

A new digital divide threatening resilience: exploring the need for educational, firm-based, and societal investments in ICT human capital

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Abstract

The knowledge, skills, and abilities that human capital offers create tangible and intangible assets that equip organizations to thrive. In particular, in today's Industry 4.0 environment, training, recruiting, and retaining highly qualified ICT-ready professionals remains a problem for many organizations including educational, governmental, healthcare, and business organizations. The COVID-19 pandemic revealed the importance of digital assets to our economies, and it is also demonstrating that there is potentially a new digital divide with even worse implications for companies, economies, and society, which is threatening the resilience of business, governance, and society. In this paper, we respond to the question "how can we develop ICT human capital in our global economy in an equitable, inclusive, and purposeful manner such that not organizations thrive, but also to promote social justice and equity in our global economy?"

KEYWORDS: Human Capital, Knowledge-Based Economy, ICT, Open Education.

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1. Introduction

Human capital is broadly defined as the knowledge, skills, and abilities an individual brings to the workplace (Kucharčíková, 2011). Combined, knowledge, skills and abilities create both the tangible and intangible assets that one can contribute to not only their workplace, but also to the broader society and global economy (Abdurakhmanova et al., 2020). Organizations invest in employees so that they can

provide not only essential organizational functions, but also so they might develop emerging products and innovations that bring forth business wealth and prosperity. But in today's Industrial 4.0 environment, developing human capital in Information, Communication and Technology (ICT) is not only important for organizational prosperity, but we also argue that it is essential for human survival. Though our global economy demands ICT professionals who innovate across industries and borders, the development of ICT-skilled workers is lacking (Sima et al., 2020).

ICT human capital is created in several ways including through formal and in-formal education, firm-based learning, and government-sponsored investment. The rapid pace of change in technological advancements creates a challenge within formal educational settings (Klochkova, 2020). Corporations invest in human capital in order to effectively compete, and as such, sharing knowledge broadly is not a priority of the corporation. Government-sponsored ICT learning

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suffers from limited funding and falls behind in timeliness of delivery and broad application while private sector training mostly targets individuals who are already employed thus excluding those who are lower educated, which reinforces inequalities (Bach et al., 2020).

In the next sections of the paper, we explore tools, practices, and knowledge-sharing techniques that can advance development of ICT human capital across the world. We argue that the global economy cannot thrive in Industry 4.0 without specific attention to fostering the knowledge, skills, and abilities of today's workers. Especially in the light of the current needs that the pandemic crisis is highlighting, economic well-being worldwide as well as creating equitable access to technology for all people is vital for the health and well-being of our global citizens. Developing those who can develop others' human capital is a first step toward creating a world where ICT is not a limiting factor for a nation or community. Additionally, we focus on the human element of ICT including resistance to ICT, lack of resources to develop ICT human capital, and the opportunities and outcomes of creating a global ICT human capital development initiative.

2. Human capital in a knowledge-based economy

Human capital is defined as the knowledge, skills and abilities workers bring to the workplace, and it can be developed through formal education, work experiences, on the job training, and self-learning. Becker (2002) discusses human capital in economic terms and expresses that human capital is considered an asset in organizations. In fact, an organization can capitalize on one's human capital in Becker's terminology. Human capital is a vital asset in society because societies need workers to hold knowledge, skills, and abilities to effectively do their jobs, meet work demands, and bring forth revenues and profits into our shared economies. When societies lack human capital, they experience higher risk of economic downturn as well as general societal risk such as safety, educational quality, health, communication, and technical capacity (Aluttis et al., 2014; Šlaus and Jacobs, 2011). Therefore, it is essential that global and national markets attend to not only the economic benefits of highly skilled labor, but also to the global benefits especially in relation to the environment, educational attainment, health, equity, and justice.

Several components underpin human capital, including knowledge creation, knowledge sharing, and knowledge hoarding. Nonaka (1994) was a pivotal force in our understanding of knowledge creation as he described the dynamic influences that encourage the factors that link tacit and explicit knowledge in organizations. Building upon Polanyi's early work

(1958; 1966), Nonaka defined tacit knowledge as that knowledge held within a human being and is utilized in their thinking, problem solving, creativity, and interactions with others. Tacit knowledge lives within us and it cannot be utilized by others unless it is shared, or codified, in some manner. Explicit knowledge, on the other hand, is knowledge that exists outside the human being as it is explicitly expressed, created, codified, shared, stored, and retained by those outside of the human being. Explicit knowledge can be searched and located by others either within or outside the organization.

When organizations, governments, educational institutions, and societies foster the creation, sharing and storage of knowledge, they create both tangible and intangible assets for our global society. Tangible assets are those that can be counted, stored, patented, or purchased and impact economic well-being of organizations, cities, and nations. Tangible assets are explicit, meaning they can be utilized in economic, structural, and throughout organizations and society. Intangible assets, however, are those that cannot easily be counted. More like tacit knowledge, intangible assets might be the knowledge that exists in the minds of workers, the creativity expressed by workers, or the interactions that occur within an organization that drive business success. Nonaka's inventive work helps us to see that intangible assets can be converted to tangible assets if an expressed effort is made to do so through knowledge sharing and knowledge conversion.

Knowledge sharing and knowledge conversion are actions that encourage broader use of knowledge. Imagine a team working to solve a complex problem. Each of the team members brings tacit and explicit knowledge to the situation, and through team interactions, knowledge is shared. At a deeper level, team dialogue emerges, and the team begins to adapt existing knowledge into new solutions. In the thoughts of Nonaka, a symbiotic interaction of conversation, dialogue, and eventually naming new knowledge through metaphors, the team continually fosters knowledge creation, knowledge sharing and knowledge conversion. New knowledge is linked with existing knowledge, and the team begins to document, codify, and experiment with this new knowledge. In an open and trusting organizational system, knowledge becomes an asset that is fostered through interdependence and sharing.

In organizational and broader society, however, knowledge is often hoarded, meaning trade secrets, practices and artifacts are held closely within the individual and the organization (Husted & Michailova, 2002). We ask: "why do individuals hoard knowledge, and how does individual knowledge hoarding impact organizations, nations, and society hoard knowledge?" At an even deeper level, "How might knowledge hoarding create economic disparity, injustice and place the global economy at risk, especially in our Industry

4.0 revolution?". If knowledge is an asset, and assets create organizational value, then it is likely that in competitive environments, one is not inclined to share knowledge widely. Often, individuals seek knowledge for their own personal and professional gain, they find the knowledge or solution that they understand most clearly, or they find a solution to a problem that might not be optimal for the organization or broader society (Husted & Michailova, 2002). But, when knowledge sharing is a systematic process, the resistance and errors associated to knowledge sharing are diminished. When individuals are rewarded, acknowledged, and reinforced to share knowledge, knowledge sharing is likely to increase and even sustain over time.

In terms of Industry 4.0, knowledge sharing occurs when organizations, communities, and nations build a knowledge sharing practice whereby global partners thrive in all sectors including health, education, business, and governments. To build this channel of knowledge sharing, our global society needs to understand the notion that creating skilled labor who captures, codifies, stores and shares knowledge at the global level is of benefit to all. Doing so can alleviate global injustices due to lack of knowledge, resources, tools, technology, and outlets. In Industry 4.0, it is essential and just that global citizens have access to knowledge. Knowledge and skills are key to acquiring new scientific and technological expertise and to building an economy's capacity to use this knowledge. Investment in R&D is a vital factor in human capital because it supports the generation of knowledge and the development of skills in highly qualified human resources, which are needed to increase competitiveness. Patterns in R&D investment between countries generally mirror the industrial structure of economies, differences in the knowledge intensity of sectors and their research capabilities.

3. ICT-human capital for navigating the COVID-19 pandemic

Industry 4.0 is based on cyber-physical systems, cloud manufacturing, cyber security, big data analytics, artificial intelligence and emerging technologies that are advancing at a very fast pace while also bringing new requirements for the manufacturing workforce. Intelligent data collection and interpretation as well as effective and timely decision-making play an important role as a result of the use of state-of-the-art technology. Big data capabilities and smart predictive decision support tools are used to increase productivity and efficiency, increasing the speed of the processes, and reducing the number of problems and the downtime (Kicová, 2019). The advantages of Industry 4.0 can be summarized in the increase of economic efficiency, labor productivity, flexibility, and intelligence, while at the same time achieving a reduction in production costs

and increasing returns on investment. The World Economic Forum's study (The future of jobs, 2016, <https://www.weforum.org/reports/the-future-of-jobs>) forecasted that 5 million jobs will be lost before 2020, however, some 2.1 million new jobs in more specialized areas such as engineering, mathematics, computing, and architecture will be created. Therefore, it is necessary to introduce new, flexible concepts in skills training with future-ready curricula to adapt the education system to the new development requirements of the society. Human capital can offer significant impact in this work and will facilitate a redirection of jobs and learning.

The labor market is undergoing remarkable changes in the context of technological changes, but this requires the expansion of human capacities so that people are empowered and equipped to bring about change. Investment in access to high quality education and increased enrollment in science, technology, engineering, and mathematics (STEM) programs is therefore needed. The educational profile of human capital is changing, and new approaches to education systems are emerging (Cotet et al., 2020; Carbonaro, 2010, 2019; Andronico et al., 2004). Indeed, the ability of education and training systems to anticipate and adapt to changing skills demands will require high-quality basic education that provides the fundamental skills to enable people to embrace change, take advantage of emerging job opportunities and engage in further learning. Additionally, we must facilitate dynamic learning throughout one's working life cycle to ensure that we not only sustain, but also advance digital and technological skills as well as other drivers of change to ensure productively engagement in work. Emerging patterns of employment using new technologies are evolving, and they are changing traditional job tasks in support of global and digital production and leading us towards part-time, temporary, on-demand, etc. jobs. The way of working is changing with the integration of office work, smart working, coworking, crowd-design/crowdsourcing, physical and virtual spaces, digital marketing, and new hi-tech internet-based services. The Covid-19 pandemic has radically altered and accelerated the spread of flexible forms of work, and the change companies have been forced to implement will have medium and long-term impacts. All 'agile workers' have undergone a rapid maturation as they have had to learn to fend for themselves, download applications, discover new features, and solve the problem, which we had never faced before. We accomplish in three months work that would have previously taken years of effort. For example, today more than 8 million people in Italy perform tasks that could be done remotely (Bonacini et al., 2021).

Similarly, the revolution in the labor market is revolutionizing what is required of schools and universities, leading to an ever-increasing demand for scientific and technological skills. But this increase in

demand is often not matched by an adequate supply of vital training and education, which results in a lack of viable job candidates. The aim must be one -to find solutions to direct educational aspirations and investments toward a STEM education pathway. Consider that a large proportion of today's human capital is comprised of millennial or Gen Y (born between 1980 and 2000) and GenZ (born after 2000) employees who were born in the age of the internet, social media, and smartphones. They bring different expectations to their employers, such as anytime, anywhere collaboration, instant feedback, open culture, and data-driven decision-making.

But inequalities in opportunities must be globally eliminated to expand human capabilities. While more than 90 percent of children in the world today receive some schooling, fewer than half of those in school achieve minimum proficiency in reading and mathematics when they complete primary school. In addition, over 3.7 billion people do not have access to the Internet or STEM programs, women are lagging and make up only 35 percent of post-secondary student population. Increasing the number of women in science could provide greater job security and well-paid jobs as well as create equity in STEM-based jobs. Empowering women in tertiary education and enhancing their employment opportunities in the R&D sector should be also an essential part of the research and innovation policy and a key element of the Horizon 2020 program. By building awareness and creating promotional activities that help young women nurture their ambition to work in innovation and technology while also enabling them to succeed in the digital economy throughout the world would yield positive results. A positive perspective of oneself, starting from childhood, allows one overcome stereotypes and gender inequalities and can contribute to a real cultural change with respect to the educational choices of girls. This objective can be achieved through a viable network concept in which the various educational contexts collaborate constructively. For example, initiatives that involve partnerships between educational institutions (e.g., schools, teacher training, universities, training centers, research institutions, the private sector, and active community support) can help spread, accelerate, and sustain development of innovations in education through new ideas and unexpected inspirations, increased financial possibilities, credibility, and improved human capital. Family, school, and societal levels must act jointly to promote and facilitate multi-sectoral collaboration and partnerships.

4. Opportunities and Outcomes of a Global ICT Human Capital Development Initiative

Over the past few years, our planet has been pushed into a compulsory "digital metamorphosis", a true collective experiment launched without strategy or parachute. Despite some progress, the digital divide has not disappeared. The new digital divide has become even more dangerous because pockets of social, educational, and professional exclusion have been exacerbated between those who are online and those who are not. With vision, effective actions, and joint efforts between the public and private sectors, it is possible to increase the digital heritage in a process that benefits everyone. First, a paradigm shift is needed.

More or less advanced instrumental literacy in the use of technologies spanning a theoretical approach to digital literacy and with early studies underlining the functional and instrumental understanding of digital literacy focusing on one's technological skills to operate and use ICTs is not enough. Children and young people need to be offered analytical and even critical digital skills as a key element in acquiring and consolidating knowledge and skills in a fluid, overlapping, and interactive way. Adults need an awareness of digital technology as a resource for the individual and the community in terms of shared knowledge, collective intelligence, and conscious citizenship, overcoming the barriers between hyper-specialized experts and 'normal' users who are called upon to take on the sometimes-exhausting challenge of self-learning. There is also a need to develop a broad, transdisciplinary, cultural framework to overcome the tendency to uncritically adopt the latest digital innovation and to also build cultural awareness of this innovation. The tools in use today will certainly be obsolete in a few years' time, and perhaps so will the relevant skills. What will never grow old, however, is the understanding of knowledge that is much broader and more articulated than a single device.

A long-term, national, strategy should generate knowledge outside academic environments to the benefit of social, cultural, and economic development, the so called 'third mission' (Loi & Di Guardo, 2015). The university and the knowledge creation that it facilitates, either through its own research, in its learning environments or through its innovation activities, should be central actors in the circulation of ideas and know-how. This cannot happen unless Higher Education Institutions (HEIs) include engagement with business and communities in their core functions, and act as catalysts of these processes. HEIs who embrace digital technologies can have an important role in helping firms (OECD, 2019, <https://www.oecd.org/skills/launch-of-2019-skills-outlook-thriving-in-a-digital-world-paris-may-2019.htm>). Facilitating access of businesses to research with high innovation potential is an important

contribution of the university to regional and national innovation. Start-ups, spin-offs, competency centers, research areas centers and national and regional science parks can acquire the initial know-how, equipment, and funding to test new technologies and scale-up new products and services linked to new the re-search results in the digital field (OECD, 2019). For HEIs, collaborative research and research grant income generated through research cooperation constitute a substantial and fast-growing proportion of institutional research and of its funding base. Accordingly, they may support a wider ecosystem formed by firms, institutions, and stakeholders, by providing consulting and services of new technologies, best practices, and opportunities of digital transformation (Kowal and Paliwoda-Pękosz, 2017). A well-functioning R&D system is important also to promote excellence in education and skills development.

Open education and massive open online courses (MOOCs) offer important new sources for knowledge and skills development across life. These dedicated Internet platforms represent an opportunity for digital learning because access is usually free, and students have the option to fund their own learning if they decide to invest in the certificates that recognize their enrollment and acquisition of knowledge. The development of MOOCs is one of the most prominent trends connected to the digital transformation of HEIs and can be of great interest and value to digital native students. Open education is primarily used by those who combine work and formal education as well as those who are employed but who are not engaged formal education. Therefore, open education seems to be a promising way to facilitate workers' lifelong learning, yet little is known about their standards and learning outcomes in terms of skill development, patterns of participation, and how to reproduce and sustain learning quality long term. Limited information exists regarding who engages in MOOCs and the impact they have on skill and knowledge development.

For example, MIT and Harvard University offered 2000+ online courses and enrolled more than 20 million learners, giving credence to how MOOCs are used and by whom (Kaur & Kaur, 2020). This data suggests that highly educated and skilled adults are more likely to participate in informal learning opportunities in an attempt to "skill up" in technical areas.

Digital technologies offer another important opportunity to contribute to open science in that open access to scientific publications and data provide an opportunity for science to become more inclusive. With greater access to open science to all, scientific results are available to the broader society, ensuring high-quality scientific publications and opportunities for authors to publish reputable journals (OECD, 2019). Additionally, implementation of open science principles increases the rigor, reliability, and reproducibility of scientific results (Cockburn et al.,

2020). In response to the COVID-19 pandemic, many publishers have increased opportunities for open science practice, and many researchers have contributed knowledge to open science which helps to optimize research efficiency and improve health outcomes.

Once again, the pandemic has offered us the opportunity to understand how it stimulates global scientific collaboration and the value of open science in an unprecedented way. It also highlighted the shortcomings of science policy and has accelerated many research trends already underway. The COVID pandemic has further increased access to data and publications, the use of digital tools, enhanced international collaboration, stimulated a range of public-private partnerships, and encouraged the active engagement of new actors. These developments could facilitate the transition to more open science and innovation in the long term. Similarly, it is now vital that social entities including governments, businesses, universities, and training centers each develop field-based action plans that encourage us to effectively manage these dynamics as well as exploit new opportunities offered through them rather than becoming overwhelmed by them.

For example, Artificial Intelligence (AI) is an approach to creating human capital aimed at supporting human capability (Popkova & Sergi, 2020). We suggest the possibility of obtaining optimal results by implementing the use of Artificial Intelligence system-wide, which can be effectively and profitably utilized in multiple sectors including health, education, judiciary, security, and the public administration of a country. We understand that this effort creates many challenges including ethical to technological, but above all, the need to have the appropriate digital skills to implement AI to raise our collective knowledge is worth our attention and energy. We suggest that Artificial Intelligence can become a tool reduces inequality and promotes inclusion.

Existing legal policies not only need to be adapted and applied, but they also need to provide dynamic legal mechanisms to preserve as well as anticipate risks that could emerge through the application of new AI systems. Complicating the challenge is a growing mismatch between the exponential growth of the AI market and a delayed regulatory response (European framework on ethical, 2020). Yet, as data-driven and machine-learning approaches begin to play an increasing role in society, thoughtful and detailed strategies on how we can share the benefits as well as achieve the best possible impact all while effectively managing risks is essential. Without proper management of such data that ensures quality and compliance, AI systems might become too risky to be entrusted when making consequential decisions.

To attend to this concern many organizations are utilizing data governance to exercise control over the

quality of their data and their processes. The concept of trustworthiness refers to properties through which a trusted entity is serving the interests of the trustor (Levi & Stoker, 2000). This process reinforces the use of sound information and fosters trustworthy decision-making processes.

Recently, the field of trustworthy AI has been gaining attention from the government and different scientific communities. The International Organization for Standardization, The European Union, The National Institute of Standards and Technology and The U.S. Government Accountability Office have offered varied approaches, ethical guidelines, and frameworks that can establish trust in AI systems. By adopting the properties of fairness, transparency, accountability, and controllability, trustworthy AI is more likely to govern and facilitate the development of and effective use of AI systems (ISO 2020; European Commission 2018; NIST, 2021; US GAO, 2021). The EU also recently passed a law called General Data Protection Regulation (GDPR), which gives individuals the “right to explanations” for AI decisions (Watcher et al., 2017). The Defense Advanced Research Project Agency (Gunning, 2017) also launched a program known as Explainable Artificial Intelligence, whose motive was to make these AI systems explainable and trustworthy. Gartner estimates that 30 percent of all AI-based digital products will require the use of a trustworthy AI framework by 2025 (Burke et al., 2020), and that 86 percent of users will trust and remain loyal to companies that use ethical AI principles (Edelman Trust Barometer, 2019). These examples illustrate the necessity to develop AI systems using a trustworthy framework and how vital trustworthiness is for both the success of AI systems and the safety of users and society. In all, to make knowledge accessible and trustworthy, AI becomes a viable asset globally not only for our corporations and governments, but also for formal educational systems as well as individual learners across the globe. Through the safe use of AI, human capital can be universally developed for the advancement of individuals, communities, and the broader society.

5. Conclusion

A new digital divide can threaten the resilience of people and business resulting in important implications for economies and society. The challenges are many and include the loss of competitiveness, inclusion/exclusion, and poverty, and new sources of social pressure globally. The COVID-19 pandemic revealed even more clearly the importance of digital assets to our collective and individual economies. It has also highlighted the importance of basic and advanced digital skills that ensure sustained and sustainable growth and development of our economies and

societies. Today, in addition to digital assets, organizational assets include also human capital. This paper focused on current human challenges amid COVID-induced technological challenges as well as how we create a future where digital workers learn, grow, and thrive and advance technological capacity in the workplace. We also offered a systematic tool to guide and inform policy makers, researchers, civil society, and the private sector to collaborate on different aspects of policies to promote knowledge-based societies and close knowledge gaps is the Global Knowledge Index (GKI). We reinforced an urgent, global, need for increased investment in R&D and suggested innovation as a means to advance the frontiers of knowledge for sustainable development. The goal is to provide the scientific and technical solutions needed to meet global societal challenges such as climate change and clean energy, active and healthy ageing, and to drive rapid progress in agriculture, consuming goods, and transport. The EU, with its Horizon 2020 R&D program, is helping this process by providing almost EUR 75 billion of funding for research projects aimed at addressing societal challenges, generating excellence in science, and promoting industrial leadership. Investments such as this in R&D stimulate innovation, which contributes to industrial competitiveness and job creation. We hope for greater investments such as these in the future.

An area of particular need for greater development of ICT-HC is to prepare individuals who can develop others' human capital through both formal and informal education. To obtain global economic wellbeing and to provide equitable access to technology for all global citizens, both human capital and technology are essential. We suggest it is imperative to create greater access to learning, information, knowledge, and education. The emergence of MOOC platforms, open education and open science, new digital teaching methods, together with the development of new technological infrastructures, are each development that are already changing the practices and the processes in which HEIs accomplish their mission. The risks facing our least developed countries in relation to indicators on education and training levels are great, but not all workers are equally impacted. With only 16 percent of university graduates at risk losing their jobs when compared to 45 percent of workers who have not completed higher education, it is essential that learning becomes universally democratized. If we are to solve our global problems, we need learners and workers across the globe equipped to meet the requirements of the Industry 4.0 era.

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