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ORIGINAL RESEARCH ARTICLE

Digital literacies as policy catalysts of social innovation and socio-economic transformation: Interpretive analysis from Singapore and the UAE

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ABSTRACT

Even before the COVID-19 global pandemic, the world saw the adoption and proliferation of numerous digital tools and technologies, or a global digital transformation. This paved the way for digital inclusion, particularly through e-commerce and shared services platforms which helped to reduce barriers to entry and created abundant socio-economic opportunities across income groups. As a result, digital literacy becomes a vital aspect of modern life due to the rapid global shift toward this digital transformation. Numerous scholars have investigated the benefits of digital literacies since 1995. The primary objective of this paper is to investigate good practices and lessons learned on how digital literacy may serve as a policy instrument for social innovation and socio-economic transformations. The empirical approach is interpretive, through an understanding of digital literacy categorized into three primary pillars: (i) the evolution and foundational concepts of digital literacy, (ii) frameworks and measures of digital literacy, and (iii) the capacity and skills associated with digital literacy. The paper also examines how digital literacy capacity and skills shape social innovation initiatives in Singapore and the UAE, impacting the socio-economic transformation of individuals, families, and communities. Our interpretive approach from field observations and policy implementation, offers a multi-dimensional perspective on digital literacy research, and its socio-economic impact on people and communities. These insights can assist researchers new to this field to gain a more thorough understanding of digital literacy's broad ecosystem and its extensive impact on communities and nations as a key driver of socio-economic change.

Keywords: digital literacy; social inclusion; social innovation; socio-economic transformation; Singapore; United Arab Emirates

1. Genesis of digital literacy

In 1995, Lanham[1] first conceptualized digital literacy as the ability to comprehend information,

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regardless of the digital medium in which it is made available, conveyed, or communicated. He describes how literacy has developed from its traditional definition of the ability to read and write, to a more culturally relevant concept of "the ability to understand information, however, presented". It soon emerged as the conceptual hallmark of the wider notions of digital inclusion and engagement[2].

What is particularly significant about his interpretation of digital literacy is that he examines it in terms of its communicative medium and the user's ability to navigate between the various online and offline mediums. He posited that digital literacy enables us to "match the medium we use to the kind of information we are presenting and to the audience, we are presenting it to", stating that "digitally literate" people are "quick on [their] feet in moving from one kind of medium to another… they know what kinds of expression fit what kinds of knowledge and are skilled at presenting [their] information in the medium that [their] audience will find easiest to understand". Beyond encoding, Lanham also looked at digital literacy as the ability to decode, where those who are digitally literate are "skilled at deciphering complex images and sounds as well as the syntactical subtleties of words". Again, this demonstrates the communicative function of digital literacy, as well as an adherence to the context through which one chooses the medium, or to understand the information given within the choice of medium.

Since this original conceptualization, the term digital literacy has evolved along with pervasive Information and Communication Technologies (ICTs) in society. While Lanham created awareness of the need to comprehend the transformations brought about by the incorporation of ICTs, it was Gilster[3] who popularized the concept of digital literacy and its emergence as a critical skill.

Gilster's portrayal of digital literacy as "mastering ideas, not keystrokes"[3], positioned the concept to focus more on cognitive ability, as opposed to competencies. This altered the perception of digital literacy from a technical skillset to its focus on cognitive ability and information processing and was considered to be a milestone. As society rapidly digitized, network effects arising from social media led to the development of social capital as a socio-economic advantage. Gilster's definition of digital literacy almost seems straightforward, as he states it as "the ability to understand and use information in multiple formats from a wide variety of sources when it is presented via computers"[3]. Based on his definition, he highlights four key competencies of digital literacy: (i) Internet searching, (ii) hypertext navigation, (iii) knowledge assembly, and (iv) content evaluation. However, Gilster's definition of the term "digital literacy" has been critiqued for being too narrow, where it limits digital technologies to computers, and competencies focused on computer-based literacies.

One of the key arguments that Rassool[4] makes is that unless society adopts new definitions of literacy, the social and cultural basis of development runs the risk of being undermined, which would then impact the quality of civil society that provides the basis of the democratic process for digital literacy. Civil society refers to the informal organization of social life (going beyond the direct control of the state). It serves as an arena in which people can exercise pressure and restraint on the state and thereby strengthen the assumptions and practices of democratic self-management. The importance of cultivating a literate, knowledgeable, and active civil society is to (i) regulate internal inequalities, (ii) interpret and analyze inequalities that are externally imposed, (iii) have adequate levels of communicative competence to build links with international pressure groups, and (iv) be able to interact effectively within the re-defined textual environments provided by information technology. All these requirements of knowledgeable and active civil society abilities cannot be adequately emphasized. In this regard, links with social knowledge play an important role in influencing how people would be able to give meaning to the multiple conceptual worlds in which they live: "Literacy can no longer be divorced from its knowledge base, as a mode of discourse and its links with social structures"[4].

Literacy is so highly regarded and is often considered one of the greatest socioeconomic equalizers because it has the power to enable participation, the power to allow communication, and the power to create meaning[2,5]. Rassool[4] makes a very powerful statement in this regard: if programs of basic literacy within the framework of universal primary education remain the basis of educational policy and provision within these societies, it could mean that social and technological inequalities between the developed and the developing world would be created and sustained—through the model of learning advocated and supported financially within these societies[4]. To contextualize this statement, it was made in 1999, even before technology had come to have the pervasive effect that it does on lives, communities, businesses, and organizations today. If her work was important at that time, it is even more so now for imparting digital literacy to bridge the knowledge disparity gap and enable sustainable development, particularly for marginalized or at-risk groups or communities.

Eshet[6] describes digital literacy to consist of specific types of literacy. While there is an overlap between his work and Martin's work[7], he appears to focus on literacies primarily as information-providing skills for the digital era. His five specific literacies are (i) photo-visual literacy, or the ability to understand visual imagery; (ii) reproduction literacy, or the ability to repurpose media for one's use; (iii) information literacy, or the ability to seek, evaluate and synthesize information; (iv) branching literacy, or the ability to navigate webpages; and (v) social-emotional literacy, or the ability to behave appropriately and engage safely online. Of these five digital literacies, four of them are largely based on specific digital skills. In contrast, socio-emotional literacy is of particular interest. The definition of socio-emotionally literate users offered by Eshet[6] is individuals who can work with others, sharing and evaluating information and knowledge, to construct new knowledge. This refers to the participation and communication that occurs in the digital world, as well as opportunities offered via this medium. Where participation leads to collective intelligence, new knowledge may be developed. Through socio-emotional literacy as a digital literacy skill, the Internet and media can provide a new cultural environment, with its unique values and practices for social engagement.

Tornero[8] takes a different approach and examine digital literacy in various dimensions. They propose four dimensions involved in digital literacy: (i) operational, which is the ability to use computers and communication technologies; (ii) semiotic, which is the ability to use all the languages that converge in the new multimedia universe; (iii) cultural, which describes a new intellectual environment for the information society; and (iv) civic, as a new repertoire of rights and duties relating to the new technological context.

The socio-cultural dimension of digital literacy is further discussed by Bélisle[9]. Although her work focuses on a re-conceptualization of literacy and not merely digital literacy, Bélisle's research is important as it explains the changes to society as a result of the digital knowledge revolution. In fact, it could be said that Bélisle[9] truly grasped the essence of changes to the concept of literacy within the digital society. Bélisle[9] examines three dimensions of literacy: functional, socio-cultural, and transformational. Functional literacy refers to the basic skills required for day-to-day living. In the conventional sense, this refers to the skills of reading, writing, speaking, and listening. In relation to digital literacies, this includes the ability to perform operational computer skills, such as information input, output, and searching, as well as the ability to understand their applications, such as in medical signal processing and image processing and their employment in medical diagnostics. This dimension of digital literacy could be read in parallel with Lanham's original concept. Function becomes the foundation of literacy but does not necessarily develop abilities in literacy.

Bélisle's second dimension of literacies is socio-cultural. Literacy ultimately serves to address a purpose; it "[gives] access to, and understanding of, the structures of power and authority through mastery of written texts and numbers"[9]. Socio-cultural literacy includes knowledge of a society's values, attitudes, practices, and conventions, along with an understanding of where each of these applies. This is important in relation to digital

literacy, as the digital world provides new channels for participation and communication. Literacy is only meaningful when contextualized to the cultural fabric of society; the socio-cultural dimension of digital literacy enables individuals to comprehend and participate in the social and economic structures of a digital society.

The final dimension which Bélisle describes is the transformational dimension of digital literacy. This "brings a profound enrichment and eventually entails a transformation of human thinking capacities"[9]. The individuals' intellectual empowerment through literacy may have the power to transform society, especially where creative cognitive ability leads to the creation of new cognitive tools[9]. If Bélisle's transformative digital literacy is viewed alongside Eshet-Alkalai's socio-emotional literacy, the online world opens up new opportunities for collaboration and creation. This ultimately brings new knowledge to society, transforming it and those within it.

What is interesting is that Bélisle's model can actually be seen to parallel Martin's ages of ICT literacy model. The mastery phase can be compared to the functional model; the application phase to the socio-cultural model; and the reflective phase compared to the intellectual empowerment model, in terms of how our knowledge of technology and its applications has brought about changes in the way we think and participate in providing new technological information in society.

To explain this slightly more in-depth, Bélisle discusses how cognitive ability has transformed in accordance with digital cultures. In Oral cultures, where listening is the main access to existing knowledge, the dominant cognitive activity is memorizing. In writing cultures, where knowledge is accessed by reading, the dominant cognitive activity is memorizing, including organization of information and textual interpretation. In today's digital cultures, search engines, information-processing tools, data-mining tools, and knowledge-discovery tools allow access to knowledge, implying that the dominant cognitive activity is information structuring, knowledge processing, and the construction of meaning.

Recall that the primary objective of this paper is to investigate good practices and lessons learned on how digital literacy may serve as a policy instrument for social innovation and socio-economic transformations. With the above introduction to digital literacy as a policy concept, the remainder of this paper is organized as follows: Section 2 provides a review of digital literacy research. Section 3 delves into measurement frameworks that assess the impact of digital literacy. Section 4 examines how digital literacy may be a significant contributor to social innovation and well-being. Section 5 examines good practices and lessons learned from two diverse case studies of effective digital transformations—namely, Singapore and the UAE. The paper concludes in Section 6, with a synthesis of key findings and implications for research and practice.

2. Background review

The extant literature on digital literacies draws on multiple facets of digital lifestyles, including culture, engagement and citizenship. Expounding on the various aspects of digital cultures, several related literacies are spawned: digital literacy, computer literacy, among other related literacies. This demonstrates our changing relationship to knowledge, where AI machines deal with information, and users deal with knowledge-related activities, whilst extending knowledge processes through knowledge tools that analyze and synthesize information.

The changing attitude towards digital technology is best examined in the 3 phases of computer and ICT literacy, as described by Martin[7]. In the mid-1980s, the relationship with technology positioned the computer as "arcane and powerful", meaning that in terms of computer literacy, emphasis was placed on gaining specialist knowledge and skills to master it.

In the application phase from the mid-1980s to 1990s, the computer was seen as a tool that could be applied to different segments of everyday life, meaning that ICT literacy focused on practical competencies and the ability to use application software. From the late 1990s, when Gilster's text was written, this was identified as the period of the reflective phase. The transformative capacity of digital technology created a synthesis between the different life segments. Technologies no longer were limited to specific life segments but flowed through and between them, becoming increasingly incorporated into everyday lives. Thus, there was a focus on more generic skills in terms of ability. However, there also came a realization that it was no longer possible to limit these new literacies to simply "computer literacy".

The main confusion around "computer literacy" was the divide between "literacy" in terms of culturally-valued knowledge, and "literacy" as being bound up with the skills of reading and writing. Both knowledge and skills are elements that need to be dealt with explicitly in any definition of literacy. The term computer literacy conflates procedural knowledge about how to use a computer, and the ability to use a computer in creative and communicative activities. This overlooks the fact that being able to use a computer to access knowledge and media is different from using a computer to create knowledge and media.

Generally speaking, "computer literacy" has acquired a "skills" connotation, implying competency with computer applications, such as word processing, the ability to use an online search tool, and e-mail. Literacy is too modest a goal in the presence of rapid change because it lacks the necessary "staying power". As technology changes by leaps and bounds, existing skills become antiquated and there is no migration path to new skills. A better solution is for the individual to plan to adapt to changes in technology.

A most recent and inclusive definition from Margaret Rouse in Technopedia (10 July 2023): "Digital literacy is the ability to use technology to find, evaluate, organize, create, and communicate information safely and responsibly. The concept, which applies to individuals, societies, and economic groups, encompasses skill sets that may also be referred to as computer literacy, ICT literacy, data literacy, or data fluency." In the same Technopedia contribution by Rouse, functionally, digital literacy and fluency capture the abilities tabulated below.

Box 1. Digital literacy & fluency identified by Rouse in Technopedia.

- Understand and manage their own digital identity and digital footprint;
- Locate and use information from a variety of sources;
- Assess the credibility of online information;
- Create and share digital content, such as documents, presentations, and videos;
- Use communication and collaboration software effectively;
- Gather, read, interpret and discuss quantitative data as a source of information;
- Operate digital devices safely and securely;
- Understand the fundamental concepts, technology, and functionalities of blockchain and cryptocurrencies;
- Understand the ethical implications of social networking use and misuse;
- Use technology responsibly to participate in online digital communities and engage in civic discourse;
- Understand the ethical implications of generative AI use and misuse;
- Navigate the complexities of online applications for telehealth and online government services;
- Navigate the complexities of decentralized financial (DeFi) insurance services and lending platforms.

Hence, it is undeniable that digital literacy affords the individual, organization or society the competitive ability to create and capture value in the knowledge economy. It empowers digital nomads as well as functioning in the metaverse. In the following subsections, these concepts are elaborated in the context of social innovation.

2.1. Digital literacy and its subsets

Some theorists thus position digital literacy to consist of computer literacy amidst other literacies. Martin[7] is one such theorist, focusing on five types of literacies as subsets of digital literacy: (i) technological

literacy; (ii) information literacy; (iii) media literacy; (iv) visual literacy; and (v) communication literacy.

Technological literacy emerged in the 1970s as a response to two very different concerns: (i) the growing awareness of the enormous potential dangers of technological development for humanity; and (ii) the growing fear that ignorance of developing technologies would render the workforce vulnerable to competition from countries with greater technological awareness. Technological literacy thus straddles both a skills-based vocational approach (with a preference for a behaviorist pedagogy) and the other a critical, action-oriented "academic" approach (a liking for a more constructivist pedagogy).

According to the Society of College, National and University Libraries (SCONUL) in the United Kingdom, information literacy focuses on seven "headline skills":

1) Recognizing an information need;
2) Identifying ways in which an information "gap" can be addressed or fulfilled;
3) Constructing strategies for locating information;
4) Locating and accessing the information sought;
5) Comparing and evaluating information obtained from different sources;
6) Organizing, applying, and communicating information; and
7) Synthesizing and building upon the information. (Adapted from the study of Bent and Stubbings[10])

In summary, information literacy has tended to focus on the ways in which information is accessed, evaluated, and used. As technologies and media tools developed, interest in and concepts of media literacy surfaced.

Media literacy developed from the critical evaluation of mass media, and describes the ability to access, analyze, evaluate, and communicate information in a variety of forms. It served as a response to the complex, ever-changing electronic environment and communication mediums that surround us, focusing on the nature of various genres of medium and the way in which messages are constructed and interpreted (the characteristics of the author/sender and the receiver are crucial in understanding the meaning of the message and its content).

Visual literacy enables everybody, not merely the artistic elite, to engage with the visual aspects of culture. It gives access to a common body of information, enabling cultural communication. This is especially considering visual images as a powerful medium for the interpretation of information and the communication of meaning, in science as well as arts, and in dealing with the exigencies of everyday life.

Communication literacy underlines the importance of communication as a human activity and as the basis of social interaction. It is seen as a basic personal attribute, whether mediated orally or digitally.

There is considerable overlap between and among the five literacies outlined above. In some cases, the definitions of the different literacies are almost identical, and only nuanced in different directions, because of their diverging pathways from pre-digital foci, and their focus on the concerns of the particular community whom they have developed to serve. Part of the convergence also involves the evolution of literacies from skills focus with regard to applications, towards a concern with critique, reflection and judgement, and the identification of generic cognitive abilities or processes, as well as meta-skills. Even so, this discounts how these literacies exist outside of the digital realm, viewing them entirely through the lens of digital literacy and subsequently, the digital medium.

Even while Martin[7] looked at digital literacies in terms of these different abilities, he still focused on five key elements:

1) Digital literacy involves being able to carry out successful digital actions embedded within work, learning, leisure, and other aspects of everyday life;

2) Digital literacy for the individual, will therefore vary according to their particular life situation and will continue to develop as the individual's life situation evolves;
3) Digital literacy is broader than ICT literacy, and will include elements drawn from several related literacies;
4) Digital literacy involves acquiring and using knowledge, techniques, attitudes and personal qualities, and will include the ability to plan, execute and evaluate digital actions in the solution of life tasks; and
5) It also includes the ability to be aware of oneself as a digitally literate person, and to reflect on one's own digital literacy development.

As evident, these qualities exist within the previously described forms of literacy, but these appear to be less medium-based, and more aligned to the "reflective" phase which they exist within. While there are numerous perspectives, Bawden's[11] definition of digital literacy draws on Gilster's[3] ideas, stating that digital literacy is about (i) the ideas and mindsets within which particular skills and competencies operate, and (ii) information and information resources, in whatever format they exist. His identified key skills of digital literacy include knowledge assembly, building a "reliable information hoard" from diverse sources, retrieval skills, critical thinking for making informed judgments about retrieved information, wariness about the validity and completeness of Internet sources, reading and understanding non-sequential and dynamic material, awareness of the value of traditional tools in conjunction with networked media, awareness of "people networks" as sources of advice and help using filters and agents to manage incoming information, and being comfortable with publishing and communicating information, as well as accessing it[11].

2.2. The information society and knowledge economy

Later in this paper, we make the claim that digital literacies are accelerators of social innovation and catalysts for socio-economic transformation. This was known as the information society thesis, and since the term is out of fashion, scholars refer to it as the knowledge economy[12,13]. Perhaps it would be best to introduce the concepts of the information society and knowledge economy in this section. The term "information society" is relevant to demonstrate the abundance of information made available in today's society through digital technology and the Web. In enabling the production of online content even by users with limited technical skills, Web 2.0 has incited a profusion of content, made available through online collaboration and collective intelligence.

As phrased by Lévy[14], "no one knows everything, everyone knows something, all knowledge resides in humanity". Such is the reality of digital literacy. In enabling more users to publish content, an increasing amount of information sources has been made available on online platforms, creating access to the sum of expertise within the community. A subset of digital literacy should be to enable access to these information-rich platforms and allow participation within the information society. However, access to information is insufficient to bridge the knowledge disparity gap.

Modern society exists as a "knowledge economy", an economic system where a dollar value is placed on knowledge and ideas as commodities, over goods and services. The knowledge economy stems from the information society, as economic value is ascribed to the users within an information society who are able to critically engage with information, rather than those who simply accept it at face value. Castells[15] states that access to information technology and the ability to use it is essential to production in the knowledge economy, where "value lies in producing knowledge and processing information". Indeed, Castells' work[15,16] proves exceptionally valuable in demonstrating the need for digital literacy, as he presents the knowledge economy that dichotomizes individuals into those who are deemed valuable to an information society, and those who are not.

These new literacies and skills related to digital literacy are seen in users who are deemed valuable in the knowledge economy—a group consisting of individuals who are "able to adapt to new situations, to redefine the skills needed for a given task and to draw on a range of resources for learning new skills". Castells[15] portrays them as valuable assets within the knowledge economy as they enable the production of knowledge and ideas. In contrast, the second group of individuals that Castells[15] portrays as being deemed unimportant in the knowledge economy is termed "generic labor". These are individuals who are able to receive and execute instructions but lack further value-add as they do not possess any unique or specialized skills, making them easily replaceable. Castells[15] positions new literacy skills to distinguish between these two groups, demonstrating a need for new literacies in education for society to develop valued workers for the knowledge economy.

Bawden's[11] work fits nicely into the types of literacies necessary to create workers valued by Castells[15] as part of the knowledge society. Beyond this fit, Bawden's theory does appear to be lacking in terms of the social and cultural aspects of literacy.

2.3. Digital literacy or literacies?

In later work, Belshaw[17] utilized the term digital literacies, rather than digital literacy, both to avoid reducing it to a finite outcome, as well as to address the complexity and different aspects of the concept. Based on an extensive literature review of the term digital literacy, Belshaw proposes a definition of digital literacy as the following: "Literacies involve the mastery of simple cognitive and practical skills". To be "literate" is only meaningful within a social context and involves having access to the cultural, economic, and political structures of society. In addition to providing the means and skills to deal with written texts, literacies bring about a transformation in human thinking capacities. "This intellectual empowerment happens as a result of new cognitive tools (such as writing) or technical instruments (such as digital technologies or digital devices)"[17]. This definition encompasses three major facets of digital literacy, namely: (i) practical skills, (ii) cognitive ability, and (iii) the socio-cultural element. In this regard, Belshaw's work draws heavily on Bélisle's; his definition of literacies feeds directly into Bélisle's proposed three dimensions of digital literacy. Linking Belshaw's work to Bélisle's work[9], transformative digital literacy can go beyond the ability to transform an individual through self-enhancement to transforming societies through these "entitlements" gained by individuals.

These are addressed in the 8 non-hierarchical elements of digital literacy elaborated below: (i) cultural, (ii) cognitive, (iii) constructive, (iv) communicative, (v) confident, (vi) creative, (vii) critical, and (viii) civic.

The cultural component refers to the need to understand various digital contexts an individual may experience. Different digital contexts have different codes and ways of operating, things that are accepted and encouraged, as well as those that are frowned upon and rejected. It is not solely about technical proficiency but about the issues, norms and habits of mind surrounding technologies used for a particular purpose.

The cognitive component is about developing habits of mind and "expanding the mind". It is about the ability to use a cognitive set of tools to manage information.

The constructive component is about creating something new, including remixing content from other sources to create something original, which bears similarities to Eshet-Alkalai's "reproduction literacy".

The communicative component is about understanding how communications media work, and knowing how to communicate in digital networked environments. This boils down to the ultimate function of literacy to facilitate communication.

The confident component refers to confidence based on the understanding that the digital environment can be more forgiving in regard to experimentation, than physical environments. The OECD identified the unique affordances of technology and digital environments to promote confidence in problem-solving—a skill seen as important in the information or knowledge society, where "…modern society is increasingly looking to [people] who can confidently solve problems and manage their own learning throughout their lives, the very qualities which ICT supremely is able to promote"[18].

The creative component is about doing new things in new ways. It is about using technologies to perform tasks and achieve things that were previously either impossible or out of reach for the average person.

The critical component involves reflection upon literacy practices in various semiotic domains. This component is crucial in developing "thinking and analytical individuals" in the knowledge society. However, there is a need to consider the power structures and assumptions behind such literacy practices.

The civic component is the ability for the literacy practices resulting from new technologies and tools to support the development of civil society; it places focus on participation, social justice, and civic responsibility.

Within the above elements, it is evident that digital literacies have evolved from a mere set of skills, to encompass cognitive ability that can facilitate cultural engagement and enable critical analysis. Continuing the evolutionary path of digital literacies, Belshaw's research[17] can be seen as particularly prominent, especially where it links the element of "cultural" to that of "civic". This emphasizes participation, social justice, and civic responsibility. Digital literacies are not simply about functional ability but they incorporate issues related to inclusion, participation, and empowerment that result from socio-cultural interactions. These civic components, while covered in Tornero's work, are more strongly brought across in Belshaw's work. Hoechmann and DeWaard[19] closely examines the mapping between digital literacies policy and practice in the Canadian educational context and concludes that the Canadians are at a transitional moment. Ultimately the competencies related to these identified civic components can prove particularly valuable especially when read alongside Rassool's work on "Literacy for sustainable development in the age of information"[4].

In the following section, selected measures and frameworks related to digital literacy are explored and discussed.

3. Existing frameworks for measurement of digital literacy

Scholars and practitioners have attempted to measure digital literacy and skills using various instruments and methods. In addition to this, there is work that presents frameworks to better understand and define digital literacy; refer to the study of Sharma et al.[5] for a review. The measures and frameworks can be classified into three distinct levels: (i) country or worldwide measures; (ii) group or community measures; and (iii) individual measures.

3.1. Country-specific and global measures of digital literacy

At this level, which is focused on worldwide or country efforts, as well as national-level information and digital policies, much attention has been given to providing adequate infrastructure to enable access to the digital world, regarding how the Internet is adopted and used by the general population, and development of related human capital.

Table 1 highlights the international efforts taken to measure these elements. Each of these aids in measuring progress along the digitalization path, and in some ways predict the future of digitalization in different countries. This provides an opportunity for comparison of countries across different elements and enables policymakers to better understand how to improve technical infrastructure in their respective regions.

Table 1. Worldwide indicators.

Organization/authors	Measures	Purpose
ITU[20]	World communication/ICT indicators database	The ITU collects data worldwide on fixed line, and cellular subscriptions, households with computers, and/or internet access as well as individuals utilizing the Internet.
The World Bank[21]	World development indicators	The World Bank collects various infrastructure indicators, including internet related information such as number of internet users, secure internet servers, and general statistics on education and economic growth.
European Commission[22]	Digital economy and society index (DESI)	This scoreboard consists of 30 indicators that help in measuring the EU member countries digital performance. There are 5 main dimensions: connectivity, human capital, use of internet, integration of digital technology, and digital public services.
World Economic Forum[23]	Network readiness index	The Network readiness index measures, on a scale of 1 (worst) to 7 (best), how well 143 economies leverage ICTs to boost competitiveness and well-being.
Johnson School, Cornell University[24]	Global innovation index	A ranking of the world economies' innovation capabilities. There are five pillars in this index: institutions, human capital and research, infrastructure, market sophistication and business sophistication.
OECD[25]	Program for International Assessment (PISA) survey	Tests how 15-year-olds use computers and the Internet to learn.
Chakravorti B et al.[26]	Digital evolution index	The outcome of this project, spanning across 6 years (2008 to 2013), was an index that enables pattern recognition on how the internet is transforming the marketplace.
Sabbagh K et al.[27]	Digitization index	This index measures a country's level of digitization on a scale of 0 to 100 (most advanced). Six key attributes are measured: ubiquity, affordability, reliability, speed, usability and skill.

The work by other organizations within countries must also be acknowledged. Apart from the efforts of the EU, Europe has done a significant amount of work on digital literacies. For instance, the European and International Computer Driver's License Foundation[28] conducted a survey on digital literacy across 15 countries. About 8000 participants were surveyed across three measures: (i) perceived digital literacy measure (participants self-rated their overall ability with ICT); (ii) confidence of digital literacy measure (participants rated confidence in performing specific tasks using computer applications or answering specific knowledge areas, where they were asked to rate their confidence at performing a total of 13 questions covering 4 topic areas); and (iii) actual digital literacy measure (participants performed specific tasks across 13 matching question areas to the ones which measured their self-rated confidence).

It was found that the countries with the highest scores for actual skills also had the highest participation in training. There was no observable difference between genders. Digital literacy in urban areas was slightly greater than in rural areas. Ferrari[29], as part of the European Commission Joint Research Centre, developed the DIGCOMP framework, a detailed framework on digital competence, for three proficiency levels. The framework also provides examples of knowledge, attitudes and skills, and applicability of each competence for different purposes.

Hoechmann and DeWaard[19], as part of Media Smarts in Canada, presented a framework for incorporating digital literacy into education systems in Canada. There are three building blocks of digital literacy: "the skills and ability to use digital tools and applications; the capacity to critically understand digital

media tools and content, and the knowledge and expertise to create and communicate with digital technology"[29]. The International Telegraph Union[30] or ITU, took a different approach to digital literacy by developing a measure for calculating the number of digital natives in a country. A digital native is defined as a youth, aged 15–24 years old inclusive, with five years or more experience using the Internet.

Scholarly efforts include the work by van Deursen et al.[31], who utilized performance tests to examine operational (use an online search engine, use a browser), formal (navigation skills, maintaining a sense of location while navigating), information (recognizing information required, evaluating this information), and strategic (using the internet to achieve a particular goal and improve ones' position in the society) internet skills of 109 participants, based across 20 villages in the Netherlands. While 80% of participants were able to complete the operational tasks, only 11% were able to complete both strategic tasks.

Tengtrakul and Peha[32] focused on whether the use of ICTs in schools affected residential adoption and adult utilization outside schools. The study was based on the SchoolNet project in Thailand, which supported the provision of Internet access to schools. For that, ICT-related variables found in a 2007 census of households in Thailand, were utilized. Some of the relevant survey measures included (i) demographic information on age, income, and education level, (ii) the existence of computers, internet and broadband internet at home, and (iii) usage of computers in the last 1 year. In that study, 80,000 households were surveyed, and the relevant data was utilized for the study. It was found that the spill-over effect was there in households with older children, and where there were computers with Internet access. Hence, policies that encourage ICT implementation in schools had an indirect effect on the adoption of ICT in communities.

Markauskaite[33] proposed an analytical framework that can aid in discovering inconsistencies in the understanding of ICT literacies at various levels of our education systems. Although the term digital literacy is not used, the underlying importance of these literacies is the same—to contribute to the well-being and prosperity of societies. Structured literature review and document research were used to develop the framework. There are several layers to this framework, as presented in **Table 2**.

Table 2. Layers of ICT literacy.

Layer	Focus	Emphasis
1st	Educational policies	Intended ICT literacy: aims of ICT (economic, social, educational); aims of literacy (beneficiaries of literacy whether individual or society); and models of literacy (autonomous or ideological)
2nd	Teaching and learning approaches	Implemented ICT literacy: stages of ICT infusion (emerging, applying infusing, transforming); and ICT curriculum approaches (discovering ICT, using ICT, understanding ICT, specializing in ICT)
3rd	ICT literacy capabilities and experiences	Achieved ICT literacy: isolated ICT literacy (fundamental ICT knowledge, basic ICT skills); and integrated ICT literacy (cognitive capabilities, inter-literacy, situated literacy, meta-cognitive capabilities)

This framework provides a structured way of implementing ICT literacy. It can be a way of understanding and identifying ICT literacy policies in different countries.

3.2. Groups and community measures of digital literacy

This level of research focuses on groups or small communities. Most researchers attempt to understand the factors that influence the adoption of ICT and the level of digital literacy of diverse groups of users in a particular context.

Moghaddam and Khatoon-Abadi[34] chose to focus on the adoption of ICTs in rural Iran. The researchers attempted to identify the factors that influence the adoption of ICT in Gharn Abad's ICT Center of Golestan

Province. There were 342 residents of Gharn Abad and the surrounding villages who were first interviewed and then surveyed—45 were teleworkers and 297 were tele-users. The survey examined three elements: individual, contextual (related to the users' household), and technological (innovation-related characteristics). It was found that the main characteristic that affected adoption was the pre-existing skills of the users.

A survey instrument to measure web-oriented skills was first developed in 2005 and then updated in 2009[35,36]. The survey was mainly tested with tertiary level students, but can also be used with other groups. For instance, Dun[37] tested the digital literacy skills of Arab-speaking natives in Qatar, and found this to be a robust instrument measure in this context. The measures were based on the results of performance tests that measured the users' actual online skills. The researcher tested this instrument in studies after 2005. In 2007, there were 1189 first-year students surveyed from the University of Illinois. In 2009, new students to the university were surveyed (1041 students). In 2010, a follow-up survey was done with 505 participants in 2009. The survey instrument was considered robust. Measures in the survey were divided into four areas: (i) self-report questions on digital literacy, (ii) degree of understanding of digital literacy items, (iii) multiple-choice tests on digital literacy, and (iv) an overall rating of Internet skills.

Teo[38] developed a self-reporting instrument known as the "Digital Natives Assessment Scale". This instrument enabled students to assess their own perceptions of the degree to which they are digital natives. This instrument took into consideration four factors: (i) growing up with technology, (ii) being comfortable with multitasking, (iii) being reliant on graphics for communication, and (iv) thriving on instant gratification and rewards. A total of more than 1000 students from three secondary schools supported the validation of the survey instrument, which comprised a 21-item, four-factor scale for use by students between 13 and 16 years of age. It was found that this is a robust model but needs to be evaluated with more groups of students.

Stoican et al.[39] conducted a study on preschool teachers. The aim was to identify ways in which they formed and developed their digital skills, and how these were put into practice. A total of 63 preschool teachers were surveyed for this study. Measures included background, level of education, teaching experience, and level of continuous training. It was found that most respondents acquired their skills during their university education and these skills were further strengthened by frequent use of the computer in the classroom, in other words, digital literacy in practice.

Shariman et al.[40] sought to analyze the digital literacy competence level of students based in three universities in Malaysia. Three main themes were studied: (i) coding practice (scanning, searching, scrolling, navigation); (ii) pragmatic practice (using the Internet for functions such as searching, for the tasks given); and (iii) semantic (exploring the Internet to achieve a given task) and critical (critically evaluate web content to achieve a particular task) practice. Three focus groups, consisting of between eight to ten participants, took part in a four-hour focus group: two hours for completing the tasks online and two hours for interviewing. The study concluded that even though students liked information presented in a stimulating way in multimodal forms, they were not able to go beyond semantic practice due to language barriers, short attention spans, and low motivation or interest in the digital content.

Knutsson et al.[41] wanted to identify different registers of digital literacy in virtual learning environments (VLEs). The social semiotics framework was used as an analytical tool for digital literacies in VLEs. Three levels of digital literacy were identified: every day, specialized, and reflexive. Each level was measured using three contextual aspects: (i) field, comprising "activity" (type of task); "knowledge for participation" (knowledge required to complete the task), and "knowledge of semiotic resources" (type of resources required for the task); (ii) tenor; and (iii) mode. The data for the study came from a criminology course, taught through distance learning, by a Swedish University in 2010. The data from the VLE Mondo was used. In addition, two

students and five teachers participated in semi-structured interviews and fifteen students participated in a survey. Apart from finding that the levels of digital literacy varied between designers, teachers, and students, the study revealed that digital literacy is a "situated practice"[41] and varies across different contexts and how VLEs are adapted in specific contexts.

Reynolds[42] proposed a framework for digital literacy that was grounded on social constructivism and named it the "Social Constructivist Digital Literacy". Based on the education context, this framework was task-driven, rather than skills driven. The framework was made up of six Contemporary Learning Practices (CLPs): (i) create (creation and completion of a digital project); (ii) manage (project planning and management); (iii) publish (distribution of created artifact to community); (iv) socialize (giving and getting feedback on the project); (v) research (find information to support artifact's design, planning and execution); and (vi) surf (play and experiment with existing websites and tools). The framework was empirically tested with students who created a game using Adobe Flash at schools, based in West Virginia, USA. A longitudinal survey, over a year, was used to collect the data from 679 students. Both pre- (before the program) and post- (following completion of the program) surveys were utilized. Results found that students were more engaged by the end of the program, and the CLPs were inter-correlated and supported the theoretical perspectives of the framework. **Table 3** categorizes the above studies conducted on the adoption and level of digital literacy in different groups and communities.

Table 3. Studies on digital literacy.

Study	Focus	Participants	Measures
[34]	Adoption of ICTs in rural Iran	342 residents of Gharn Abad and surrounding villages	Individual, contextual, and technological factors affecting the adoption of ICTs
[35], [36]	Web-oriented skills in tertiary-level students	1189 first-year students surveyed in 2007; 1041 new students surveyed in 2009; 505 participants surveyed in 2010	Self-report questions, degree of understanding of digital literacy items, multiple-choice tests, and overall rating of internet skills
[38]	Self-assessment of digital nativeness	More than 1000 students from three secondary schools	Digital Natives Assessment Scale with four factors: growing up with technology, comfort with multitasking, reliance on graphics, and desire for instant gratification
[39]	Digital skills of preschool teachers	63 preschool teachers	Background, level of education, teaching experience, and level of continuous training
[40]	Digital literacy competence of university students in Malaysia	Three focus groups with eight to ten participants each	Coding practice, pragmatic practice, semantic practice, and critical practice
[41]	Different registers of digital literacy in virtual learning environments (VLEs)	Data from a criminology course taught by a Swedish University in 2010, two students and five teachers participated in semi-structured interviews, and 15 students participated in a survey	Every day, specialized, and reflexive levels of digital literacy are measured using three contextual aspects: field, tenor, and mode
[42]	Framework for digital literacy grounded in social constructivism	N/A	Social constructivist digital literacy framework made up of six Contemporary Learning Practices (CLPs)

3.3. Individual measures of digital literacy

Much of the research concerning digital literacy measures and frameworks concern country/worldwide indicators or group/community indicators. This is not surprising given the fact that digital literacy needs to be measured on a larger scale to impact the overall infrastructure, national policies, and educational initiatives[21].

One study that focused on individuals was conducted by Ching and Ching[43]. This study utilized technological literacy and autobiographical narratives that were written by twenty-three graduate students enrolled in a teacher-preparation course. The aim of the study was to understand the meanings and values created by the past use of information and communication technology, as well as any resistance created by the same technology. It was found that past experiences of participants during their school years were not as critical as extracurricular motives, such as social contact, experimentation, or pursuing current interests, for instance, in programming.

Another study investigated formal information skills and substantial information skills, where the former are skills required to navigate the Internet, and the latter is required to select, process and evaluate the information presented to the user[44]. Eighty participants, between the ages of 25 and 35 years old were recruited in Northern Italy from among universities and private firms. Navigation performance was the method used to measure the two skills mentioned. It was found that better performance in both skills was related to the proper use of research tools, using queries that can result in relevant information being shown, the ability to select relevant links in search engines, as well as knowledge and familiarity with specific resources.

The following section will discuss studies that have explored the impact of digital literacy and skills on socioeconomic development and transformation.

4. Digital literacy and socio-economic transformations

In this section, the focus is on the critical role that digital literacy plays in socio-economic development, as well as social innovation initiatives, which have led to the transformation of individuals, families, and communities.

4.1. Socio-economic perspectives

Piketty[45] expressed concern over the fact that wealth and income inequalities have gone back to their historical patterns after three decades of post-war equalization. In agreement with him, Kaplan and Rauh[46] stated that the utilization of ICT tools can support the productivity of highly talented individuals, who then receive higher compensation for their efforts. However, this will in turn, increase the inequalities on an intellectual and skills level, and has significant implications in building a knowledge society. Following his position-argument, Piketty posed the question as to whether digital inclusion, participation and opportunities negate the inequalities of "patrimonial capitalism", that is, opportunities facilitated through social capital, heredity, or family connections. Digital literacy is one way of leveling the playing field, allowing rural communities, poverty-stricken individuals, or individuals with little to no social capital, to contribute economically and politically to society. Research supporting this idea will be detailed first, and if it is then followed by research that presents the counter-arguments.

It has been suggested by Armenta et al.[47] that digital participation and inclusion enable grassroots engagement, bridging some of the prevailing socio-economic disadvantages (SEDs) that exist within societies and countries. Through a four-stage model of digital development, this research explains that there is a transition from focusing on (i) access to technology, to (ii) differences in socioeconomic indicators and use of this technology, to (iii) grassroots participation, and finally, (iv) human values, where community involvement, technology adoption, and sustainability are the main areas of focus. While each level of the developmental

model seeks to discourage digital exclusion, it is the fourth level of human values that could ensure that as society progresses, the socio-economically disadvantaged (SEDs) do not get marginalized and disenfranchised further. Their argument is similar to that of Ramírez[48] who emphasized the importance of community participation in being able to evaluate the long-term benefits of ICT implementations within rural and remote communities.

Morris and Morris[49], sought to understand whether access to the Internet could impact the amount of political influence in America, and aid in closing the participation and knowledge gaps between individuals of high and low socio-economic statuses (SES). They focused their attention on the 2012 presidential elections in America. Through analysis of secondary data from the Pew Research Centre, they found that lower SES individuals gain higher returns on political knowledge and voting, through increased access to the Internet, when compared to higher SES individuals. Therefore, they argued that those who are more educationally and socially disadvantaged, gain more through access to various online resources, whereas higher SES individuals find limited new information online and few social networking opportunities, in comparison.

Digital inequality among the SEDs was studied by Hsieh et al.[50]. Specifically, they wanted to explore the forms of capital for using ICTs, (i) how these differ between SEDs and those considered socio-economically advantaged (SEA); (ii) how these capitals are impacted through public policy regarding ICT access; and (iii) how each form of capital influences SED's intention to adopt and continue to use ICTs. Around 784 survey responses were analyzed from participants residing in LaGrange, USA. It was found that Government Digital Inequality (GDI) initiatives, that support the provision of basic Internet connectivity for free, can increase the cultural and social capital of SED groups. Thus, the use of the Internet can yield constructive changes to different forms of capital. Similarly, Shim[51] discussed the Information Network Village Project, a government-funded project that aimed to provide broadband infrastructure to rural areas in South Korea, and the social impact of this project. It was found that this government initiative increased community attachment and reduced migration from rural communities. The increase in social capital gave the community a sense of belonging, thereby increasing attachment to the community.

The above discussion suggests that basic access to the Internet can aid in equalizing the socio-economic status of communities. However, these studies have their limitations. Other scholars have suggested that these socio-economic inequalities can widen because of access to or availability of the Internet, or because of policies that are inadequate to support or facilitate digital inclusion and participation. For instance, from an educational point of view, Howard[52] discussed the rapid technological changes that are leading students to learn more from ICT use in the after-school space, rather than in-school lessons or classes carried out within curriculum time. After-school space is where students experience independent learning through peers, the Internet, and social media. This has implications for educators and education policies. Those who have access to education may not have access to other Internet-enabled devices at home. This can influence potential learning opportunities, access to knowledge, and eventually participation in the digital, knowledge-based society.

The term digital participation refers to the active involvement in digital society through the use of modern information and communication. Digital participation is pivotal in improving socio-economic development. One aspect of participation is creating content and sharing it online. Hargittai and Walejko[53] discussed the creation and sharing of content online and found that in spite of the Internet offering new ways to share content, relatively few people are making use of these opportunities. One reason is their socio-economic status, as measured by parental schooling. If at least one parent has a graduate degree or higher, the student was more likely to share content online.

van Deursen et al.[54] investigated the types of Internet activities conducted within a subset of the Dutch population between the years 2010 and 2013, and related this to four demographic variables: ender, age, income, and education. For activities that improved capital, it was found that men who were younger and highly educated individuals with higher-than-average incomes benefitted more. In other words, more capital-enhancing opportunities are primarily available to a subset of the population who already hold a strong position within society.

Hence, as promising as some government initiatives are across the world, inequalities are still prominent and, in some instances are accentuated by the Internet. Some research highlights lessons from countries that have succeeded in reducing this digital divide. For instance, Loo and Ngan[55], discussed the success that China has had in reducing the digital divide by combining technological advancement and government measures. This has encouraged competition and supported the development of the telecommunications sector, a lesson for developing countries. Larson and Park[56] examined the role of government leadership and strategic restrictions that have helped the Republic of Korea's ICT-led developments to date. A competent bureaucracy within a political system that allows them autonomy, assigning a "control tower" to oversee technology policy and projects, and encouraging ICT leaders to gain cross-cultural experiences and a global outlook via the higher education, were the key factors in Korea's success.

Policies that encourage the evolution of knowledge societies must be built upon the pretext of creating a digitally literate society to support socio-economic development. Good governance can bridge the access divide, infrastructure development can create devices and networks for communities, and education and digital literacy support utilization of these networks and devices. At the same time, social innovation projects or initiatives by individuals, the non-profit sector, or companies and organizations keen to strengthen their corporate social responsibility, can help to bridge some of these socio-economic inequalities and the digital divide between the haves and have-nots. In studying social issues and inequalities, social innovation (SI) has been identified as a platform where structures, policies, and initiatives can be questioned, reviewed, and re-explored, particularly those related to recurrent global and social issues such as "epidemics, social inequality, hunger and weather changes"[57].

In the following section, specific examples of social innovation projects or initiatives in Singapore and the United Arab Emirates (UAE) are described, where such projects or initiatives have facilitated the development of digital literacy knowledge and skills, particularly among the less privileged or the vulnerable. These skills and knowledge, in turn, have played a significant role in the individuals' socio-economic transformation and opportunities. These two countries are selected because, despite their rather distinct cultural and ethnic backgrounds, they have similar nationwide initiatives and support systems for digital literacy and skills development by their respective governments, which have accelerated a whole-of-nation drive in digital literacy.

4.2. Impact of digital social innovation on society and policy

The seminal work by Cho and Yi[58] on "Adaptive social innovation derived from digital economy and its impact on society and policy" serves as a key reference. According to this article, today's social innovation derived from the digital economy environment is transforming our way of life, values, and even social relations. The digital economy and technology have a wide range of impacts derived from the rapid socio-economic transformation, namely the transformation of production, consumption, and distribution due to the digital economy. The below figure illustrates how in digital economy, production, consumption, and distribution impact society and policy: unemployment and purchasing power, market transparency and entry barrier, public education, and fiscal structure.

Figure 1 illustrates that the production and distribution sectors commonly impact the government. In other words, the government's leading role is needed for society to cope with the change in production and distribution. Constructing education governance to cope with job losses and increased/decreased demand for job skills and improving public financial health to secure the sustainability of public services are the tasks of the government to cope with the digital economy.

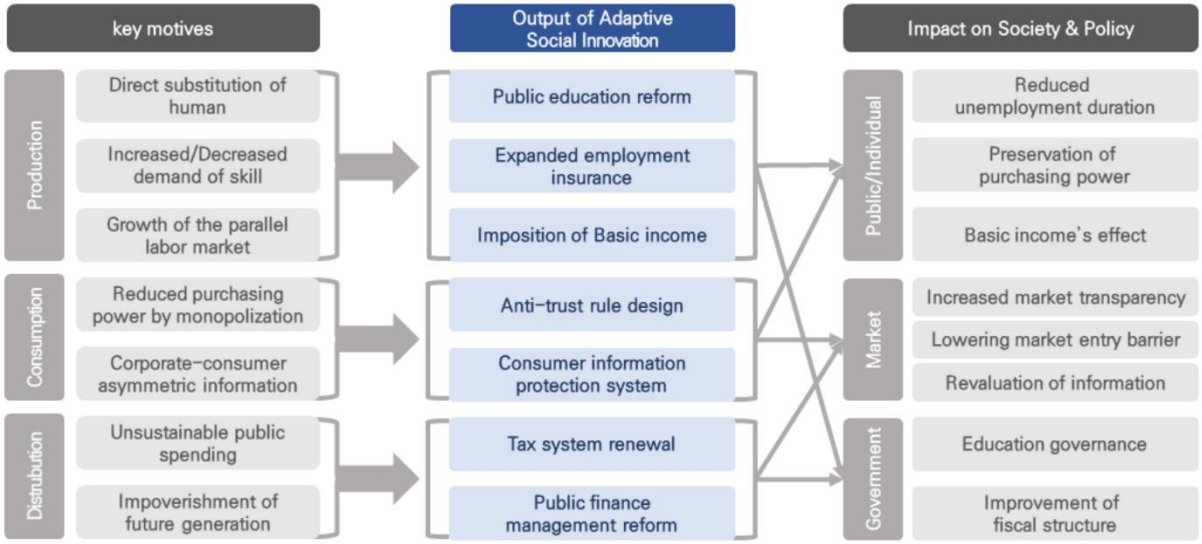

Figure 1. Impact of digital economy on society and mitigating policy (source: the study of Cho and Yi[58], Figure 5).

4.3. Digital social innovation and sustainable development goals

The impact of the COVID-19 pandemic has increased the search for solutions to social problems associated with the sustainable development goals (SDGs). Main actors are turning to digital social innovations (DSIs), defined as collaborative innovations where enterprises, users, and communities collaborate using digital technologies to promote solutions at scale and speed, connecting innovation, the social world, and digital ecosystems to reach the 2030 Agenda. An important study was conducted by Dionisio et al.[59] to identify how digital transformations and social innovations solve social problems and address SDGs. Based on a systematic review of 45 peer-reviewed articles (published from 2010 to 2022), it was observed that the increasing use of technologies associated with all 17 SDGs, especially blockchain, IoT, artificial intelligence, and autonomous robots had a big impact on many different segments, such as health care, smart cities, agriculture, and the combat against poverty and inequalities. Also identified were many threats concerning ethics, especially with the increased use of public data, and concerns about the impacts on the labor force and the possible instability and impact it may cause in low-skill or low-paying jobs.

There is consensus in the research literature that digital skills and capacities can make the world a sustainably better place through social innovation and socio-economic transformations by improving participation and collaboration, fostering job creation and growth, and enhancing regions' abilities to create new industrial paths. For example, in a recent field study, using the International Digital Economy and Society Index (I-DESI) and the Social Innovation Index (SII), Nagy and Somosi[60] investigated how digital transformation of the economy and society affects the capacity for social innovation with a dataset of 29 countries and through regression/correlation techniques. They concluded that the digital transformation of the economy and society has a significant positive impact on the capacity for social innovation and that the integration of digital technology plays a critical role in digital transformation. Hence, a country's progress in digital transformation is beneficial to its social innovation capacity. But this study did not address the question

of whether digital social innovation leads to positive socio-economic transformations and sustainable development.

4.4. Digital transformations for a sustainable future

In the two years since the sixth Ministerial Conference on the Information Society in Latin America and the Caribbean, held in Cartagena de Indias (Colombia) in April 2018, issues in the digital sphere that were then considered to be emerging or incipient have come to occupy center stage. Meanwhile, the coronavirus (COVID-19) pandemic has had an unprecedented economic and social impact on Latin America and the Caribbean. It is estimated that the region's GDP has contracted by about 7.7%, that the value of exports has fallen by 13% and that reduced demand and the slowdown of supply have led to the closure of over 2.7 million businesses, resulting in more than 18 million unemployed. All these dynamics will have major effects on the level of inequality and poverty in the region, and it is estimated that the number of people living in poverty will increase by more than 45 million.

In respect of digitalization, 15 years from the approval of the first digital agenda for Latin America and the Caribbean, the region is facing a new world and a challenging context. Digital technologies have grown exponentially, and their use has globalized. Ubiquitous and continuous connectivity has reached much of humanity, thanks to the mass take-up of smartphones and the consequent access to information, social networks, and audiovisual entertainment. The acceleration of technical progress in the digital realm has contributed to the use of devices and applications employing cloud computing, big data analysis, blockchains, or artificial intelligence routine. The technological revolution has combined with a change in the strategies of the companies at the forefront of digital technology use to greatly increase the role of global platforms. The result is that excessive economic and political power is wielded by no more than twenty or so corporations based in two or three world powers, with market capitalizations of close to or more than a trillion dollars.

Technological progress has gone along with socially negative outcomes, such as the exclusion of a large proportion of the world's people from the benefits of digitalization, essentially because their incomes are too low for them to have meaningful connectivity (i.e., high-quality access), access to devices, fixed home connections and the ability to use this day to day. A large demand gap has thus opened up, as coverage is adequate but is not reflected in connections and usage. Other problems have also worsened, such as the proliferation of fake news and cyber-attacks, the growing risk to privacy and personal data security, and the large-scale production of electronic waste. The global backdrop to the unresolved balance between the benefits and costs of digitalization is more adverse than was anticipated 15 years ago. Geopolitical struggles, often centered on digital patents, standards and production, have markedly weakened multilateral decision-making and action. The environmental crisis has escalated into an environmental emergency or, according to some analysts, an environmental catastrophe. The increase in inequality in many countries and the exclusion of vulnerable population groups are making it even more difficult to build social and political systems capable of adequately steering digital development.

The COVID-19 pandemic has accentuated all these problems and driven the world into the worst economic crisis since the Second World War, with all the attendant negative effects on jobs, wages, and the struggle against poverty and inequality. Digital technologies have played a key role in addressing the effects of the pandemic. However, the benefits from their use are limited by structural factors, such as limits on connectivity (access, use and speed), social inequalities, productive heterogeneity and low competitiveness, and restricted access to data and information management, among other factors. Thus, new opportunities and new challenges are opening up for the countries of Latin America and the Caribbean. The region is the hardest hit by the crisis and will have to confront long-standing problems from a position of greater structural

weakness. In particular, it will have to surmount the slow economic growth of the last seven years, with falling investment and stagnant productivity, while at the same time vigorously recommitting itself to the struggle against poverty and inequality. To overcome these problems, it will have to embark on a big push for economic, social, and environmental sustainability leading to progressive structural change based on the vigorous creation and incorporation of technology to diversify the production system.

Against this background, an UN-sponsored report from the Economic Commission for Latin America and the Caribbean[61] titled "Digital technologies for a new future" (LC/TS.2021/43) sought to contribute to the debate and the deployment and use of digital technologies at national and regional level in support of development. Its contents have been organized into four sections. The first section discusses the need to move towards a sustainable digital society within the framework of the systemic impact of digital disruption. The second section analyses the effects of digitalization on social welfare and equality, posits the need to universalize access to these technologies, and assesses the cost of doing so. The third section examines the relationship between digitalization and productivity and the impact on agricultural, manufacturing, and services production chains, and looks at some policies for post-pandemic recovery involving economic transformation. Lastly, the fourth section analyses the state of digital agendas in the region, in particular on data management, and presents recommendations to strengthen regional cooperation and the move towards a regional digital market. It also summarizes the main conclusions of the working meetings and panels of the seventh Ministerial Conference on the information society in Latin America and the Caribbean, which was held virtually in November 2020 and chaired by Ecuador.

The proposals put forward in the document could pave the way for more inclusive and sustainable digitalization, i.e., digitalization that creates the conditions not only for faster recovery from the current crisis but for a more productive and efficient use of these digital technologies, as well as greater productivity, better jobs and higher wages, helping to reduce the high levels of inequality in Latin America and the Caribbean. This outlines the digitalization that is needed for a new future and for progress towards a digital welfare state.

4.5. Role of social innovation in addressing global poverty and exploitation

Tackling the rapid rise in global poverty is one of the most pressing challenges the world faces today, especially in this new age of turbulence and rapid changes. On top of the ongoing environmental crisis, the last fifteen years have been rocked by the financial crisis of 2007–2008, compounded by the 2020–2021 COVID-19 pandemic and then by the 2022 Ukraine-Russia War, each of which has negatively impacted all aspects of sustainable development. Although in practice many development organizations have been using the methods and processes of social innovation to tackle poverty and vulnerability for many years, it is only recently that they have specifically begun to analyze and codify their contribution to these and other SDGs. Social innovation provides beneficial social outcomes for citizens and other actors, often at local levels with the strong bottom-up involvement of civil society through its cross-actor, cross-sector, cross-disciplinary and cross-cutting strengths. Importantly, it aims to empower those with a social need, particularly when they have little, to begin with. It focuses on increasing the beneficiaries' own agency and capability, rather than passively relying on others to act on their behalf. This is done by transforming social relationships and developing new collaborative processes.

Among a wide range of recent and contemporary sources, this paper analyses a large-scale quantitative and qualitative global survey of social innovations that tackle poverty and vulnerability in different global regions. It examines various definitions of poverty, including extreme, absolute, and relative measures as well as arguably more useful approaches like the Multidimensional Poverty Index. It proposes how social innovation should be recalibrated to meet the increasing threats of the new age of turbulence, including by

deploying the sociological lens of the agency-structure dichotomy to show why the public sector needs to become involved more proactively in social innovation. It also looks at certain myths around poverty and vulnerability, examines why we need to revise our understanding of sustainable development and resilience, and why a new nexus approach is needed that combines SDG1 (i.e., end poverty in all its forms everywhere) with other strongly related SDGs.

Harnessing social innovation to tackle poverty and vulnerability has traditionally turned a blind eye to prevailing political and socio-economic structures, largely accepting the latter as "given" and not directly relevant or useful to the ongoing practical on-the-ground work required to alleviate the problems being tackled. To some extent, this is due to the relatively recent emergence of social innovation as a recognized and robust set of goals and methods for this purpose. Thus, even the rapid rise in poverty and inequality in the wake of the resurgence of neoliberalism in the 1980s through its "Washington consensus" focus on freeing-up markets from regulation and reducing the role of the state, as well as the more sudden crisis of the 2008 financial crash, tended to cement the largely bottom-up, here-and-now mindset of social innovation[62]. The new set of global crises commencing in 2020, which are seemingly ongoing, provides a new opportunity for social innovations that tackle poverty and vulnerability to take a radically new, and arguably more mature and nuanced approach. This requires clear-sighted and painstaking work to combine social innovation's undoubted success in galvanizing the agency and capabilities of beneficiaries with the determination to achieve appropriate top-down structural changes and purposeful nexus partnerships to dramatically enlarge the degrees-of-freedom within which it operates.

5. Interpretive analysis of Singapore and the UAE

In this section, we share the findings from an interpretive field study of two country-specific exemplars of digital social innovation that have brought about positive socio-economic transformations to societies, organizations, and individuals within these two countries, namely, Singapore and the United Arab Emirates. In an early classic, Walsham[63] prescribed the following as guidelines for interpretive field research. Specifically, this paper presented "philosophical and theoretical issues concerning the nature of such interpretive case studies, and methodological issues on the conduct and reporting of this type of research… and a useful reference point for researchers who wish to work in the interpretive tradition, and more generally to encourage careful work on the conceptualisation and execution of case studies in the information systems field." Regrettably, presumably for "objective" reasons, IS scholars have taken a preference for developing behavioural questionnaires for data-collection over the power of qualitative observations and the use of multivariate methods over deep ethnographic insights.

In the sequel published a decade later, Walsham[64] elaborates his view that "interpretive methods of research start from the position that our knowledge of reality, including the domain of human action, is a social construction by human actors. Our theories concerning reality are ways of making sense of the world, and shared meanings are a form of intersubjectivity rather than objectivity… [but] … accept the plausibility of the ontological position of the critical realist that there is an objective reality. Indeed, I see critical realism as one possible philosophical position underpinning interpretive research, along with others such as phenomenology and hermeneutics." He gives dimensions that guide interpretive studies: i) the primary audience of the research; ii) the literature or body of knowledge that is contributed to; iii) the claim that is made which would be novel to the audience; and iv) the intended use of field research findings. We shall address each of these in the concluding section.

5.1. Digital social innovation in Singapore

Singapore is a small city-state in Southeast Asia, situated just one degree north of the equator, off the southern tip of peninsular Malaysia. Having gained independence in 1965, this young city-state has grown quickly, from an underdeveloped country to a progressive and advanced nation with impressive achievements in education, healthcare, information technology, as well as scientific research and development, among others. The Singapore education system, which has garnered sufficient interest and scrutiny from academics, practitioners, and policymakers globally, has, to a large extent, a significant part to play in shaping the psyche, mindsets, and aspirations of youths in Singapore. One of the enduring and endearing aspects of the Singapore education system is the integration of a values-based foundation in the school curriculum, which was instrumental in developing common core values among Singaporeans. These common core values form the basis of the framework for 21st century competencies student outcomes that undergird teaching and learning in the Singapore education system.

Arising from the desire to move beyond the theatrics and hypothetical of these common core values and put to action what these values truly mean, curriculum initiatives such as civics and moral education, national education, and values in action were introduced over the years to inculcate and reinforce these common core values through "…action-oriented and student-centric initiatives such as experiential learning, service-learning or community involvement projects, and perspective-taking"[57].

For many youths in Singapore, "…volunteering has become central to our civic narrative"[65]. This is because "…many young Singaporeans have gained meaningful, even transformative, experiences of direct community service from their years in school." As a result, many youths—at least 7 in 10 youths—in Singapore are involved in community groups[66]. Some have gone beyond just volunteering their time and effort to social causes and have started non-profit organizations or social innovation initiatives to help, and support marginalized and underserved communities; others have led advocacy groups, social movements to seek policy or even legislative changes related to social or environmental issues.

There are numerous examples of such initiatives in Singapore, many of which are youth-led. In this section, we explore 3 social innovation initiatives—ranging from one that is led by youths or individuals, one that is led by a non-profit organization, and one that is led by the government—and where all three are specifically related to digital literacy. These 3 initiatives have engendered positive social impact, particularly on vulnerable or underserved groups such as (i) persons with disabilities; (ii) less privileged families; and (iii) seniors or older persons.

5.1.1. Project DUST

A youth-led initiative in Singapore called Project DUST—which stands for Differently-Abled UpSkill Training—is introduced by Codesurance, a social enterprise registered in Singapore. Project DUST is led by Mr Max Ong and Mr Jayren Teo, who met and became friends when they were undergraduates in the Singapore Institute of Technology (SIT). The Project DUST aims to equip persons with disabilities (PwDs) with digital skills to develop or create websites with just a drag-and-drop application programming interface (API) or low code platforms and seeks to create networking opportunities between the trained PwDs and prospective employers[67].

Opportunities for PwDs to work remotely and from home were also identified amidst developments arising out of the COVID-19 pandemic. These led to Project DUST's objective of training PwDs in APIs and low-code platforms so that they can continue to do technology-based work remotely, despite the restrictions imposed during the pandemic. Even after the pandemic, the ability for PwDs to work remotely or from home make it easier for them to be employed and financially independent, with little worry about the need to be

physically mobile. After a successful pilot of Project DUST, the team is now expanding the scope of the initiative and will be launching a bigger roll-out in 2023.

5.1.2. Computers against COVID

Engineering Good, a non-profit organization in Singapore, started this initiative to help less privileged or low-income families continue to stay digitally connected during the COVID-19 pandemic. Since April 2020, when Singapore went into its COVID-19 circuit breaker, more than 6000 computer laptops and notebooks have been donated to the "Computers Against COVID" initiative, and which are refurbished by youth volunteers of Engineering Good. These refurbished computer laptops and notebooks are then donated to families who "…do not have access to these devices to stay digitally connected. These laptops are used for purposes such as children's home-based learning needs and adults looking for employment to access on-line job databases"[68].

This initiative has helped many young people from less privileged families be more digitally ready and digitally connected, despite the pandemic which hampered many physical meetings and interactions. This initiative is still ongoing.

5.1.3. Seniors Go Digital

The "Seniors Go Digital" initiative was launched in May 2020, precipitated by the COVID-19 pandemic, which saw a massive migration to digital means for products and services across Singapore. It was observed that many older persons or seniors (aged at least 60 years old) felt left behind as daily routines and services moved to digital means, largely because of the seniors' lack of experience in using digital tools and navigating the various numerous applications and platforms in the digital space. To help these seniors, the Singapore Digital Office (SDO), housed under the Ministry of Communications and Information, deployed at least 1000 digital ambassadors to reach out to, engage and help seniors use mobile applications, pick up digital skills and navigate the digital space[69].

These digital ambassadors comprised a mix of volunteers as well as new staff hired for the role. The SDO prioritized their recruitment from among the graduating cohorts of institutes of higher learning (IHLs) in Singapore, as it was reported that they faced challenges in finding jobs in the economic downturn caused by the COVID-19 pandemic[69]. Older individuals who were made redundant in their jobs because of the pandemic were also redeployed or rehired as digital ambassadors.

As of October 2022, about 190,000 seniors in Singapore have been trained in basic digital skills—such as using a smartphone to make electronic payments and video calls—under the "Seniors Go Digital" programme[70]. The nationwide basic digital literacy programme is also bolstered by the nation's Cyber Security Agency's "Cyber Safe Seniors" programme, which aims to "…raise awareness and drive adoption of cyber hygiene practices". This is in light of the number of seniors who became victims of online scams[71].

Hence, government-initiated and government-funded programmes such as "Seniors Go Digital", were truly initiatives that are socially innovative—which helped not just vulnerable groups such as the seniors, but also those who faced employment challenges as a result of global disruptions such as the COVID-19 pandemic.

5.2. Digital social innovation in the UAE

In recent years, the UAE has witnessed a surge in digital transformation initiatives across various sectors, including education, healthcare, transportation, and other whole-of-government services[72]. Initiatives have been developed, such as the (i) Wareed E-Health Information System that allows the sharing of integrated health-related information and records across hospitals and healthcare institutions under the Ministry of Health; and (ii) the inclusive initiative targeted at persons with disabilities (or persons of determination as

termed in the UAE); they have made the management of information, services, and assistance more integrated among service providers. These government-led initiatives have not only improved the efficiency and effectiveness of public services, but have also initiated further social innovation and brought about social inclusion for all citizens and community groups, including those deemed most vulnerable and least privileged. Box 2 shows a tabulation of some recent, significant digital transformation initiatives undertaken by the social sector in the UAE.

Box 2. Digital transformation initiatives in the UAE.

Dubai Cares. (2021). https://www.dubaicares.ae/
Abu Dhabi Sustainability Week. (2021). https://abudhabisustainabilityweek.com/
Emirates Foundation. (2021). https://emiratesfoundation.ae/
Smart Dubai. (2021). https://www.smartdubai.ae/
Dubai Electricity and Water Authority (DEWA). (2021). https://www.dewa.gov.ae/en
Abu Dhabi Global Market (ADGM). (2021). https://www.adgm.com/
Emirates Wildlife Society. (2021). https://www.emirateswildlife.org/

In this section, we briefly explore 3 specific social innovation initiatives that are directly related to digital literacy in the UAE. These 3 initiatives have brought about significant social impact on traditionally underserved groups, such as (i) children and youth from disadvantaged backgrounds, and (ii) women; in addition, there is a government-led and nation-wide social innovation initiative. In general, we may note that digital transformation initiatives have played a critical role in promoting social innovation and socio-economic well-being in the UAE, and have helped to create a more inclusive and prosperous society for citizens and residents.

5.2.1. Massar Programme

The Massar Programme is a social initiative led by the Federal Authority for Government Human Resources (FAHR) that leverages technology to provide education and life skills to children and youth in the UAE, especially for those from disadvantaged backgrounds[73]. This initiative has not only helped to improve the academic performance of students but also promoted their social and emotional well-being through the use of digital tools and interactive learning experiences. These skills training have empowered them to participate in the digital economy, bridging gaps with those who come from more privileged backgrounds.

Other than the provision of skills and training through the use of digital tools and interactive learning experiences, students enrolled in the program also have the opportunity for employment in the government sector. This delivers employment and financial security for these students and their families.

5.2.2. Sharjah Tatweer Forum

The Sharjah Tatweer Forum (STF) is a youth-empowerment organization that offers programs and activities to support young leaders and entrepreneurs to either establish start-ups or expand existing businesses. STF aims to empower and educate UAE nationals in the field of technology and innovation. Moreover, it has also received substantial support and interest from UAE women who are keen to stay abreast of changes in the digital revolution and become more financially independent[74].

The various programs offered under STF include training courses and workshops on topics such as coding, digital marketing, and entrepreneurship, and has helped many women in the UAE acquire new skills and launch successful technology-related startups. The STF also collaborates with organizations such as the Sharjah Business Women Council, and programs such as the Sharjah Leadership Program (SLP) and Entrepreneurs Leadership Program, to support and promote entrepreneurship among women. It has also

empowered women with knowledge and skills on the latest technological trends, such as e-commerce, smart applications, and the Internet of Things, to help them navigate the demands of the 21st century.

5.2.3. Authority of social contribution-Ma'an

The Department of Community Development of the UAE established the Authority of Social Contribution also known as Ma'an, in 2019. The main objective of this Federal Authority is to "support the growth of the community through developing social innovation solutions, encouraging a culture of giving"[75].

Among the initiatives under this Authority is the Ma'an Social Incubator (MSI), which is a social impact incubator in Abu Dhabi, devoted to encouraging innovation and entrepreneurship to develop solutions to social, cultural, or environmental challenges. Each year, MSI provides support for up to 10 teams of budding entrepreneurs in developing their innovative ideas for social impact into a social enterprise or not-for-profit association. Each team under the MSI is offered an initial investment or seed funding, a stipend, learning and development training, mentorship, and networking opportunities.

Another initiative under Ma'an is the Ma'an Grant Programme, where eligible social organizations and not-for-profits can apply for financial assistance and support to build and grow their organization, and increase their social impact. Initiatives such as these help to bridge the gap between (i) budding entrepreneurs who come from more established social capitals and networks, as well as family affluence, and (ii) those who come from less privileged backgrounds with little to no social capital or network.

Table 4 is a synthesis of good practices and lessons learnt that were induced from our examination of Singapore and the UAE.

Table 4. Cross case comparisons of good practices and lessons learnt.

	Good practices	**Lessons learned**
Digital inclusion & participation	● Digital literacy has evolved from a mere set of skills to encompass cognitive abilities that facilitate cultural engagement and critical analysis. ● The concept of digital literacy includes civic components, emphasizing participation, social justice, and civic responsibility. ● Digital inclusion and participation can bridge socio-economic disadvantages and engage grassroots communities. ● Basic access to the internet can help equalize socio-economic status and prevent further marginalization of disadvantaged groups.	● Technological changes are leading students to learn more from ICT use outside of formal education settings, which has implications for educators and education policies. ● Access to education may not necessarily mean access to other internet-enabled devices, limiting learning opportunities and participation in the digital society. ● Digital transformation initiatives can improve efficiency, effectiveness, and social inclusion in public services.
Social innovation	● Successful reduction of the digital divide can be achieved through a combination of technological advancement, government measures, and competition. ● Government leadership, strategic restrictions, and a competent bureaucracy play key roles in driving ICT-led developments and digital transformation. ● Social innovation projects and initiatives by individuals, non-profit organizations, and companies can contribute to addressing socio-economic inequalities and the digital divide.	● Social innovation provides a platform to question and explore structures, policies, and initiatives related to social issues and inequalities. ● Social innovation initiatives, particularly related to digital literacy, can have a positive social impact on vulnerable or underserved groups. ● Establishing social impact incubators, providing funding, training, and networking opportunities can support social innovation and bridge gaps in social capital and networks. ● The integration of values-based education and experiential learning fosters common core values and civic engagement among youths.

Table 4. (*Continued*).

	Good practices	Lessons learned
Socio-economic outcomes	● Policies supporting digital literacy, good governance, infrastructure, education, and digital inclusion can bridge socio-economic inequalities and the digital divide. ● Digital literacy is crucial for bridging the knowledge disparity gap and enabling sustainable development, particularly for marginalized or at-risk groups and communities. ● Basic access to the internet can aid in equalizing the socio-economic status of communities, providing opportunities for engagement, participation, and economic and political contributions.	● Socio-economic inequalities can both be reduced and widened due to internet access and policies that may either support or hinder digital inclusion and participation. ● Access to the internet and online resources can have a higher impact on individuals with lower socio-economic status, providing them with new information and networking opportunities. ● Government initiatives supporting internet connectivity and broadband infrastructure can increase social capital, community attachment, and reduce migration from rural areas. ● Educational policies should consider the rapid technological changes and the potential learning opportunities and access to knowledge provided by ICT use outside of formal curriculum time. ● Socio-economic status, measured by parental schooling, can influence the creation and sharing of content online, with higher-educated parents more likely to engage in online content sharing.

In summary, social innovation initiatives related to digital literacy and the digital economy, in both Singapore and the UAE, seem to demonstrate the potential for greater social inclusion, social impact and socio-economic transformation and opportunities to happen.

6. Discussion and conclusions

In the previous sections, we have made the case for the relationship between digital literacy and social innovation, with social inclusion and socio-economic transformation and opportunities being outcomes. We now make the case for how digital enterprise in the form of applications, people and innovation may serve as key enablers of socio-economic transformations in the emerging sharing, circular and sustainable economy. We posit that the findings of this field study are fundamental first steps towards a deeper understanding of the symbiotic relationships among digital literacy, social innovation and socio-economic transformation. The application of digital literacies to bring about positive socio-economic transformation through social innovation is a concept we would like to introduce to the literature. We call this digital social innovation.

To reiterate, the primary objective of this paper was to investigate good practices and lessons learned on how digital literacy may serve as a policy instrument for social innovation and socio-economic transformations. In our analysis of findings, we revisit Walsham's 2006[64] guidelines for framing interpretive field research: i) the primary audience of this research are policy-makers and technology firms who influence the outcomes of "tech for good" initiatives; ii) the body of knowledge we hope to contribute to is the field of ICT for development; iii) the claim that is made which would be novel to this audience of policy-makers is that tools for digital literacy, inclusion and participation may be catalysed by befitting policies in social innovation and target socio-economic transformations; and iv) the intended use of field research findings, we may conjecture, is in the practice of digital transformations for development.

We may extract the following findings from **Table 4**: (i) there are numerous field trials and pilot projects underway across the globe, such as in Singapore and the UAE; (ii) many of the best practices and lessons learned from these applications suggest that digital literacies are significant enablers and catalysts of socio-economic transformation; (iii) such innovation is key success factors (KSFs) of social transformation, primarily because they bring about synergies in citizen's competencies as well as society's capacities; and (iv)

governments, through Public-Private-Partnerships, play a significant role in setting the vision and landscape, and in providing the necessary digital and technology-supported infrastructure that can facilitate such innovation and transformation.

For instance, in Singapore, the government's Smart Nation initiative is a nationwide multi-year, multi-sectoral blueprint in digitally transforming the government, economy, and society[76]. The government believes that a whole-of-nation approach to digital transformation is needed to ensure that a sustained, socio-economic transformation can happen where no one is left behind. The Smart Nation initiative is under the Prime Minister's Office.

In the UAE, the Digital Government Strategy 2025 is driven by eight dimensions, among which are in "Leaving no one behind", and being "User driven". The nationwide strategy seeks to establish "world class digital infrastructure for the country as well as providing a unified digital platform" for all government and social services[77].

How do we justify the choice of Singapore and the UAE as units of analysis, and would our grounded theory be generalizable? Although it may appear that our choice is "convenience sampling", the 2023 Institute for Management Development (IMD) Smart City Index[78] ranks Singapore, Abu Dhabi, and Dubai among the "Top 20 Smartest Cities" in the world (Box 3). Smart City Index[78] was more relevant and useful than the Euro-centric Digital Economy and Knowledge Society Index[79], as it served our objective of deriving through field observations, a grounded theory of good practices in order to examine and better understand the various factors that affect how digital literacy knowledge and skills shape these initiatives and in turn, their impact on individuals, families, and community groups, including overall community development and socio-economic transformation and opportunities.

Box 3. IMD Smart City Index 2023.

				Rankings			
Country	Country HDI	City	City HDI	2019	2020	2021	2023
Switzerland	0.962	Zurich	0.989	1	1	1	1
Norway	0.961	Oslo	0.98	2	2	2	2
Australia	0.951	Canberra	0.98				3
Denmark	0.948	Copenhagen	0.967	4	3	5	4
Switzerland	0.962	Lausanne	0.966			4	5
United Kingdom	0.929	London	0.973	3	10	3	6
Singapore	0.939	Singapore	0.939	10	7	7	7
Finland	0.94	Helsinki	0.96	6	5	9	8
Switzerland	0.962	Geneva	0.966	7	8	6	9
Sweden	0.947	Stockholm	0.972	9	9	11	10
Germany	0.942	Hamburg	0.972		6	8	11
China	0.768	Beijing	0.907	30	22	17	12
United Arab Emirates	0.911	Abu Dhabi	0.911	16	14	12	13
Czech Rep.	0.889	Prague	0.96	8	4	10	14
Netherlands	0.941	Amsterdam	0.962	11	11	13	15
Korea South	0.925	Seoul	0.952	23	20	18	16
United Arab Emirates	0.911	Dubai	0.911	13	19	14	17
Australia	0.951	Sydney	0.952	22	32	29	18
Hong Kong	0.949	Hong Kong	0.946	38	34	33	19
Germany	0.942	Munich	0.95		17	15	20
USA	0.921	New York	0.938	34	12	19	21
New Zealand	0.937	Auckland	0.951	5	15	16	22

Adopting a field research methodology referred to as an interpretive analysis of field observations and existing policy implementation, we have derived an in-depth analysis of the various social innovation and digital literacy-related initiatives in both Singapore and the UAE, including a longitudinal-study approach to assess the measurable outcomes of individuals, specific community groups, and society at large. As the authors of this paper have majorly lived and worked in both Singapore and the UAE for a number of years, they possess real-live experiences and deep insights on the socio-economic functioning of each society. We could claim that this field research method is similar to immersive ethnographic studies where researchers document in detail phenomena of interest, while being passive or active participants in the treatments, moderators and outcomes. To restate Walsham's[64] aphorism: our knowledge of reality, including the domain of human action, is a social construction by human actors. Our theories concerning reality are ways of making sense of the world, and shared meanings are a form of intersubjectivity. Thus, we have developed our theory of good practices and lessons learnt from our knowledge of living in Singapore and the UAE through intersubjective insights and discussions.

As suggestions for future work, there is also a need to identify and understand how and to what extent digital knowledge, skills and literacy are integrated into these social innovation initiatives and how they contribute to desired outcomes. Scholars and policy analysts would need to probe further. There are questions that can guide further investigation and research into the connections between digital literacy and social innovation, inclusion, and participation. We propose the following as an agenda for further research.

First, for both countries, our field observations and analysis of existing policy implementation seem to support our literature review that: i) basic access to the Internet can aid in equalizing the socio-economic status of communities; ii) digital participation is pivotal in improving socio-economic development; and iii) policies that encourage the evolution of knowledge societies must be built upon the pretext of creating a digitally literate society to support socio-economic development.

We propose that further research builds on these three pillars to guide the theoretical framework to be used.

In addition to the theoretical framework based on the above, there are several pertinent questions that can guide future research:

1) How do the social innovation initiatives use digital tools and technologies to achieve their end-goals?
2) How do these initiatives foster collaboration among different end users and community groups as well as with government agencies or corporates to achieve their objectives?
3) What kind of digital skills and knowledge are required for individuals and organizations to participate in and contribute to these initiatives?
4) What impact do these initiatives have on the development and level of digital literacy among individuals and communities?
5) How do these initiatives address issues related to digital inclusion and socio-economic equity?

Evidence-based findings to the questions above will help us to better understand the relationship between digital literacy and social innovation in both Singapore and the UAE, and to develop rich insights that can inform policymaking, nation-wide initiatives as well as national agendas for various broader contexts. It is acknowledged that neither the UAE nor Singapore are representative in a global context. Another possible extension to the research reported in this paper is to investigate cutting-edge Web 3.0 platforms such as the Metaverse. While there is considerable agreement among scholars and policy-makers[2] that Web 2.0 technologies have supported social innovation in areas such as distance learning, crowd-sourcing, online

volunteering, and micro-financing, the application of Web 3.0 is an entirely different context worthy of further research.

While there are several gaps and challenges in digital skills and capacities that hinder the implementation of sustainable social innovation projects, our interpretive field study reveals the following fundamental good practices.

1) Lack of digital skills: there is a large pool of people with great ideas, but without the digital skills to bring their ideas to life. A great effort is needed to enable people to access digital skills. Digital social innovation education can contribute to enhancing solutions in several strategic sectors, such as healthcare, education, public participation, and the environment.
2) Limited scalability of digital social innovation projects: assessing how digital social innovation projects can scale to have a better impact is crucial to provide a concrete European model to innovation creation that considers values beyond economic factors. A one-year training program aimed at supporting the scalability of digital social innovation projects was designed to address this issue. The program applied an open design approach to the design of a P2P mentoring model and a sustainability toolkit that faces the issue of generating capacity building in emerging community of tech social innovators.
3) Uneven progress in digital transformation: the digital transformation of society and the economy is already underway in all countries, although the progress in this transformation can vary widely. There are more social innovation projects addressing global and local social problems in some countries than in others. This suggests that different levels of digital transformation might influence the social innovation potential. The integration of digital technology plays a critical role in digital transformation. Therefore, a country's progress in digital transformation is beneficial to its social innovation capacity.

In closing, some of the current gaps and challenges in digital skills and capacities that hinder the implementation of sustainable social innovation projects include the lack of digital skills, limited scalability of digital social innovation projects, and uneven progress in digital transformation. As benchmarked with the European Commission's Digital Economy & Society Index (DESI), we may categorically state that there is much for the world to learn from the examples of Singapore and the UAE as inductive research of use-cases in this paper suggest. Digital wellness is more than human capital, connectivity, integration of digital technology and digital public services while a women in digital (WiD) scoreboard is a welcome addition, it is insufficiently inclusive.

Author contributions

Conceptualization, RSS, IAM, DNG, MN and SZK; methodology, RSS, IAM; validation, MN and DNG; formal analysis, RSS, IAM, DNG, MN and SZK; investigation, RSS, IAM, DNG, MN and SZK; resources, SZK; data curation, SZK; writing—original draft preparation, RSS, IAM and SZK; writing—review and editing, RSS, IAM, DNG, MN and SZK; supervision, RSS; project administration, RSS; funding acquisition, RSS. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

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