

Exploring the Relationship between National Intellectual Capital Management in the Romanian Healthcare Sector and Technological Innovation

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Abstract

This paper explores the association between the National Intellectual Capital (NIC) of Romania in the healthcare sector and technological innovation, based on available data from national and international sources. As this is the first study of its kind, to the best of the author's knowledge, it attempts to take stock of the current situation, identify possible gaps, analyze the NIC components, and reveal trends and future capabilities. To achieve its objectives, this research employs the NICI model, which proposes a range of indicators for the human, process, market, and renewal national capital. Limitations arise from extant data availability for certain indicators or periods. Overall, the Romanian healthcare sector experiences underfunding, brain drain, substandard governance, and lack of focus on patient needs, which lead to development and performance deficiencies, while possible remedies like an extension of digital technologies' use and multisector coordination are overlooked. Our investigation concludes with recommendations for future development strategies and policies.

Keywords

Healthcare; Romania; national intellectual capital; technology; innovation.

Introduction

Advanced economies spend a sizable share of their GDP on health, education, and R&D, harnessing the value of intangible resources (Lin & Edvinsson, 2011), as they are the foundations of innovation and growth. Such countries have also focused attention on uncovering and developing national intellectual capital (NIC) in its four main components, which are human capital, market capital, process capital, and renewal capital (op.cit., p. 4). In a knowledge-based view, NIC includes a country's overall knowledge, foresight, capacities, and prowess that allows it to achieve a competitive advantage over other countries and influence its prospects for growth (Lin, 2018, p. 502). Following a resource-based view, Andriessen and Stam (2008, p. 490) define NIC as the totality of available intangible resources that enable countries to obtain a relative advantage, and whose combination is the basis for future benefits. Svarc, Laznjak, and Dabic (2021, pp. 779, 777) have proposed a new dimension of NIC, social capital, which is deemed to assess social cohesion and engagement, community, and family, political participation, and institutional trust.

Research purpose and methodology

While the organizations' intellectual capital (IC) is traditionally classified into three main categories, human, organizational and relational, at the country level the concept of NIC has been developed by various authors. This study will make use of the model put forward by Lin and Edvinsson (2011, p. 19), which is the NIC Index, or NICI (Table 1), as this model has been developed by reputed authors, based on extensive experience with national systems with advanced IC, its indicators are clear and can serve as a reference for emerging economies, since it comprises a renewal component which focuses on R&D. While in the referenced model some variables can be measured with absolute value data, others are assessed on a scale from 1 to 10, then transformed into a 1-10 score. Each country receives a ranking based on the total score of the dimensions assessed. In addition to the aforementioned components, the financial capital, according to the cited authors should be measured through GDP per capita based on purchasing power parity (PPP).

This study's purpose is to investigate the current state of the Romanian national healthcare system in comparison to other EU states and international trends, to reveal downfalls and development capabilities. To this end, the NIC indicators will be used as a reference, to analyze an essential public sector, especially in the context of the COVID-19 pandemic, with a focus on technological innovation, in accordance with national, regional, and international strategies for development in the context of digital transformation. Recommendations for improvements will be proposed as a consequence. In this paper technological innovation refers to technology-enabled new products, services, processes, etc., in line with Eurostat Glossary (2007).

Table.1 NICI 40

IC Index	Indicators
Human Capital	Skilled labor Employee training Literacy rate Higher education enrollment Pupil-teacher ratio Internet subscribers Public expenditure on education
Process Capital	Business competition environment Government efficiency Intellectual property rights protection Capital availability Computers in use per capita Convenience of establishing new firms Mobile phone subscribers
Market capital	Corporate tax encouragement Cross-border venture Culture openness Globalization Transparency Image of country Exports of goods

Renewal Capital

Business R&D spending
Basic research
R&D spending/GDP
R&D researchers
Cooperation between universities and enterprises
Scientific articles
Patents per capita

Lin & Edvinsson, 2011

As this is an exploratory paper and data is not available for all the proposed indicators to allow a thorough, longitudinal analysis, this study will undertake a general assessment of the context of the Romanian healthcare sector, stressing the perspective of technological innovation, referring to the NICI indicators and based on the latest data available from the National Institute of Statistics (NIS) and other national sources, the European Commission Digital Economy and Society Index (DESI), Eurostat, OECD, and the World Bank. To our best knowledge, such an undertaking has not been conducted before, as indicated by a general search on the topic of intellectual capital in the healthcare sector in Romania, which returned very scarce and not up-to-date results. The positive role of the intellectual capital in the healthcare systems in Europe has been confirmed by researchers (Miller, 2015; Gravili, Manta, Cristofaro, Reina, & Toma, 2021), but the literature concerned with this topic remains scarce overall.

Analysis of the healthcare sector in Romania

Overview of the current state of the healthcare sector in Romania

The overall national health situation affects all economic sectors. Life expectancy at birth is currently situated at 75 years in Romania compared to the EU average of 81 years (Eurostat). Romania occupies an undesirable top position in the EU when it comes to infant mortality (op.cit.), the birth rate is low, while people aged above 60 years make a quarter of the current population of 19,3 million (NIS). The main determinants that affect the population health are socio-economic, occupational, and environmental, as well as individual lifestyles. To ensure a better responsiveness of the health system to beneficiaries' needs, to diminish inequities related to access to healthcare, and to increase efficiency, the current National Health Strategy (NHS) 2014-2020 has set among its main objectives the development of the e-Health (and m-Health) services in accordance with the EU policies, through the Integrated Information System relying on information and communication technology (ICT), as well as making effective use of the collected health data (H.G. 1028/2014). Other objectives concern ameliorating health and nutrition for women and children, reducing morbidity and mortality, improving access to healthcare, increasing performance and service quality, promoting research and innovation.

According to the NHS, ICT-enabled systems and tools are envisioned to support the development and coordination of public health programs related to disease prevention, diagnosis, treatment, monitoring, and management of health care. Certain projects such as the integrated system of the National Health Insurance House (NHIH), the electronic prescription system, the electronic patient file, and the electronic health insurance card are unfolding, while computer-based national disease registries are on

the way, as is the development of telemedicine services to reach remote areas, a paper-free trail between emergency services and hospitals, developing digital competencies and use of advanced technologies in healthcare, e-learning platforms, investments in technology and research for medical equipment and vaccine production (H.G. 1028/2014).

Financial capital

In terms of PPP adjusted GDP per capita, situated at 28,833 \$, Romania pertains to the upper-middle-income segment (World Bank, 2021). However, when compared to the European Union (EU) average of 41,504 \$, the country lags behind. A study by Lin, Edvinsson, Chen, and Beding (2014) has found that Romania's economy was hit hard by the 2008 financial crisis, but the country had a perspective for growth due to a more developed human and renewal capital than other neighboring countries in the early 2000s. However, the structural reform in the analyzed sector has been delayed. On the positive side, the healthcare allocation from the national budget has slightly increased during the last years, rising from 4,9% in 2015 to 5,6% in 2018, which is almost half of the average EU spending (Eurostat) and the lowest share in the region (OECD, 2019a). The national healthcare system is centralized under the leadership of the Ministry of Health (MoH), represented by the district public health authorities at the local level. The health system is financed from public sources up to 80%, while out-of-pocket payments cover up to a fifth of the total expenditure (Vlădescu, Scîntee, Olsavszyk, Hernandez-Quevedo, & Sagan, 2016, p. xix). Informal payments for healthcare are significant (OECD, 2019a). Investment funding for specialized units is provided by the MoH, while at the primary care level the funding comes from owners of the practices. The second source of funding is ensured by the World Bank and the EU structural funds (op.cit.).

85% of the population is insured through the NHIH, which is a key player in this sector, as voluntary insurance is marginal at less than 1% (Vlădescu et al., 2016, p.xx). As underlined by the MoH in the NHS and its accompanying action plan, the performance of the health services is affected by the unsustainable service pyramid, which is to be reverted, by supporting the functional transfer of services from hospitals to primary assistance at the community level and reallocating resources accordingly (H.G. 1028/2014; OECD, 2019a). The Strategy is a required instrument for accessing external funding for the development of the national health system within the EU Health 2020 program.

Human capital (HC)

IC comprises the knowledge resources that can be converted into value (Buenechea-Elberdin et al., 2018). HC is the „source of innovation and strategic renewal” (Bontis 1998, p.65). The intellect of the human capital allows the transformation into structural capital through organizational routines that serve efficiency and innovativeness, while information is codified into structural knowledge. In healthcare, innovation is dependent on specific knowledge and building competencies relies on knowledge sharing between individuals that lead to co-creation (Huang, Leone, Caporuscio, & Kraus, 2021, p. 296).

HC encompasses the knowledge and skills of the employees, which in the researched sector includes the entire healthcare community (Gravili et al., 2021, p.262). Based on panel data analysis concerning the 28 EU Member States between 2011 and 2016, Gravili et al. (2021) have studied the impact of IC in health systems and organizations. Their results showed the paramount role of IC in the healthcare sector. The number of physicians, medical academic publications, and e-government services was found to significantly impact the quality of healthcare and diminish mortality rate, while the number of available hospital beds proved to be an ineffective solution in the long-term, without specialized knowledge and technological endowment. Furthermore, the authors supported their arguments with evidence from the Italian experience at the outbreak of the Covid-19 pandemic. The policy of budget-cutting for education and training in the healthcare sector, combined with a shortage of specialized personnel and technology in the intensive care units hampered the crisis management, while the authorities had to recall retired medical professionals, who contributed also with real-time knowledge-sharing to the emergency response to the pandemic (op.cit., p. 281).

Looking at the HC component, it can be noted that in respect of numbers of healthcare personnel, Romania occupies a middle position in the EU with 721 practicing nurses per 100,000 inhabitants and a position in the last third with 304,7 physicians, despite having one of the highest rates of graduates in medicine in 2018 (Eurostat). The number of physicians has continuously increased, reaching 63,303 in 2019, and so did the number of other medical staff with tertiary education (22,623) (NIS). A similar trend applied to the medical personnel with secondary education, their number topping 150,251. However, as Table 2 indicates, in the fields of medicine and health/social assistance the number of graduates for almost every level of educational achievement has slightly decreased in 2018 compared to 2017. In addition, there is a discrepancy between the availability of medical services in various regions of the country, with the capital area enjoying close to double or more than double figures in comparison to other zones (OECD, 2019a, p.19).

Table 2. Number and percentage of graduates in medicine and health/social assistance per level of educational achievement for years 2017/2018 (NIS last available data)

Education level	Year	2017	2018
Total	Total	126,271	124,759
	Medicine & social assistance	16,912 (13,39%)	14,026 (11,24%)
Graduate	Total	82,848	83,210
	Medicine & social assistance	12,413 (14,98%)	1,217 (14,68%)
Master & Post-Graduate	Total	41,580	39,629
	Medicine & social assistance	4,226 (10,16%)	1,481 (3,74%)
Doctorate	Total	1,843	1,920
	Medicine & social assistance	273 (14,81%)	328 (7,08%)

The National School of Public Health, Management, and Professional Development (NSPHMPD) provide a variety of courses to physicians and other medical personnel, with a range of modules available on e-learning platforms. NSPHMPD is set among its objectives supporting research and development in public health, with the view to promote policies and strategies based on scientific evidence, to achieve higher service quality in healthcare (SNSPMS). Moreover, it publishes its open-access journal (Management in Health), which focuses on the management of public health. This institution has established a Center for Research and Evaluation of Health Services, which acquires data from the DRG registry.

In the Sixty-ninth World Health Assembly in 2016, member states have adopted a resolution concerning the Framework on integrated people-centered health services (IPCHS), which switches the focus of health systems from disease to people and communities (WHO). This framework introduces a paradigm shift requiring health systems' reformation, intending to achieve people-centered healthcare and to empower individuals to actively participate in their health. It is expected that improved health literacy and patient engagement leads to more effective healthcare and better performance (op.cit.).

Process capital (PC)

Medical infrastructure

PC is the equivalent of structural (organizational) capital at the national level. Core competencies in healthcare organizations can be found among others in clinical capabilities, technologies, IT systems (that incorporate e.g. databases, policies, procedures), the organization's mission, culture, and values, managing a patient-friendly environment, risk management, organizational learning, etc. (Evans, Brown, & Baker, 2017, pp. 5, 6). However, as a significant part of IC is tacit, knowledge can be lost through staff turnover, while an ever-increasing volume of data makes processing explicit knowledge difficult; furthermore, there is a divide between clinical and managerial knowledge; in addition, multiple stakeholders are involved in healthcare organizations, which can impede evidence-based innovation (Evans, Brown, & Baker, 2015, p. 2). The medical field is one of those that most relies on technological innovation, from clinical decision support software to patient records, to computer-assisted surgeries, and wearable technology. New technologies, like blockchain, bring about advantages such as cost and risk reduction and can be utilized in the healthcare sector for electronic records, insurance, research, medicine supply chain and procurement, and medical education (Radanović & Likić, 2018, p. 583). Digital servitization strategies can enhance structural capital in healthcare (Huang et al., 2021, p.302), and thus moving the focus from product to service-centric logic.

While HC in Romania has had an inconsistent evolution, PC has enjoyed continuous development, in accordance with the GDP growth (Lin, 2018, p.508). One area in which Romania ranks in the EU top 5 is the number of hospital beds per 100,000 inhabitants, which is 528,5 (Eurostat). However, as previously explained, this indicator per se is not necessarily indicative of efficiency and performance. Actually, as noticed by some sources (Vlădescu et al., 2016; OECD, 2019a) there is no reliable data on the quality of

services offered by the healthcare system, as such an assessment is not conducted consistently. Nevertheless, the availability of medical facilities proved beneficial during the Covid-19 pandemic, when one of the major concerns of all governments has been the overburden of the medical infrastructure. On the other hand, the statistics on medical technology and in particular imaging equipment in the EU shows that for all categories (CT scanners, MRI units, gamma cameras, mammography units, and PET scanners) the numbers were lower in Romania in 2018 than in the EU average (Eurostat), affecting, therefore, availability of service.

When it comes to medical facilities it can be noted that, while most hospitals are still in public ownership, the vast majority of the medical infrastructure pertains now to private ownership (see Table 3). Nevertheless, while this context is expected to foster competition, it should be considered that the absolute majority of the population is enrolled in the public health insurance program, and there are inequities concerning access to health, with great differences generated by the income level, the regional development status, and also the urban vs. rural location. In addition, public funding efficiency and managerial competence remain deficient (Vlădescu et al., 2016, p. 137).

Table 3. Medical facilities overview by ownership 2017-2019 (NIS last available data)

Medical unit	Ownership	2017	2018	2019
Hospitals	Public	367	368	368
	Private	209	147	155
	TOTAL	576	515	523
Specialty medical centers	Public	38	37	37
	Private	654	633	638
	TOTAL	692	670	675
Family medicine offices	Public	21	21	21
	Private	11,034	10,923	10,845
	TOTAL	11,055	10,944	10,866
Dental practices	Public	32	30	33
	Private	15,063	15,173	15,509
	TOTAL	15,095	15,203	15,542
Medical labs	Public	2,074	2,141	2,171
	Private	2003	2,139	2,175
	TOTAL	4,077	4,280	4,346

Digitalization and digital skills

In the context of the COVID-19 pandemic the digital technologies have come to play an outstanding role, both at the individual and public level, in various, oftentimes innovative activities, from communication to data and information sharing, to e-health, to teleworking, to e-learning, to e-justice, to entertainment, to e-government, and so on (OECD, 2020b). At the same time, the increased reliance on digital solutions during the pandemic has revealed some challenges also, from infodemic and disinformation to privacy, surveillance, and security aspects, to isolation and psychological effects, to an increased digital divide.

According to Svarc et al. (2021, p. 776), there are two levels of a digital divide in the EU, which, as a region, lags behind the top-performing countries in the world. The first level concerns the physical infrastructure, while the second level is related to the use of digital technologies by citizens and companies. As resulted from the cited study, working skills (and not the general education level) and social capital (measured through crime and corruption levels) are predictors of the digital transformation readiness and the citizens' use of digital technologies. On the other hand, education achievement, knowledge (measured through the share of scientists and engineers), as well as social capital are predictors of the integration of digital technologies by companies.

In what concerns the numbers of households in Romania with Internet access, according to the NIS data, a constant increase can be seen during the last years, from 72,4% in 2018 to 78,2 % in 2020. There is however a 15% gap between urban and rural facilities. It can also be noted a trend of switching from fixed broadband internet to mobile connections. In respect of the number of people who have ever used the internet, the figures rose in 2020 to 66,11% of the population. By age group, over two-thirds of the users were under 55 years old (NIS). This indicates that elder people, who mostly need continuous medical care, are unable to make use of e-health services by themselves, either because they do not have access to online services, or they lack the digital skills required to utilize them.

When looking at the ways the individuals have used the internet in Romania during 2017-2020, it can be seen that most people participated in online social networks (82,7% in 2020 and similar values before), they made calls using VoIP applications or other video call apps (71,1% in 2020), they used instant messaging applications (58%), or they searched for information about goods and services (58,4%) (NIS). There are no substantial differences between urban and rural users. Where the discrepancies increase is the usage categories related to healthcare. Overall, and paradoxically in only 35,8% of the cases was the internet accessed to search for medical information in 2020, in a continuous decline trend from 2017 (51,1%). While accessing health records online accounted for only 8,5% of the cases in 2020 and telemedicine use in 2020 topped 4,9% for the urban users, the figures are more than double compared to the rural population (NIS). For all three health-related indicators, the figures are on average 1,5 times bigger for female vs. male users.

The first electronic reporting requirement in the health field was implemented in Romania in 1999 for family medicine physicians to report to NHIH for reimbursement of medical costs, while hospitals began using the DRG (diagnosis-related group) system in 2006. In 2010 was launched the SIUI (Integrated Unique Information System) managed by NHIH, which includes all healthcare providers and pharmaceutical care. Then, in 2012 came to the introduction of the e-prescription system and the National Health Insurance Card was debuted in 2015, with the view to ensure more transparency on health insurance expenditure and healthcare delivery (Vlădescu et al., 2016, p.130). Some other projects like the electronic patient file or the telemedicine systems are in various stages of development.

Vlădescu et al. (2016, p.27) have noted that a great amount of data is collected in Romania in what concerns the health system functioning and population health status, but to a certain extent this data is incomplete, fragmented, duplicated and its use for planning and decision making is limited. In addition, access to the aggregated data is usually restricted to health care units and there is no comprehensive feedback to the data providers, which impedes them to make decisions by comparison with the peers' activity. Another issue is the limited integration of various information systems that exist in the health system.

Romania is in the first half, next to the top 10 EU countries in what concerns connectivity (through mobile and fixed broadband and high-capacity network coverage for households), and is the leader in the broadband price index. Instead of capitalizing on these capacities, Romania tremendously underperforms when it comes to digital skills, digital economy, and e-Government, is in the top position of the EU countries that lack ICT specialists, and not surprisingly in this context, occupies one of the last ranking positions for business digitalization (DESI 2020, p. 54). A ranking overview can be seen in Figure 1.

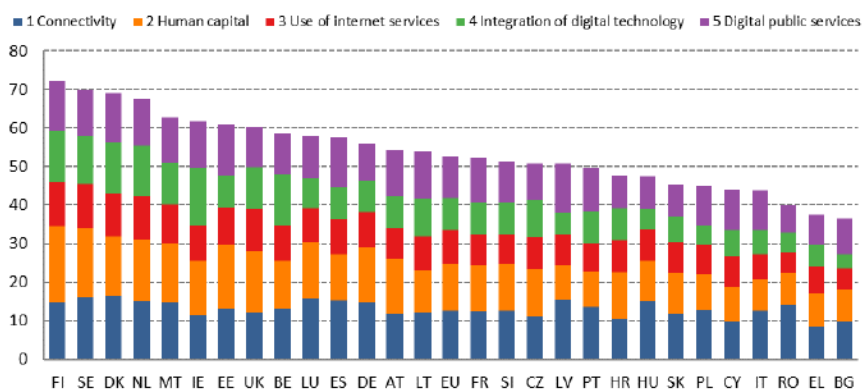


Figure 1. Country ranking in EU DESI 2020 based on five indicators
(DESI, 2020, p. 14)

As underlined by Vătămănescu, Alexandru, Cristea, Radu, and Chirica (2018, p. 541), within the digitalization context, the online intellectual capital empowers the consumer and enables knowledge-based consumption patterns. Such a development can also be translated accordingly in the healthcare sector. Former and future patients tend to share important information about the quality and accessibility of the available services. The network-based IC shapes the relationship between human, structural and relational capital on the one hand, and digitalization dynamics on the other (Vătămănescu, Andrei, Dumitriu, & Leovaridis, 2016, p. 596). Such input for the relationship and structural capital is especially relevant for the private healthcare service providers, for whom the patient feedback is important and is incorporated into decision-making processes for service development (SC) and HC management. This in turn shapes the patient-medical staff relationship. However, like access to private medical services is less affordable, the benefits of relational capital development for public healthcare institutions are currently more limited.

Another important area where Romania scores lowest in the EU is the provision of public digital services (e-Government) (EC DESI, 2020, p. 74). This is even more relevant in the pandemic context, as it limits the range of e-health services that can be provided to the public e.g. telemedicine. Though the first telemedicine information systems have been piloted in 2018 for rural and military testing, the COVID-19 pandemic worked as a driver for telemedicine deployment to the public, as the regulatory framework has been adapted to allow remote consultations and digital transmission of medical documents (Galaon & Ciutan, 2020, p. 6). The utilization of telemedicine is expected to grow, as it is an important service for out of reach rural communities, it enables a better patient-physician interaction for remote communities, as well as better health education and monitoring (op.cit., p.8). There are, however, limitations to the wide extension of this service, due to lack of digital skills, the financial burden on disadvantaged categories, cultural resistance, which prevent patient engagement in the e-health services and impede performance transparency. In addition, other impediments concern the limited number of medical specialties where telemedicine can be applied, ethical and security considerations, etc.

Market capital

Romania ranks 46 in the Global Innovation Index 2020 (World Intellectual Property Organization, 2021), and the assessment by pillar shows that it lags behind in Creative Outputs, Human Capital and Research, and Market and Business Sophistication. The country has made a slight move forward, by gaining three positions in the upper-middle-income group since last year. As noted in the report, while Romania fares well in the domains of knowledge impact and diffusion, ICT services and high-tech net exports, as well as ecological sustainability, it underscores when it comes to expenditure on education and government spending per pupil, but mostly in innovation linkages through university-industry research collaboration, cluster development, financing of the private sector, venture capitals deals and intensity of local competition.

The Eurostat 2021 data shows that the overall life satisfaction in Romania is perceived as being at a medium level, scoring 7,3 out of 10, with a similar score for job satisfaction and a slightly lower score for satisfaction with finances. Nevertheless, this perception might be influenced by the respondents' personal status and views, as for example 70,6 % of the inquired people self-assessed their health as being good and very good, and they scored at 7,4 their satisfaction with the living environment, while the urban exposure to air pollution in Romania is close to the EU maximum. In addition, the country has one of the highest EU death rates from preventable and treatable causes (OECD, 2019a). At the same time, the percentage of persons in Romania reporting unmet needs for healthcare due to financial reasons is higher at 4,9% than the EU average at 1,7%, situating Romania in the top 3 after Estonia and Greece in 2019 (Eurostat).

In healthcare, the relational capital i.e. the relations between medical staff and patients, as well as the organizational networks are paramount for output quality (Alfiero, S., Brescia, V., & Bert, F., 2021, p.3). Furthermore, as noted by Hamzah, Hassan, Saleh & Kamaluddin (2017, p. 32), relational capital is particularly important for those

healthcare organizations that rely on doctors that are not employed by them, as reputation and knowledge retention are dependent on external human resources. The relation between patients and healthcare providers is affected by patients' health literacy, and in e-health service deployment also by patients' digital skills and internet access. Health literacy is defined as an individual's ability to acquire, handle and understand essential health information and services with the view to decide properly on their health (WHO) and this capacity impacts a person's quality of life and livelihood (Hampton, 2020, p. 50). Moreover, health literacy is directly related to patient engagement, understood as involvement by patients or the people they designate, in healthcare decision-making that concerns them (op.cit., p. 17). Furthermore, health and digital illiteracy make individuals fall prey to the spread of fake news, hate, and conspiracy theories that impede technology acceptance and undermine prevention, containment, and recovery measures in public health emergencies. In addition, lack of health literacy prevents patients to exercise rights they are entitled to, such as those established by the European Charter of Patients' Rights e.g. the right to be involved in the treatment decisions, which are implemented in the EU Member States legislation.

Recently, the MoH has launched an online application to measure patients' satisfaction with the health services they received. To avoid paperwork and bureaucracy, and also in line with the NHS and the measures for pandemic containment, the patient receives a notification by SMS and then either answer - directly or through a weblink - a 9-question survey. To ensure transparency, the results are afterward published on the MoH website (www.ms.ro).

In the context of the COVID-19 pandemic, Romania has both imported and exported medical products, such as medical consumables, medical devices, protective garments, medical vehicles and furniture, oxygen equipment, diagnostic testing equipment, and sterilization products, occupying a middle position in terms of imports and a position in the last third for exports (Eurostat, 2020). The pandemic has also shown strong dependencies in the global supply chains, which in case of global emergencies can become difficult to access. To cope with the pandemic health crisis, countries have banned exports of certain medical, sanitary, and food supplies (OECD, 2020a). In addition, the assessment of supply chains for much-needed vaccines has shown strong interdependencies between goods needed for vaccine production, distribution, and administration, with high geographical concentration, as 10 developed countries accounted for 80% of the global volume of vaccine exports (OECD, 2021). It is therefore of strategic importance to take measures to overcome such shortcomings and ensure self-sufficiency for both food and health security (WHO).

Renewal capital

Romania ranks last in terms of expenditure on R&D in the EU, with only 0,48% of GDP in 2019, compared to the area average, which was 2,09% (Eurostat) and the amount of public money spent on this sector has not changed significantly over the past years (Chioncel & Del Rio, 2018, p.10). As a consequence, it is not surprising that the number of patents submitted to the European Patent Office has been insignificant up to 2013 and dropped to 0 afterward (Eurostat, 2021; OECD, 2019b). The need for continuous

structural reforms, investment in R&D to increase competitiveness, and competent governance to ensure growth has become stringent especially after the 2008 financial crisis (Lin et al., 2014, p.83). The knowledge-based economy requires investments in education, ICT, and intangible resources such as R&D to foster innovation, as proven by the advanced economies, which excel in the creation and utilization of state-of-the-art technologies associated with Industry 4.0 (OECD, 2019b).

The number of people employed in R&D in Romania has drastically diminished (by half) since the beginning of the '90s, due to underfunding of the sector, the lack of perspectives, the brain drain phenomenon associated with migration, and also the ineffective and delayed public policies, while the private sector is less inclined to invest in R&D due to associated risks and limited financing options (Chioncel & Del Rio, 2018, p. 12). However, according to the available NIS data, the situation seems to have stabilized during the last few years, with medical research enjoying a slight increase, as shown in Table 4, unlike the decline in the number of researchers in engineering and technology. Most of the researchers currently employed are under 45 years old.

Table 4. Researchers numbers by gender, age and relevant fields

	2017	2018	2019
Total researchers	27,367	27,471	27,168
Male	24,266	24,561	23,721
Female	20,535	20,172	20,252
Researchers aged 25-34	3,808	3,881	3,962
Researchers aged 35-44	7,696	7,358	7,243
Researchers aged 45-54	5,540	5,631	5,735
Researchers aged 55-64	3,866	3,768	3,518
Researchers over 65 years	1,174	1,152	1,189
Engineering & technology researchers	12,371	12,817	11,936
Medical researchers	3,452	4,014	4,586

NIS, last available data

The University of Medicine and Pharmacy in Bucharest (UMFCD) has established several research centers and has launched projects with national or EU funding in areas such as bionanomaterials for treatment and diagnosis, smart digital systems for illness prevention and monitoring, etc (UMFCD). The University of Medicine in Iași (UMFIASI) has set up e.g. a Research Center in Bioengineering and Medical Biotechnologies and the Computer Simulation Center DentSim and Robodent, with EU funding. Both UMFCD and UMFIASI, as well as the University of Medicine, Pharmacy, Sciences and Technology in Târgu Mureș (UMFST) offer postgraduate studies in research fields such as biotechnology, bioengineering, and biophysics. UMFCD has established a partnership with Polytechnic University in Bucharest in the field of e-health technologies. Furthermore, UMFCD has recently established the Center for Innovation and E-Health (CieH), which gathers multidisciplinary expertise in four nuclei: Digital Solutions and Innovative Technologies, Big Data Analysis, Artificial Intelligence in Health, and Entrepreneurial Hub. CieH launched its activity with 3D printing training (UMFCD).

Discussion and recommendations

As argued by Roos (2017, p.745) national prosperity depends on a country's openness to trade and interconnectedness with the world, institutional infrastructure, good macroeconomic policies, an educated and skilled labor force, and innovation capabilities. These prerequisites can be achieved through the development of intellectual capital in all its components (human, structural and relational), which in turn lead to economic complexity, and therefore to national competitive advantage. To attain this, it is paramount to have competent, growth-oriented intellectual capital management and to support innovation.

The analysis of the national intellectual capital in the Romanian healthcare sector as presented in previous sections shows that, while certain areas are not functioning to standards or not performing fully, there are underutilized capabilities for development and innovation. Romania has an emerging economy that has been under stress from global events such as the financial crisis and the COVID-19 pandemic. The brain drain phenomenon followed by shortages of skills further aggravated the recovery prospects. It is estimated that 14.000 physicians have left the country mainly after the 2007 EU accession (Botezat & Moraru, 2020, p. 312). A survey conducted by the cited authors showed the three main reasons for leaving the country: the discontent with the pay scale, the lack of equipment in medical institutions, and the reduced opportunities for professional development.

The underfinancing of health, education, and research, together with an unbalanced healthcare system and the delayed digital transformation have restricted innovation and development. Apart from objective hardships, there have been also missed opportunities to access EU structural funds for development. In addition, Romania has not taken advantage of the wide broadband coverage and the cheapest internet service in the region. On the other hand, challenges bring with them chances for reformation and efficiency improvements. The global health crisis contended bureaucracy, minimal patient engagement, and the lack of transparency, under the pressure of providing optimal health services. Advanced technological solutions had to be quickly employed by all countries, to counter the resource shortages and to cope with public health needs. Nevertheless, authorities have to pay attention and find solutions to the socio-economic and digital divide, the healthcare access inequities between urban vs. rural and remote communities.

Based on the conducted analysis, several recommendations can be made:

- a) Public expenditure should increase at least incrementally in the next period in the health, education, and R&D sectors while enhancing spending efficiency by employing evidence-based management and financial controls. This should aim at developing human capital and lay the foundations for innovation in essential public sectors.
- b) Develop a patient-centered healthcare system to increase service effectiveness, by taking advantage of new technologies.

- c) Cross-sector collaboration in research and innovation should be encouraged, and the university-industry partnerships should be stimulated through supportive policies and specialized personnel, with the view to increase EU funding uptake. Such initiatives should be focused on boosting technological innovation in the healthcare sector.
- d) Governmental policies should stimulate private investment and entrepreneurship in the health sector, to raise the level of service quality, as well as service availability, through advanced technologies, related to the 4.0 Industry standards.
- e) Dissuade the brain drain through tailor-made policies and competence rewarding, as well as measures to favor brain return, for expert knowledge input into modernizing the process capital in the healthcare sector.
- f) Ensure medical security by diminishing dependency on international supply chains in strategic areas, while developing innovation capabilities and taking advantage of extant knowledge and facilities for medical research.
- g) Enhance digitalization, upskill digital competencies of medical personnel and deploy e-health services, by employing a targeted strategy to enhance access for disadvantaged communities.
- h) Establish strategies to increase health literacy and patient engagement by building trust and skills, while employing available new technologies.
- i) Build reliable health data and employ Big Data analysis to sustain performance and innovation in the public health sector.
- j) Improve transparency and public health communication, by employing new information and communication technologies.

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