. DESI index reveals the same pattern of north/south and west/east digital divide (Figure 1). Although there are different classifications of digital divide, the most common differentiates between first-level digital divide, which concerns differences in physical infrastructural access, and second-level digital divide, which refers to the actual use of digital technologies by citizens (individuals) and companies. Seeing as the digital divide is a great obstacle to social inclusion, technological development, and business opportunities, the relationship between the digital divide and NIC of EU countries will be explored. As result the following hypotheses are established.

H3. *The NIC score of the countries that are below and above the EU average of NIC is related to the first and second digital divide of EU countries*:

- *H3.a. Dimensions of NIC are positively related to the first level digital divide;*
- *H3.b. Dimensions of NIC are positively related to the second level digital divide regarding companies;*

- *H3.c. Dimensions of NIC are positively related to the second level digital divide (citizens' use of internet services and digital public services).*

4. Research methods

4.1. Sample and data

The sample considered in this study consists of 28 member states of the European Union. For each country the level of the National intellectual capital (NIC) is calculated based on the composite scores. The sample is given in the Table 3 within results' section since the calculation of NIC for each member state is a part of empirical analysis of this research. Data on NIC for all 28 member states was collected from different secondary resources as systematically presented in Table 2. Data on Knowledge and education as a component of Human capital and data on Renewable/Development capital are selected directly from the Eurostat online databases. Working skills as a component of Human capital, Policy stability as a component of Structural capital, Openness of trade as a component of Relational capital and Social capital in its entirety is collected from the selected pillars of WEF (2019). The data for Ease of doing Business as a component of Structural capital is collected form the World Bank report (2019). Finally the data for Globalisation as component of Relational capital is collected from the KOF Globalisation index (KOF, 2017).

4.2 Measures

The relationship between NIC and digital transformation has far not been explored at the level of the European Union or individual nation. Without previous theoretical and empirical grounds this research proposes a new measurement framework for both NIC and national digital transformation readiness (DTR) and combines them in a novel conceptual model to explore the relationship between NIC and DTR, providing thus an original contribution to the empirical exploration of NIC. The main method used is unobtrusive measure, the secondary data analysis of published and publicly available composite indices.

Construction of National Intellectual Capital index

There is no unique conceptual and measurement framework for NIC research, and the NIC components suffer from a lack of homogeneity in their taxonomy. Because this field is still

developing, this study proposes a new NIC measurement framework, which consists of the five most often used dimensions of NICs, as given in Table 1, and include: Human capital, Relational capital, Structural capital, Renewable/Development capital, and Social capital.

The 15 variables were selected for their assessment of NIC components, the selection of which was based on the concept of this study, past research in this field, and data availability. Data for all 28 member states of the EU was collected from different resources, as systematically presented in Table 2.

Insert table 2 about here

All dimensions except Renewable/Development capital were composed of two sub-dimensions in order to determine the content of each NIC dimension that was the most relevant for digital transformation, in the author's view. Each variable was measured on a scale from 0 to 100. Data for the variables was taken from several available sources (listed in Table 2), with the exception of Knowledge and education and Renewable/Development capital, which were calculated by the authors from the EUROSTAT database. The subcomponent Control of corruption and Organised crime was the inverse scale for the values of pillars 1.01 and 1.13, taken from the Global Competitiveness Report (WEF, 2019), in order to preserve the logic of the scale in which higher values indicate better performance.

Human capital represents knowledge, education, and the competencies of individuals or groups needed in this analysis for digital transformation. Human capital in this research also includes working skills as they are estimated to be a critical factor for manipulation with digital media and technologies within Industry 4.0. Structural capital (originally company's organisational or process capital) refers to the national organisational assets that provide the healthy business environment needed for digital transformation. This involves the policy stability of a country and its ease of doing business. Relational capital is a national asset linked to a country's international relations and cooperation, and it is measured in this research through trade openness and the globalisation of the economy/society. Renewable/Development capital, defined by Bontis (2004, p. 24) as the "nation's future intellectual wealth", is captured in this research through R&D investments (in total and in business) and by a number of researchers which together make a guarantee for the future of technology and knowledge development (Secundo et al., 2020). Finally, Social capital is a new NIC dimension, which is understood in a classical sense as the trust, norms, and networks that enable better governance, institutional performance, and economic development (Putnam, 1993). Social capital is a composite indicator that assesses

social cohesion and engagement (bridging social capital), community and family networks (bonding social capital), and political participation and institutional trust (linking social capital).

National digital transformation readiness

The national digital transformation readiness (DTR) of EU countries is measured by the DESI index. In our research, digital divide, defined as the gap in digital transformation readiness between EU countries, is analysed separately on first and the second levels.

The first level digital divide is measured by the DESI index subcomponent "Connectivity", which assesses the availability of physical infrastructure in each country via coverage of fixed and mobile broadband Internet access. Physical infrastructure is important as people and firms can only benefit from DT if they have access to the Internet. The assessment of the second digital divide is made for a) companies based on the DESI index subcomponent "Integration of Digital Technology", which measures the use of digital media in companies and, b) individuals in the two DESI index subcomponents - "Use of internet services" and "Digital public services" – in order to assess the use of digital technologies and public services by citizens. The use of digital technologies is key in creating active and informed citizens in the public sphere and productive companies and economic growth in the business sphere (de Pablos, and Edvinsson, 2020).

4.3 Statistical analysis

SPSS 25 software was used for data processing. In order to evaluate the reliability of NIC index all variables included in dimensions of our NIC model were tested for internal consistency by Cronbach's Alpha (Bontis 2004). All dimensions except Structural capital have higher value than .70 (see Table 2).

First, Kendall's Tau b rank correlation for dimensions of NIC and DESI was calculated, and T-tests were conducted to identify statistically significant variations in comparing NIC score and second digital divide in EU countries. The hypotheses were tested using stepwise multiple linear regression models in order to find which NIC dimensions are associated with DTR (digital transformation readiness) and with first and second digital divide. We have performed several linear regressions with multiple independent variables. First all dimensions of NIC were put in the model and in the second round we created a model with variables (indicators) of dimensions that were proven significant in the first regression. Also, regression models with NIC dimensions and variables were tested for first and second level of digital divide. The models were decided upon checking residual plots and Collinearity statistics (tolerance and VIF).

5. Results and discussion

National intellectual capital (NIC) and national digital transformation readiness (DTR) of European countries (RQ1)

Even though previous analysis found a certain degree of convergence between EU countries in NIC assets (Mačerinskienė and Aleknavičiute, 2017), the results shown in Table 3 confirm the findings of previous research concerning disparities between EU countries regarding NIC resources (Michalczuk et al., 2019; Stam and Andriessen, 2009; Mačerinskiene, et al., 2016). Leading economies have greater values of NIC assets that confirm the old north-south division between European countries. Scandinavian countries (Finland, Denmark, and Sweden) including Luxembourg are in the group of countries with very high levels of NIC. They are followed by a group of eight countries with a score above the EU average (48,6): Germany, United Kingdom, Ireland, Netherlands, Belgium, Austria, Estonia, and Spain. Another group of countries which is considered to have a moderate level of NIC (score below the EU average but above 45) includes five new member states: Lithuania, Czechia, Latvia, Poland, and Slovenia, and four Southern European countries: Malta, France, Cyprus, and Portugal. The fourth group, countries with very low levels of NIC (scores of below 43) consists of five countries from Eastern Europe (new member states): Slovakia, Bulgaria, Hungary, Croatia, and Romania, and two Southern European countries - Italy and Greece. This last group confirms previous findings showing that the north-south division is, after enlargement of the EU with the countries of Eastern Europe, complemented by the new east/west division (Stam and Andriessen, 2009).

Insert table 3 about here

Figure 3 depicts the location of 28 European member states on the two basic dimensions explored in this research - the level of NIC and DTR.The exceptions to this trend are Germany and Austria, with rather low scores in the DESI index. It is worth stressing that Estonia is a leading country among the new member states in terms of both digitalisation and intellectual assets.

Insert Figure 3 about here

Figure 3. European member states by DESI index and NIC

After the composite index of NIC was constructed for 28 EU member countries, the first hypothesis tested was H1: Countries with higher NIC score have higher level of readiness for digital transformation. The results of the Pearson correlation indicated that there was a high significant positive association between NIC and readiness for digital transformation, (r (27) = .91, p = .000). The authors used the Kendall rank correlation to test the similarities of all dimensions of NIC separately with DESI in order to determine the strength of association between pairs. There is a strong correlation between all NIC dimensions and DESI. (Table 4)

Insert table 4 about here

The score for 28 countries was than divided into two groups: one group that was below the average EU score for NIC, and another group of countries with a score above the EU average. The independent sample t test was conducted to compare the level of digital transformation readiness (DTR) between these two groups. There was a significant difference in the scores for DTR in EU countries with a below average NIC (M= 45,45, SD= 6,66) and those with a score above the EU level (M=58,93, SD=7,75) t= 4,83; p= .000, which confirms H1.

Multiple linear regression analysis was used to explore how different dimensions of NIC affect digital transformation readiness and test H2: Dimensions of NIC are associated with the readiness for digital transformation.

Regression analysis revealed that the only two proposed dimensions Social and Human capital are statistically significant predictors of digital transformation readiness (Table 5). The regression analysis hasn't confirmed in full the second hypothesis (H2). Only two dimensions of NIC are better predictors of readiness for digital transformation. This result indicates that our conceptual model developed upon previous studies in this field which are few, needs further improvement in selection of variables for measuring the component of NIC with the influence on DTR.

Insert table 5 about here

Drawing on this, the associations with digital transformation readiness of each variable used for these two dimensions were analysed separately.

The next step was to establish which of the two variables that were components of Human capital and Social capital had the most impact. The regression model suggested that Working skills as a dimension of Human capital was the most important predictor of digital transformation readiness out of all of the NIC dimensions (Table 6). Working skills is a composite indicator, compiled of nine components taken from the WEF competitiveness report (WEF, 2019), such as mean years of schooling, extent of staff training, quality of vocational training, skillset of graduates, critical thinking in teaching, etc. This finding is also rather illuminating as Working skills as a part of Human capital proved to be a more influential factor for digital transformation than education and knowledge, as measured by the classical indicators such as persons with tertiary education, share of scientist and engineers, and persons employed in science and technology. This finding suggests that factors like vocational education, staff training, dexterity, agility, and practical creativity are indispensable tools for the manipulation of digital technologies, and are therefore critical factors for digital transformation.

Social capital, and particularly Crime and corruption as its dimension, are significantly correlated with Digital transformation (Table 6), which suggests that along with technological, also social and cultural transformation should be considered for the successful DT. Quality and quantity of social interactions, which were assessed in this research in the three areas measured by WEF (2019) of social cohesion (bridging social capital); community and family networks (bonding social capital); and political participation and institutional trust (linking social capital), turned out to have a significant influence on digital transformation. From a more holistic perspective, this suggests that DT is a social construction, a process of social interaction and collective learning by which citizens acquire, understand, exchange, disseminate, and embrace digital technologies. Therefore, it seems that a society with a higher level of trust, justice, equality, and social inclusion should also have better predispositions for digital transformation.

Insert Table 6 about here

National intellectual capital and digital divides (RQ2)

The independent sample t tests confirmed the first and second level digital divide between countries with their NIC score above and below EU average (48,33), which confirms the third hypothesis (H3) There was a significant difference in the first level digital divide between EU countries with NIC scores below the EU average (M= 55,01, SD= 7,0) and countries with NIC scores above the EU average (M=64,11, SD=5,92) t= 3,72; p < .01. The significant differences in the second level digital divide between EU countries with NIC scores below and above EU averages are shown in Table 6.

Insert table 7 about here

In order to further explore the ways in which NIC relates to the first and second digital divide, regression analysis was performed to uncover which dimensions of NIC were predictors for each component of digital divide. The second digital divide was analysed separately for companies and citizens.

The regression analysis revealed that the only predictor of the first level digital divide (physical infrastructure that enables access to the Internet) was Structural capital (Table 8). This confirms the third hypothesis (H3a) that some dimensions of NIC are better predictors of the first level digital divide. The obtained result seems rather reasonable, as Structural capital refers to intellectual capital embedded in the national organisational structures which provide appropriate environments for business and social development. This includes digital transformation as well. In this research, this involved the policy stability of a country and its ease of doing business, meaning that these aspects of NIC were the most important in terms of building the adequate fixed and mobile broadband needed for successful digital economy and society.

Regression analysis revealed that the predictors of better usage or integration of digital technologies by companies were Social capital and Knowledge and education as dimensions of Human capital. This confirms hypothesis H3b and suggests that the adaptation of companies to new business models and modes of production, such Industry 4.0, depends on social factors such as social cohesion, networking, trust, collective learning, and other elements which have already been identified as predictors of digital transformation at a national level (H2). Education attainment and knowledge (measured by the share of scientists and engineers in a population and the number of people employed in science and technology) play a role in the digital transformation of businesses. Specifically, in companies in countries with lower levels of Social capital, education and knowledge assets will probably also lag in terms of embracing new digital

models of business, which are an essential component for the economic progress and competitiveness of Europe.

Finally, the regression analysis revealed that the only predictor of the second level digital divide in terms of citizens' use of internet services was Working skills as a dimension of Human capital (Table 8). This confirms hypothesis H3c and suggests that working skills for manipulation and handing with digital technologies are the most important factors for the usage of digital technologies on a citizens' basis.

In conclusion, the analysis confirms H3, and all three specific hypotheses: H3a, H3b, and H3c.

Insert table 8 about here

6. Conclusions

The relationship between intellectual capital and digital transformation in Europe has not been explored thus far, despite the importance of intangible assets and digital transformation to the future of Europe. To shed some light on the issue, the purpose of this research was to explore the relationship between the NIC of the EU member states and their readiness for digital transformation, considering the digital divide between European countries as well.

The descriptive analysis confirms the findings of previous research showing that the EU is geographically divided in terms of IC assets (Michalczuk et al., 2019; Stam and Andriessen, 2009; Mačerinskiene, et al., 2016). Leading economies headed by Northern European countries have greater value of NIC assets, which aligns with the old north/south division between European countries. After enlargement of the EU with the countries of Eastern Europe, the old division was complemented by the new east/west division (Stam and Andriessen, 2009) as the new member states - Hungary, Poland, Slovakia, Bulgaria, Croatia, and Romania – had the lowest levels of NIC. There are some exceptions to this rule: Greece, for instance, occupied one of the lowest positions and Estonia was among the countries with the highest levels of NIC.

The research hypotheses were not focused only on the possible relationships between NIC and digital transformation, but also on the digital divide between EU member states that jeopardize the socio-economic progress of Europe as a whole. The research results suggest the following seven key findings.

1. Countries with higher NIC score have higher levels of readiness for digital transformation (Table 4);
2. Human and Social capital are better predictors for DTR than other dimensions of NIC. In the second regression model where variables of Human capital (Working skills and Knowledge and Education) and Social capital (Social capital and Crime and corruption) are tested separately, Working skills are confirmed as the most important predictor of DTR;
3. Since only two dimensions (Social and Human capital) proved valid as predictors for DTR, the model is still insufficient for reliable national level analyses of impact of intellectual capital on DTR. Future studies in this field need to consolidate theoretical frameworks and measurement models in order to achieve more coherent results with practical implications.
4. There is a digital divide between EU member states, which are related to the NIC dimensions in different ways;
5. Structural capital seems to be the only predictor among NIC dimensions of the first level digital divide, i.e. the physical infrastructure that enables access to the Internet;
6. Social capital and Knowledge and education (as dimensions of Human capital) are predictors of the second level digital divide in terms of the integration of digital media by companies;
7. Working skills (as dimensions of Human capital) are predictors of second level digital division in terms of citizens' use of internet services and digital public services rather than other dimensions of NIC.

The implications of these results, in combination with the previous literature sources, are manifold. Firstly, Social and Human capital as dimensions of NIC are important factors of digital transformation and should be strengthen in order to bolster Europe's ability to cope with digital economy. Secondly, NIC and digital transformation seem to develop simultaneously and in mutual coevolution. Although the causality between these two phenomena remains undetermined, it appears to be impossible to improve one without the other since digital transformation requires proficiency in intangible assets provided by the intellectual capital (Mayer, 2018; Petty and Guthrie, 2000; Stahle et al., 2015; Andriessen, 2004). Therefore, policy makers should act on both plans in order to facilitate the adoption of the next industrial revolution in Europe.

Thirdly, special concerns deserve NIC assets in the European peripheral countries in order to overcome digital divides between EU members (European Commission, 2018; Michalczuk et al., 2019; Mondekar, 2017; Cruz-Jesus, 2016). The peripheral countries mainly consisted of southeast EU states that shared weak digital capacities and assets of NIC and were unable to manage their intangible resources for technological and industrial development. These were captured in the low-tech "tangible" industries dependent on material resources. This weakens Europe's propensity to remain one of the world's leaders in the digital economy as it is unlikely that digital-core countries with high levels of NIC (manly Northern Europe, plus the most economically developed countries) could achieve this task by themselves without including peripheral countries (Smith at all. 2016, p.66). The imbalances within Europe could also threaten its unity and the principles of its democratic solidarity.

Fourthly, Social capital appeared as an important factor of digital divide since it emphasizes the importance of social factors such as social cohesion, networking, and institutional trust when it comes to enhancing IC assets at a national level. Previous research such as those by Kapyla et al. (2012), Salonius and Lönnqvist (2012), Mačerinskienė and Aleknavičiute (2017), Michalczuk et al. (2019) already contributed to explanation how social capital can generate intellectual capital.

Our results reveal that social capital is predictor of integration of digital media into companies which is an important aspect of digital divide (Table 8). Considering this result, it is important to note that the digitalisation of companies is often a ground-breaking process which almost automatically changes the company's business model and regularly results in firms' re-designation of strategic goals, knowledge management, and market repositioning. The digital transformation of incumbent large companies like Netflix, Amazon, etc. clearly illustrates the processes that Europe is missing and neglecting (D'Ippolito et al., 2019). Seeing as Europe threatens to be digitally marginalised (Degryse, 2017; Schweer and Sahl, 2017; UNCTAD, 2019) the strengthening of NIC for digital transformation appears to be a critical factor in allowing European companies to (re)gain global market positions and avoid marginalisation.

Fifthly, Working skills as components of Human capital, with emphasis on staff training, quality of vocational training, skillset of graduates, etc. appears to be an important factor in terms of standard indicators of Human/knowledge capital (third-level education, share of scientists and engineers, etc.) for two aspects of digital transformation: a.) national readiness of digital transformation and b.) second level digital divide in terms of citizens' use of the Internet and digital public services. They contribute, therefore, not only to NIC capacities but also to the remediation of the second level digital divide.

In testing the association of NIC model with digital readiness. Structural capital hasn't proven to be significant, nevertheless it is confirmed as important variable in first level of digital divide, i.e. access to physical digital infrastructure.

7. Implications and limitations of research

From a conceptual point of view, this article has opened a new perspective in terms of NIC exploration by providing insight into the relatively unexplored connection between NIC and digital transformation. The six findings of the research explicated in the Conclusions section have important implications for future scientific research, policy practices and societal changes.

Research implications

This research provides an original theoretical framework and conceptual model through which to analyse the relationship between NIC and DT, which has thus far not been explored at the level of the European Union. Therefore, it makes an original and novel contribution to the body of the current literature and hopefully, it draws the attention of scholars to digital transformation through the lens of intellectual capital and initiate new research in this area.

Practical implications

The critical importance of both phenomena - NIC and DT - for the future of Europe in the new digital economy was highlighted. Digital economy based mainly on intangible resources requires different business models and knowledge management in comparison to standard industrial economy and promotes intellectual capital into the basic instrument of a nation's competences and capabilities in digital era. This has strong practical implication for both entrepreneurs and policy makers who are challenged to formulate effective strategies to put the intellectual capital in use for digital transformation. Research findings also offer policy makers an indication of the relationships between NIC and DTR and points out which dimensions of NIC are important for the adoption of digital technologies and for overcoming the digital divide. Policy makers are challenged to define the correct policy frameworks to stimulate digital transformation and digital convergence between EU countries.

Societal implications

Finally, the research highlights certain societal implications. Firstly, it emphasises, drawing on literature resources that DT shapes social interactions, the way we live and how

society is organized. The societal changes (relevant for specific society as a whole) can be progressive but also can be detrimental in terms of the digital divide among countries, rising social inequality and labour uncertainty to mention just a few. Secondly, proper management of IC can positively influence DTR for the benefit of the society at whole. For example, the findings that Social capital appeared as a predictor of integration of digital media into companies emphasises the importance of social factors such as social cohesion, networking, and institutional trust for enhancing DT. This suggests that DT can be considered also as a "societal phenomenon", a social process determined by the structural elements of Social capital (social interaction, collective learning, etc.) by which employees and citizens understand and embrace digital technologies. It gives Social capital important role in society's digital transformation towards the higher level of DTR.

The main limitation of this research is the reduced generalization potential of the findings due to a lack of a common measurement model in the field of NIC exploration. As a result of the lack of unique definitions of NIC, underdeveloped theoretical frameworks, and commonly accepted measurement methods, the results of the research are necessarily subject to arbitrary interpretations and subjectivity. In this context, this research proposes, following the practice of other authors in this field who are few, its own model and selection of variables.

Future studies in this field need to consolidate theoretical frameworks and measurement models in order to achieve some common and coherent results with practical implications.

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Figure 1. DESI index, 2019

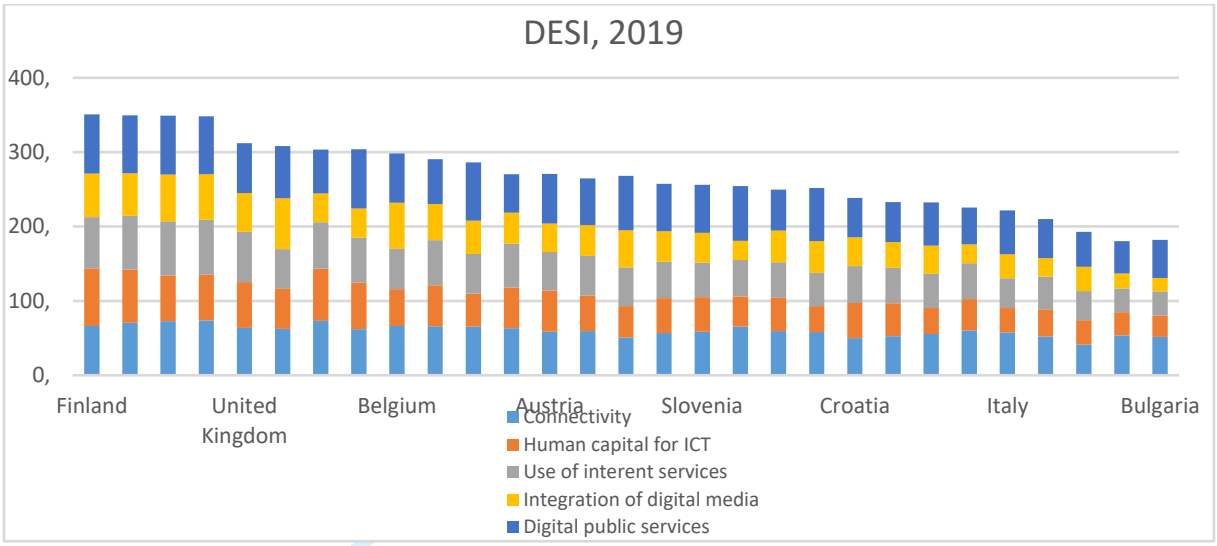

Figure 2. Concept of research

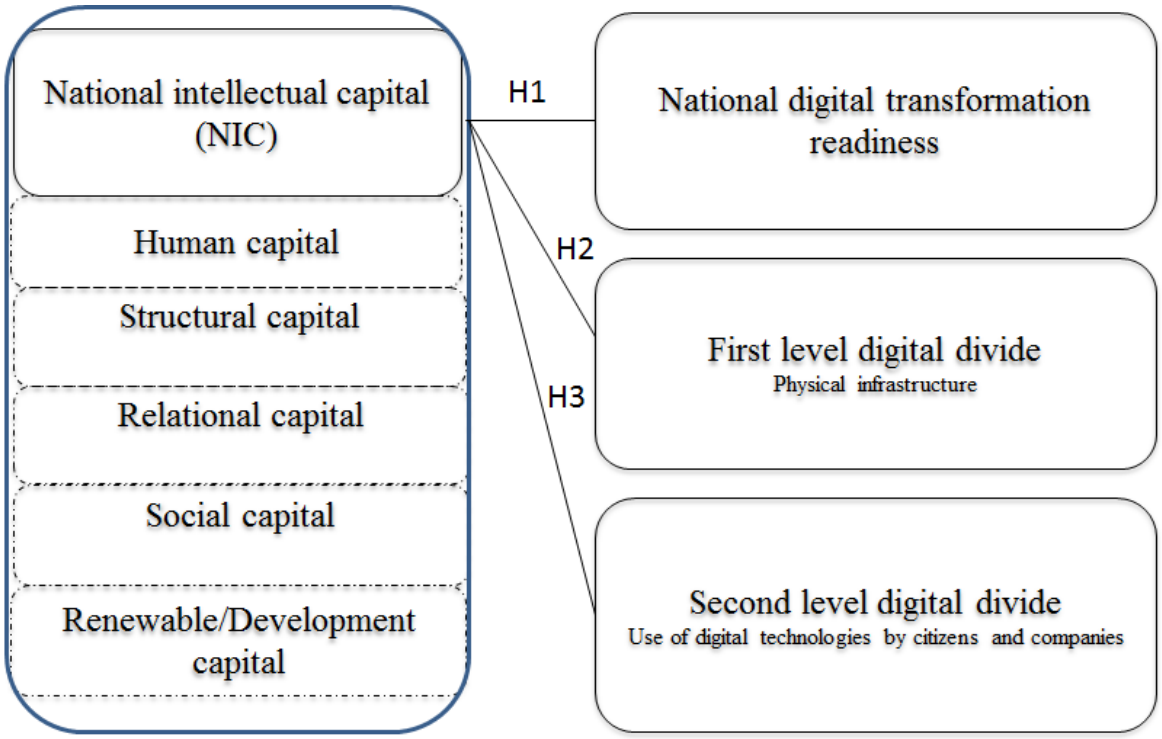

Figure 3. European member states by DESI index and NIC

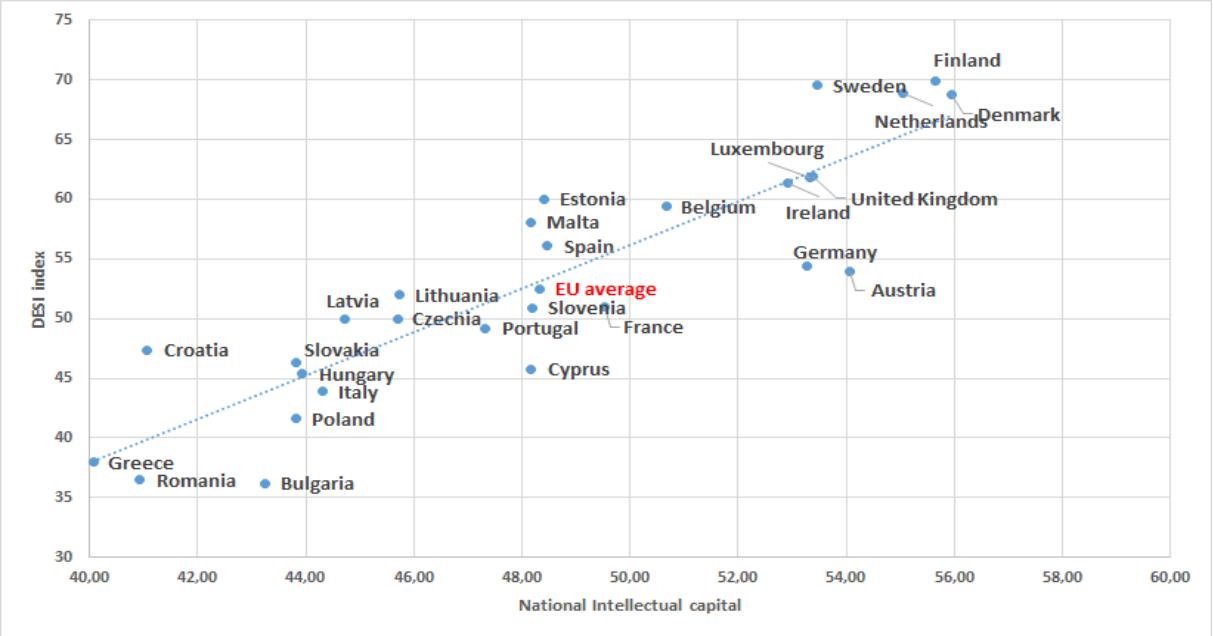

Table 1

	Components of IC	Purpose
Malhotra, 2000, 2003	1. Human capital; 2. Structural capital; 3. Market capital; 4. Organizational capital; 5. Process capital; 6. Renewal and Development capital	Better conceptualization and measurement of national knowledge assets
Bounfour, 2003	1. Human capital; 2. Market capital; 3. Structural capital; 4. Innovation capital; 5. Social capital	Measuring intellectual capital in a dynamic way at the level of EU
Bontis, 2004, 2005*	1. Human capital; 2. Market capital; 3. Process capital; 4. Renewal capital; 5. Financial capital	Development of the national intellectual capital index of Arab countries
Pasher and Shachar, 2005	1. Human capital, 2. Process capital, 3. Market capital, 4. Renewal and development capital	IC of Israel and economic growth
Pulić, 2005	VAIC™ method based on human and structural capital and capital employed	IC efficiency of Croatia, Slovenia, Hungary, Poland, and Czechia
Lin and Edvinsson, 2008, 2010, 2011*	1. Human capital, 2. Market capital, 3. Process capital, 4. Renewal capital, 5. Financial capital	Status of NIC of Nordic countries in comparison to the NIC of 40 countries; NIC and global financial crisis
Stam and Andriessen, 2009	1. Human capital; 2. Structural capital; 3. Relational capital within the 3x3 matrix: assets, investments and effect.	Measuring the progress of EU countries towards the Lisbon Agenda
Alfaro Navarro, Lopez-Ruiz and Nevado-Pena, 2011	1. Human capital, 2. Process capital, 3. Relational or trade capital, 4. Marketing or image capital, 5. Research, development and innovation capital, 6. Social and environmental capital.	Proposal of a new model for measurement NIC
Lin and Edvinsson, 2012, 2012a*	1. Human capital, 2. Market capital, 3. Process capital, 4. Renewal capital; 5. Financial capital.	NIC and resilience to financial crises in Greece, Italy, Portugal, Spain, Brazil, India, China, Korea, and South Africa
Salonius and Lönnqvist, 2012 **	1. Human capital; 2. Relational capital; 3. Structural capital; 4. Social capital	Perception of IC of policy makers in Finland
Kapyla, Kujansivu, and Lonnqvis, 2012 **	1. Human capital; 2. Relational capital; 3. Structural capital; 4. Social capital.	Conceptual foundation for NIC on the example of Finland
Seleim and Bontis, 2013	1. Human capital; 2. Structural capital; 3. Relational capital	Effect of NIC on economic performance of less developed countries

Borin and Donato, 2015**	1. Human capital; 2. Relational capital; 3. Structural capital; 4. Social capital.	Components of NIC for cultural ecosystem in Italy
Stahle et al., 2015 ***	1. Human capital; 2. Market capital; 3. Process capital; 4. Renewal capital	Effect of NIC on GDP and growth using a new method of ELSS production function
Mačerinskienė and Aleknavičiūtė, 2017**	1. Human capital; 2. Structural capital; 3. Relational capital; 4. Social capital	Effect of NIC on economic growth in European countries
Lin, C.Y.Y., 2018 ***	1. Human capital; 2. Market capital; 3. Process capital; 4. Renewal capital.	Comparison of NIC of South Africa with Poland and Romania.
Michalczuk, Skrodzka, and Paszko, 2019 **	1. Human capital; 2. Structural capital; 3. Relational capital, 4. Social capital;	Measuring NIC in European Union countries, using the TOPSIS method

Note: The number of asterisks indicates the models that use the same or similar NIC dimensions

Table 2. National intellectual capital by dimensions, variables, and sources

NIC dimensions	NIC sub dimensions	Variables	Sources
Human capital			
	Knowledge and education	1. Persons with tertiary education and/or employed in science and technology, % of total population aged 15-74, 2018 (HRSTO); 2. Scientists and engineers, % of total population aged 15-74, 2018; 3. Persons with tertiary education and employed in science and technology, % of total population aged 15-74, 2018, (HRSTC)	EUROSTAT (authors' calculation)
	Working skills	4. Working skills	WEF, 2019, Pillar 6 -Skills
	Cronbach's Alpha	.937	
Structural capital			
	Ease of doing Business	5. Doing Business	World Bank, 2019
	Policy stability	6. Government ensuring policy stability	WEF, 2019, Pillar 1.20
	Cronbach's Alpha	.512	
Relational capital			
	Openness of trade	7. Trade openness	WEF, 2019 Pillars 7.04 - 7.07
	Globalisation	8. KOF Globalization index	KOF, 2017
	Cronbach's Alpha	.855	

Renewable/Development capital		9. Total R&D personnel and researchers as % of active population (head count), 2015; 10. R&D personnel and researchers in the business sector as % of active population (head count), 2015; 11. Gross expenditures on R&D as % of GDP (GERD), 2017; 12. Expenditures on R&D in the business sector as % of GDP, 2017.	EUROSTAT (authors' calculation)
	Cronbach's Alpha	.965	
Social capital			
	Social capital	13. Social capital	WEF, 2019, Pillar 1.05
	Control of corruption and organised crime	14. Organized crime; 15. Incidence of corruption	WEF, 2019, Pillars- 1.01 and 1.13.
	Cronbach's Alpha	.764	

Table 3. National intellectual capital (NIC) composite score and ranking of 28 EU member states

	National intellectualc apital	Human capital	Structural capital	Relational capital	Renewable/De velopment capital	Social capital
Finland	58,51	54,67	81,02	78,1	2,29	76,45
Denmark	57,32	54,02	80,32	77,13	2,44	72,7
Sweden	55,29	54,60	71,93	78,81	2,51	68,6
Luxembourg	55,15	52,17	78	74,5	1,44	69,63
Germany	54,12	50,05	74,95	77,65	2,12	65,83
United Kingdom	54,03	52,35	71,37	77,37	1,45	67,63
Ireland	53,74	49,65	75,2	73,53	1,3	69
Netherlands	52,80	53,40	77,17	78,9	1,72	72,13
Belgium	52,43	50,08	66	76,19	2	67,9
Austria	52,19	49,55	79,98	76,72	2,51	69,7
Estonia	51,44	50,48	66,1	73,43	0,96	66,25
Spain	49,75	44,35	65,39	74,8	1,01	63,2
EU	48,64	46,66	64,69	73,34	1,31	61,71
Malta	48,13	44,07	63,61	68,54	0,64	63,78
Lithuania	48,11	48,02	63,26	69,67	0,75	58,85
France	47,88	45,38	69,69	74,72	1,72	61,93
Czechia	47,59	44,15	59,2	73,65	1,46	59,48
Latvia	46,61	46,92	60,84	69,88	0,51	54,93
Cyprus	46,04	46,28	67,5	69,97	0,39	61,03
Poland	45,32	44,32	54,27	70,41	0,73	56,85
Portugal	45,27	42,47	63,57	73,81	1,25	64,88
Slovenia	45,23	46,52	60,6	72,12	1,67	64,08
Slovakia	43,94	41,73	53,88	70,61	0,66	52,8
Italy	43,66	41,10	51,78	72,43	1,15	51,83
Bulgaria	42,86	41,10	56,67	68,79	1,02	46,7
Hungary	42,58	41,63	55,14	72,49	1,04	50,9
Croatia	42,00	38,72	49,25	70,86	0,6	50,55
Greece	41,09	42,27	43,54	70,24	1,01	48,38
Romania	38,97	36,33	51,04	68,17	0,35	51,95

Table 4 Kendall's Tau b rank correlation for dimensions of NIC and DESI

	Structural capital	Relational capital	Renewable and Development capital	Social capital	Human capital for ICT	DESI
DESI	**.849****	**.746****	**.616****	**.772****	**.925****	**1.000**

****. Correlation is significant at the 0.01 level (2-tailed).**

Table 5. Summary of stepwise linear regression for NIC dimensions predicting DTR (digital transformation readiness)

	Model 1			Model 2		
Variable	B	SE B	b	B	SE B	b
Social capital	1.088	.103	.901**	.631	.186	.523**
Human capital				.849	.300	.434**
R^2	.811			.857		
F for change in R^2	111.807			7.987		

*p < 0,05 **p < 0,01

Table 6 Summary of stepwise linear regression for variables predicting DTR (digital transformation readiness)

	Model 1			Model 2			Model 3		
Variable	B	SE B	b	B	SE B	b	B	SE B	b
Work and skills	1.362	.151	.871**	.820	.238	.525**	.601	.236	.384*
Crime and corruption				-.369	.134	-.420**	-.328	.124	-.373*
Social capital							.381	.157	.263*
R^2	.759			.815			.852		
F for change in R^2	81.923			7.583			5.879		

*p < 0,05 **p < 0,01

Table 7. The independent t test comparing NIC score and second digital divide in EU countries

Variables	NIC EU	N	Mean	Std. Deviation	t	df	p
Integration of digital media	>= 48.33	16	49.1812	10.85334	4,009	26	.000
	< 48.33	12	32.8167	10.45787			
Use of internet	>= 48.33	16	58.5500	10.18011	3,699	26	.001
	< 48.33	12	45.2833	8.19710			
Digital public services	>= 48.33	16	69.4875	8.69857	3,934	26	.001
	< 48.33	12	55.9667	9.39287			
Human capital for ICT	>= 48.33	16	55.4625	12.32017	3,865	26	.001
	< 48.33	12	39.7917	7.71497			

Table 8. Summary of stepwise linear regression for variables predicting first and second digital divide (DD)

	First DD Connectivity			Second DD Integration of digital media			Second DD Use of Internet			Second DD Digital public services		
Variable	B	SE B	b	B	SE B	b	B	SE B	b	B	SE B	b
Working skills							1,550	0,180	0,860**	1,243	0,246	0,704**
Knowledge and education				1,353	0,520	0,415*						
Social capital				0,890	0,312	0,455*						
Structural capital	0,572	0,095	0,763**									
R^2	0,582			0,618			0,740			0,496		
F for change in R^2				6,780*			74,043**			25,583**		

*p < 0,05 **p < 0,01