Zero-Draft

Guide on PPPs in digital infrastructure: diagnostics in healthcare (telemedicine) and other digital public services

Disclaimer:

This preliminary draft is provided for discussion purposes only to participants of the 8th edition of the UNECE International PPP Forum. It is made available as received by the drafting team, and represents ongoing work that will be enhanced through dialogue and input from attendees. Following this collaborative feedback, the guide will undergo a rigorous peer-review process and is expected to be submitted for consideration by UNECE member States at the Working Party on PPPs in November 2024.

1. Introduction

a. Background rationale and context

This guide provides advice on approaching PPPs (‘Public Private Partnerships’) for the provision of digital public social services and infrastructure. To make the guide manageable it uses only healthcare, education and long-term care as example sectors. The principles and policies may be transposed into other social sectors.

The integration of digitisation in the planning and delivery of healthcare, education, and long-term care services infrastructure and services is a forward-thinking strategy that holds the promise of transforming these sectors. Procuring these through the PPP (‘Public-Private Partnerships') modality leverages the strengths and resources of both the public and private sectors, creating partnerships that not only enhance service delivery and infrastructure, but are also pave the way towards achieving the SDGs (‘Sustainable Development Goals’). In an era where digital transformation is profoundly changing capabilities and capacities, the role of PPPs in driving innovation and sustainability more generally in Social Sector services cannot be overstated. As such, governments worldwide are increasingly recognizing the value of these partnerships in creating more resilient, efficient, and inclusive Social Sector infrastructure and services. PPPs have emerged as a pivotal mechanism in advancing digital Social Sector infrastructure and services across various sub-sectors, including healthcare, education, and long-term care. These partnerships represent a collaborative endeavour between government entities and the private sector to address capability and capacity gaps.

The integration of digital solutions through PPPs is not just a strategic move to enhance service delivery but also a critical step towards achieving the SDGs. This document aims to contribute the cross-cutting theme of the 70th session of the ECE (‘Economic Commission for Europe’) on digital and green transformations for sustainable development, and is to be considered collectively with the ECE Guidelines on Improving the delivery of PPPs and infrastructure through digital transformations in support of the SDGs. This guide aims to contribute to the cross-cutting theme of the 70th session of the ECE on digital and green transformations for sustainable development, and is to be considered collectively with the ECE Guidelines on Improving the delivery of PPPs and infrastructure through digital transformations in support of the SDGs.

b. Purpose and scope of the guide

This guide focuses on leveraging PPPs to deploy digital solutions in 3 Social Sector domains - healthcare, education and long-term care sectors, aiming to enhance service delivery, outcomes, and contribute to the achievement of the SDGs. It serves as a roadmap for public sector entities contemplating or currently managing PPP projects in these sectors that incorporate innovative digital technologies throughout the lifecycle of PPPs. It draws on international best practices and lessons learned from the digital transformation efforts led by multilateral development banks and other entities.

c. Overview of the three services

Healthcare is the comprehensive provision of all categories of essential health services: health promotion, preventive care, curative care, rehabilitative care, and palliative care. Effective delivery of healthcare results in better health outcomes and the achievement, for all at all ages, of the WHO ('World Health Organisation') definition of health: "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity".

Education is a key element of sustainable development, economic well-being, social stability and peace. Children and young adults who gain basic skills such as reading, writing and mathematical aptitude are more likely to have a better lifetime outcomes than their peers who lack these skills.

Long-term care delivers a broad range of, often intimate, personal, social, and medical support to provide people with, or at risk of, a significant loss of personal autonomy (resulting from illness or other incapacity) a level of functional ability and quality of life consistent with their basic rights and human dignity.

2. PPPs in digital social infrastructure

a. The importance of PPPs in digital solutions for healthcare, education and long-term care

The exponential rate of innovation in digital solutions that are available, contrasted with the necessary procedures required in public procurement systems, means that private sector entities are often best placed to deliver enhanced outcomes or address capacity and capability gaps in the provision of social services. Much of the existing approach to the provision of digital solutions in the social sector has been on a wholly private sector basis. The business models used generally fall into two broad categories: out of pocket payment or surveillance capitalism.

With the direct out of pocket payment model, the onset, frequently sudden, of the need for healthcare or long-term care can have catastrophic economic consequences for the individual and regularly affects other family members, often leading to inter-generational poverty. The outcome is that the benefits of digital solution are limited to those with the ability to pay.

Surveillance capitalism is a business model in which the service is free at the point of use, but the provider collects, analyses and monetizes vast sets of personal data from individuals for targeted advertising and other purposes. While surveillance capitalism has brought about significant technological advancements and economic growth, it also raises several social ills and ethical concerns. The lack of accountability, transparency and ethical standards in data collection and use can lead to unfair treatment and discrimination against marginalized groups, including ethnic minorities, women, and low-income social groups.

To mitigate the social ills of surveillance capitalism, while reaping the benefits, requires a multifaceted strategy involving government regulation, corporate responsibility and public awareness. A PPP structure gives an established mechanism where incentives, regulations, roles and responsibilities can be delimited and allocated to achieve beneficial outcomes.

By leveraging and aligning PPP projects with social needs and capability and capacity gaps, digital innovations in the social sector projects can facilitate access to quality social services. Well-designed digital services can mitigate the economic cost of the uptake of health and long-term care and give access to education for future generations.

b. PPPs for the SDGs

The SDGs, which are the key element of the 2030 Agenda for Sustainable Development, are a shared blueprint for peace and prosperity for people and the planet, now and into the future. The achievement of the goals is beyond the resources of governments and international organisations acting alone and will require the mobilisation of considerable private sector resources. Therefore, the role of PPPs in advancing the SDGs is particularly significant. By integrating digital solutions into social infrastructure projects, PPPs can directly contribute to achieving several key SDGs, including:

- SDG 3 (Good Health and Well-being): Digital healthcare initiatives can significantly enhance the quality of care, improve access to health services, and support public health monitoring and response strategies.
- SDG 9 (Industry, Innovation, and Infrastructure): Developing digital infrastructure through PPPs fosters innovation and promotes resilient infrastructure, thereby facilitating sustainable industrialization.
- SDG 11 (Sustainable Cities and Communities): Digital solutions in healthcare, education, and long-term care contribute to making cities and human settlements inclusive, safe, resilient, and sustainable. For example, smart healthcare facilities can reduce environmental impacts and improve service delivery in urban areas.
- SDG 12 (Responsible Consumption and Production): Digital technologies can optimize resource use and waste management in social sectors, contributing to more sustainable consumption and production patterns.
- SDG 17 (Partnerships for the Goals): by fostering collaboration between governments, the private sector, civil society, and international organizations. This collaborative approach is crucial for sharing knowledge, resources, and technologies, thereby accelerating progress towards the SDGs.

By mobilizing the expertise, capacity and innovation of the private sector, progress towards the SDGs can be accelerated to deliver a more sustainable and inclusive future for all. Collaboration between governments, businesses, civil society, and other stakeholders is essential for unlocking the full potential of the 2030 Agenda for Sustainable Development.

3. The services

a. Healthcare

The healthcare sector is at a pivotal juncture, with technology playing a central role in shaping its future. The scope of digital technologies in healthcare is vast, including electronic health records,

AI ('Artificial Intelligence'), and mobile health applications, telemedicine, and beyond. These elements are crucial for enhancing healthcare delivery, improving patient outcomes, and ensuring the sustainability of health systems worldwide.

The healthcare sector is at a pivotal juncture, with technology playing a central role in shaping its future. This guide explores the transformative trends in healthcare, emphasizing the integration of AI, the importance of PPPs, and the transition towards value-based care. These elements are crucial for enhancing healthcare delivery, improving patient outcomes, and ensuring the sustainability of health systems worldwide.

Embracing value-based care represents a transformative shift in the healthcare paradigm, focusing on outcomes rather than the quantity of care delivered. This model prioritizes patient well-being, emphasizing the quality of care and its long-term impact on patient health. In a value-based care system, healthcare providers are incentivized to deliver the most effective treatments based on patient outcomes, fostering an environment where the best care options are pursued over the most procedures.

I. Overview of digital solutions in the healthcare sector

Technology stands at the forefront of healthcare innovation, offering solutions to long-standing challenges and unlocking new possibilities for care delivery:

1. Digital Health Records and Health Information Systems

Digital Health Records and Health Information Exchange Systems are essential for consolidating patient data across various healthcare providers, enabling seamless access to and sharing of patient information. This integration improves care coordination, enhances diagnostic accuracy, and facilitates timely medical interventions.

2. Telemedicine and remote monitoring

The significance of telemedicine and remote monitoring surged during the COVID-19 pandemic, highlighting their capacity to maintain continuity of care remotely. These technologies are pivotal in extending healthcare services to rural and underserved areas, reducing the need for physical travel, and enabling real-time health monitoring.

3. Artificial intelligence

Machine Learning in Radiology & Pathology: AI and machine learning are revolutionizing radiology and pathology by improving the accuracy of diagnoses and enabling the early detection of diseases. These technologies can analyze medical images and pathology slides with high precision, assisting healthcare professionals in making informed decisions.

AI and Generative AI: AI and Generative AI are at the forefront of transforming healthcare through predictive analytics, personalized medicine, and automated clinical decision support systems. AI can process vast amounts of data to identify patterns, predict outcomes, and provide insights that were previously unattainable. Generative AI, a subset of AI, is particularly groundbreaking, with the capability to create novel data instances, simulate patient responses to treatments, and generate realistic medical imaging for training and diagnostic purposes. These

technologies enhance diagnostic accuracy, optimize treatment plans, and facilitate the development of new drugs and therapies.

4. Other Digital Technologies in healthcare

RPA ('Robotic Process Automation'): RPA in healthcare optimizes administrative processes, such as appointment scheduling, billing, and patient data management. Smart systems can automate these tasks, accounting for individual variances in each repetition. RPA frees healthcare staff to focus more on patient care, thereby enhancing operational efficiency and reducing administrative burdens.

Internet of Things sensors, and blockchain technology in sustainable resource management: Sustainable resource management in healthcare involves the efficient use of medical supplies, energy, and water, as well as the effective management of medical and biohazard waste, contributing to environmental sustainability and reducing operational costs. Digital technologies can track resource use, identify waste, and optimize consumption patterns. As well as the effective management of medical and biohazard waste, thereby safeguarding environmental sustainability and curtailing operational expenditures. This multifaceted strategy leverages the latest in digital technologies—ranging from IoT sensors to advanced data analytics and blockchain systems—to meticulously monitor resource utilization, pinpoint waste generation, and streamline consumption patterns as well as secure and transparent way to manage health records and supply chains using blockchain technology, ensuring data integrity and improving the traceability of medical supplies.

Robotic Innovation: Innovations in robotics, particularly pharmaceutical and surgical robots, are transforming healthcare delivery. Pharmaceutical robots revolutionize the dispensing process by ensuring accuracy and efficiency, thereby minimizing errors and enhancing the overall quality of care. On the surgical front, robots are being employed to perform precise and minimally invasive procedures, significantly improving patient outcomes and recovery times. These robotic systems not only augment the capabilities of healthcare professionals but also introduce new levels of precision in medical treatments.

Mobile Health Applications: Mobile health applications offer a convenient way for patients to manage their health, access medical information, and communicate with healthcare providers. These apps support medication adherence, chronic disease management, and health monitoring, improving patient engagement and outcomes.

AR ('Augmented Reality')/ VR ('Virtual Reality') and E-Learning: AR and VR technologies are transforming medical education and patient care by providing immersive learning experiences for medical students and assisting surgeons during complex procedures. E-learning platforms facilitate ongoing professional development and patient education.

Digital Therapeutics and Gene Editing: Digital therapeutics offer personalized treatment options through software programs that can treat a range of conditions. Gene editing technologies like CRISPR represent a groundbreaking approach to disease treatment and prevention, enabling precise modifications to DNA to correct genetic disorders. The development and application of digital therapeutics and gene editing require significant investment in research and development, as well as ethical and regulatory considerations.

Digital platforms that facilitate collaboration among healthcare stakeholders: Digital platforms that facilitate collaboration among healthcare stakeholders are essential in creating a cohesive healthcare ecosystem. These platforms enable healthcare professionals, patients, policymakers, and technology providers to interact, share information, and co-create healthcare solutions. They support telehealth services, patient engagement, data analytics, and continuous medical education, fostering an environment of innovation and shared knowledge.

II. The benefits of digital solutions in the healthcare sector

Digital technologies are profoundly transforming healthcare, not only by streamlining operational processes but also by significantly enhancing clinical outcomes. The case studies and examples highlighted illustrate the significant potential of PPPs in leveraging technology to improve healthcare delivery. These advantages include not only improved access to healthcare and better disease management but also a notable increase in overall efficiency and improved clinical outcomes. Importantly, in the face of healthcare staff shortages and clinician burnout, digital innovations are crucial for automating routine tasks, thus boosting both the quality and efficiency of healthcare delivery.

PPPs can drive the adoption and standardization of these systems by providing the necessary funding, technological expertise, and regulatory framework. Private sector innovation can introduce advanced security measures and interoperability standards, while public oversight ensures these systems are accessible, beneficial across the entire healthcare ecosystem and provides appropriate oversight for the protection of patients data.

Some of the benefits of digital solutions are:

- Digital Health Records and Health Information Exchange Systems: Enhancing Care Coordination and Data Integrity: The implementation of digital health records and health information exchange systems is foundational to transforming healthcare delivery. These technologies facilitate seamless access to patient information, ensuring that healthcare providers have the most up-to-date and comprehensive data at their fingertips. By centralizing patient records, these systems improve the integrity and security of health data, reducing the risk of errors and enhancing patient safety. Moreover, health information exchange systems enable the efficient sharing of patient information among different healthcare providers, regardless of location. This interoperability is crucial for integrated care models, ensuring that all members of a patient's care team, including specialists and primary care providers, have access to the same information. This synchronization leads to more informed decision-making, better care coordination, and a more holistic approach to patient health these technologies also support public health efforts by providing aggregated data for research and analysis, helping to identify trends, track disease outbreaks, and inform policy decisions. By improving the accuracy and accessibility of health information, digital health records and health information exchange systems play a pivotal role in advancing the quality of healthcare delivery and patient outcomes.

Case Study: *Estonia's Electronic Health Record – See Annex 2.*

- Telemedicine, IoT sensors & Remote Monitoring Bridging the Access Gap: Telemedicine, wearable devices and remote monitoring have become increasingly important, especially in the wake of the COVID-19 pandemic. IoT Sensors: Enhanced access to healthcare for rural populations, early detection and intervention for chronic disease patients, and a decrease in hospital readmissions. The program demonstrates how technology can bridge healthcare access gaps and improve outcomes for underserved communities. These solutions extend healthcare services to remote and underserved populations, improving access and reducing the need for physical travel. These technologies also allow patients to receive care from the comfort of their homes, reducing the burden on healthcare facilities and minimizing the risk of infection spread. The deployment of telemedicine and remote monitoring technologies significantly reduces geographical barriers to healthcare access. Patients in rural or underserved regions can receive timely medical consultations, reducing the need for travel and enabling early intervention. This not only conserves healthcare resources but also supports patient adherence to treatment plans, enhancing the management of chronic conditions and reducing hospital readmission rates.

  Case Study: *Project ECHO (Extension for Community Healthcare Outcomes) - USA– See Annex 2.*

- Artificial Intelligence and Machine Learning in Radiology & Pathology: Precision and Efficiency: AI applications in radiology and pathology exemplify how technology can elevate diagnostic accuracy and efficiency. By analysing medical images with superhuman precision, AI supports radiologists and pathologists in detecting abnormalities earlier and with greater accuracy. This leads to improved treatment outcomes, as diseases can be identified and treated at an earlier stage. Furthermore, AI can streamline workflow processes, allowing healthcare professionals to focus on complex cases and patient care. AI is becoming an indispensable tool in radiology, acting as an ever-vigilant assistant that enhances clinical decision support and workflow efficiency. It aids in diagnosing and reducing errors while streamlining prioritization processes. Conditions such as diabetic retinopathy and age-related macular degeneration, showcasing the potential of PPPs to harness AI for improving diagnostic services.
- AI and Generative AI: AI applications in healthcare, such as diagnostic support and predictive analytics, can significantly enhance decision-making and patient care. These technologies enable accurate diagnoses and personalized treatment plans, contributing to a more sustainable healthcare system by reducing waste and predicting public health trends. AI in healthcare is a game-changer, offering capabilities ranging from diagnostic assistance to predictive analytics for patient management.

  Case Study: *AI: The collaboration between Google's DeepMind and the UK's National Health Service – See Annex 2.*

- RPA (‘Robotic Process Automation’): Enhancing Healthcare Workforce Capabilities: RPA transforms healthcare operations by automating routine, time-consuming tasks such as

patient scheduling, billing, and data entry. This automation frees healthcare staff to focus on more critical aspects of patient care and decision-making. By reducing administrative burdens, RPA contributes to lowering the risk of burnout among healthcare professionals and improves the overall efficiency of healthcare services. RPA augments healthcare workforce capabilities, allowing professionals to focus on complex care needs and improving patient outcomes. RPA in healthcare automates repetitive, rule-based tasks, such as patient scheduling, billing, and claims processing, freeing up healthcare professionals to focus on patient care.

Case Study: *San Raffaele Hospital, Milan– See Annex 2.*

- Internet of Things (IoT) sensors, and blockchain technology in sustainable resource management: Digital technologies play a crucial role in sustainable resource management within healthcare facilities. Systems that monitor and analyse energy use, waste production, and resource allocation help hospitals reduce their environmental footprint while ensuring optimal patient care. This approach not only supports environmental sustainability but also translates into cost savings and improved operational efficiency. A report by the World Health Organization[1] highlighted the potential for smart technologies to optimize supply chains and reduce healthcare costs, contributing to the sustainability of health systems globally.
    - IoT Sensors: Enhanced access to healthcare for rural populations, early detection and intervention for chronic disease patients, and a decrease in hospital readmissions. The program demonstrates how technology can bridge healthcare access gaps and improve outcomes for underserved communities.
    - Blockchain Technology: The implementation of the blockchain system leads to a significant reduction in counterfeit drugs, improved supply chain efficiency, and enhanced patient safety. The transparency and security provided by blockchain technology foster trust among consumers and stakeholders in the healthcare ecosystem.

Case Study: *Blockchain Technology– See Annex 2.*

- Robotic Innovation: Innovations such as pharmaceutical & surgical robots, Surgical and pharmaceutical robots offer transformative benefits to healthcare systems, enhancing patient care, safety, and operational efficiency. Surgical robots enable minimally invasive procedures with greater precision and control, leading to shorter recovery times, reduced hospital stays, and improved surgical outcomes. This not only enhances patient satisfaction but also reduces the risk of complications. On the pharmaceutical side, robots streamline the medication dispensing process, significantly reducing errors, ensuring accurate medication management, and freeing pharmacists to focus more on patient consultation and care. Together, these robotic innovations represent a leap forward in healthcare technology,

1 (https://www.who.int/docs/default-source/documents/gs4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf).

promising a future where medical treatments are safer, more efficient, and increasingly patient-centred enhancing healthcare efficiency and sustainability. Case Study: UCSF Medical Center's Use of Pharmacy Robots. The University of California, San Francisco (UCSF) Medical Center implemented robotic technology in its pharmacies to automate the process of preparing and dispensing medications.: While this implementation is not a PPP in the traditional sense, it showcases how partnerships between healthcare institutions and technology providers can enhance operational efficiency and patient safety. The use of robotics significantly reduced medication errors, increased efficiency, and allowed pharmacists to focus more on patient care rather than the manual preparation of prescriptions.

Case Study: *The Da Vinci Surgical System in Veterans Health Administration– See Annex 2*.

- Mobile Health Applications: Empowering Patients: Mobile health applications empower patients by putting health management tools directly in their hands. These apps can track vital signs, medication adherence, and even provide virtual coaching for lifestyle changes. By engaging patients in their health journey, these applications promote self-management of chronic conditions, improve health literacy, and foster a proactive approach to health and wellness. Health apps empower individuals to manage their health, promoting preventive care and facilitating chronic condition self-management.

Case Study: *Babyl Rwanda– See Annex 2*.

- AR ('Augmented Reality')/VR ('Virtual Reality') and E-Learning: Transforming medical education and treatment: AR and VR technologies revolutionize medical education and patient treatment by providing immersive learning environments and simulating complex medical procedures. This not only enhances the training of healthcare professionals but also offers novel therapeutic avenues, such as pain management and rehabilitation exercises, improving patient outcomes and experience. These technologies offer personalized learning experiences and training opportunities, transforming medical education and professional development. inventory management, reducing waste and ensuring the timely availability of medications.

Case Study: *Project BRAVR* – See Annex 2.

- Digital Therapeutics and Gene Editing: Pioneering New Frontiers in Treatment: Digital therapeutics and advanced gene editing technologies, like CRISPR, open new frontiers in the treatment and prevention of diseases. By offering personalized treatment plans and targeting the genetic bases of diseases, these technologies present alternatives to traditional treatments with the potential for more effective and long-lasting outcomes. Technologies like CRISPR for gene editing represent the cutting edge of disease treatment and prevention, offering potential beyond traditional therapeutic approaches.

Case Study: *CRISPR* – See Annex 2.

- Digital platforms that facilitate collaboration among healthcare stakeholders': Digital platforms that facilitate collaboration among healthcare stakeholders are transforming the healthcare landscape by enabling more efficient, patient-centred, and collaborative care. This collaborative approach ensures that the platforms are not only technologically advanced but also aligned with healthcare policies and standards, making them more effective in addressing the needs of the healthcare community. Moreover, PPPs can drive the integration of these platforms with existing healthcare systems and digital health records, enhancing interoperability and the seamless exchange of information. Through such partnerships, digital collaboration platforms can be designed to be inclusive, catering to the diverse needs of patients, healthcare providers, and other stakeholders, thus democratizing access to healthcare information and services.

Case Study: *The NHS COVID-19 app development – See Annex 2.*

b. Education

I. Overview of digital solutions in the education sector

A core objective set forth by the SDGs is quality education. SDG4 aims to ensure inclusive and equitable quality education for all and to promote lifelong learning. Digital solutions in the education sector play a crucial role in achieving SDG4. Integrating digital technologies in education can yield numerous advantages to enhance the overall quality of education, in addition to maintaining environmental sustainability. Students have the opportunity to gain equitable access to a variety of resources and materials; and to enhance and develop their knowledge and skills. Furthermore, this integration promotes engagement and motivation, and prepares students for the digital world.

The turning point for digital transformation in education was the global lockdown caused by the COVID-19 pandemic. It was estimated that 1.2 billion students were out of school, forcing educational institutions to quickly adapt to the use of EdTech ('Education Technology'). The significant surge in the usage of EdTech has accelerated the integration of technology, improved digital infrastructure, and brought about innovations in teaching methods. Long before the COVID-19 pandemic, EdTech was seeing rapid expansion; the lockdown created a burning platform for accelerating adoption. The global EdTech industry is expected to increase at a CAGR ('Compound Annual Growth Rate') of 16.3% from 2019 to 2025, resulting in a total global expenditure of $404 billion[2].

The platforms and technologies that have been developed and innovated to improve access and quality of education fall into the following categories: E-learning platforms; Massive Open Online Courses; Adaptive Learning Technologies; Virtual Labs; and Augmented Reality:

2 HolonIQ, 2020 [full reference to be provided once format is agreed].

- E-learning equips learners with educational materials, activities, and services that utilize digital technologies to access educational content outside of traditional classrooms and from anywhere in the world.
- MOOCs are a distinct class of E-learning platforms that are cost-effective and sometimes free. Enhancing accessibility among students around the world, MOOCs provide students with comprehensive course experiences, such as video lectures, group discussion forums, quizzes, and online assignments. Adaptive learning technologies influence the future of digital learning innovation. It is a system that uses algorithms to tailor students' overall learning experiences to their individual needs.
- Virtual Labs and AR mark a significant shift in educational technology. Virtual labs enable students to conduct experiments in a virtual environment, whereas AR allows them to view information layered in the real world. It is a new dimension that enhances the interactive learning experience.

In the following section we will examine these platforms and innovative technologies amongst others and evaluate their impact on improving the overall educational quality by assuring flexibility, accessibility, inclusion, and sustainability.

1. E-Learning Platforms and Massive Open Online Courses (MOOCs)

In an era defined by advancements in digital technologies, the educational sector has experienced a massive transformation, with digital technologies transcending beyond the constraints experienced in traditional classrooms. The new educational realm is one where education has no boundaries. At the center of this digital transformation are interactive e-learning platforms, followed by a proliferation of Massive Online Open Courses (MOOCs) that have contributed to the democratization of education, making it possible for people anywhere on the globe to access knowledge through the internet, eliminating geographical barriers, particularly for underserved communities or for those who have logistical issues with reaching a classroom setting. Advancements in areas such as AI and VR could further enhance engagement and learning outcomes for online learners. These factors are leading to the widespread adoption of digital technologies in education, both in and out of the classroom, which in turn will lead to reshaping the educational sector worldwide.

The popularity of MOOCs has recently experienced an explosive growth, with statistics showing that over 49% of students worldwide have completed some sort of online course (in the US the statistic is lower at 30% of American students). MOOCs have propelled the growth of overall online learning, which has grown by a massive 900% since the year 2000 when it was first started. The number of students enrolling for online learning worldwide is expected to hit 57 million by 2027[3]. Estimates indicate that between 2018 and 2026, the online learning industry will have grown at a CAGR of 9.1%. In terms of revenue, the online learning industry is projected to be worth more than USD $370 billion by the year 2026[4].

3 Peck, 2024 [full reference to be provided once format is agreed].
4 Peck, 2024 [full reference to be provided once format is agreed].

The rapid growth in the adoption of e-learning platforms and MOOCs is attributed to global accessibility facilitated by affordable digital and internet technologies; their cost-effectiveness compared to traditional education models; their efficiency and perceived effectiveness; and the flexibility that self-paced learning provides which better matches the needs of learners. In terms of efficiency, time-saving studies indicate that the time needed to learn a subject can be reduced by about 40% to 60%3. In terms of perceived effectiveness, statistics show that 70% of students consider online learning to be better than traditional classroom learning.

E-learning platforms and innovative technologies in education have caused a significant shift in educational quality and more importantly, access to knowledge and education, enabling more countries to align with SDG 4 as they provide inclusion and equitable access, notwithstanding geographical location and personal circumstances; promote a diverse learning environment, embracing learners of all backgrounds and abilities; and enhance sustainability while reducing environmental impact.

2. Adaptive Learning Technologies

Adaptive learning technology presents an innovative way of delivering learning using data-driven instruction and insights to tailor learning experiences to the individual needs of each student. Adaptive learning systems can track and generate insightful reports on student progress, engagement, and performance. Believing that every student is different, adaptive learning utilizes today's technological advancements in algorithms and data analytics to tailor learning instruction to meet the unique needs of individual learners[5]. By harnessing personalized learning pathways, adaptive feedback mechanisms, and data-driven insights, these platforms equip learners to achieve their full potential while supporting educators in delivering effective instructions[6].

Adaptive learning technologies have demonstrated remarkable outcomes in the learning process. Their transformative impact was realized when it was applied at the University of California, Los Angeles where the median scores in exams recorded a significant improvement, growing from 53% to an impressive 72% to 80%. The impact was also felt on the course attrition rate which experienced a four-fold reduction from 43.8% to a commendable score of 13.4%. In terms of DEI, a striking achievement was realized among female students who recorded a remarkable ten-fold reduction in course attrition from 73.1% to 7.4%[7]. These statistics demonstrate the transformative impact of adaptive learning technologies, amplifying comprehension of learning, as they follow a path of uniquely tailored content that enhances the growth and expansion of knowledge.

The global Adaptive learning market size was estimated at US$3.48 billion in 2023 and is expected to be worth US$8.8 billion by the year 2028, growing at a CAGR of 20.40%[8]. The key drivers for the growth and expansion include the growth of innovative technologies such as data analytics and artificial intelligence and government efforts to improve learning outcomes and prepare learners for the highly developing job market needs. This data-driven approach enhances the sustainability of educational interventions by enabling continuous improvement of teaching and learning strategies.

5 Gang, 2023 [full reference to be provided once format is agreed]
6 Malik, 2022 [full reference to be provided once format is agreed]
7 Movchan, 2018 [full reference to be provided once format is agreed]
8 Research and Markets 2023 [full reference to be provided once format is agreed]

Adaptive learning has also helped transform the teaching experience for teachers and instructors, particularly in delivering learning content more effectively. Through personalized instruction, real-time tracking of learning progress; efficient allocation of resources; and empowering teachers with data-backed decisions, adaptive learning has served as a "virtual teaching assistant" for teachers, helping students identify their strengths, weaknesses, and learning pace. As the education sector continues to grasp digital solutions, adaptive learning technologies stand out as a promising approach to address the diverse needs of learners and promote lifelong learning opportunities[9], further enabling countries to achieve SDG4.

3. Virtual Labs and Augmented Reality in Education

Virtual labs and Augmented Reality (AR) are emergent technologies that are revolutionizing the education landscape. Virtual labs present simulations of real-world environments, enabling students to undertake experiments and have hands-on, engaging learning activities in virtual settings that can be possible in a traditional class setting. AR uses digital content to represent the physical world, which facilitates hands-on learning by offering interactive and immersive experiences that create an interactive and highly engaging learning environment. Combined, these immersive technologies help learners to easily comprehend complex subjects and make learning content more appealing, and easy to remember. Furthermore, these technologies help build a collaborative learning environment where learners can collaborate to accomplish tasks in the virtual world and later apply those experiences to solving real-world problems.

AR has emerged as one of the leading and fastest-growing trends in EdTech. By 2023, there were approximately 1.4 billion active AR user devices, and this figure was expected to dramatically grow to over 17.3 billion AR user devices in the world by 2024. Currently, 3 out of 10 Americans use AR user devices. Statistics have also indicated that approximately 3 in 4 adults under the age of 44 years are aware of AR, and over 91.75% of Gen Zs are interested in AR applications. The AR market size in training and education is projected to grow to reach US$173.2 billion at a CAGR rate of 54.8% by 2028[10] and the VR market size in education is projected to grow to reach US$61.55 at a CAGR rate of 39.1% by 2028.

Key trends driving the growth of virtual labs and AR technology include growing worldwide trends towards personalized learning and, growing emphasis on STEM ('Science, Technology, Engineering, and Mathematics') education, where immersive experiences enabled by these technologies facilitate experimentation and problem-solving in STEM subjects. The growth of AR and virtual labs is also driven by their expandability and ability to offer cost-effective alternatives to traditional lab equipment, which makes learning more affordable and sustainable in the era of increasing student populations. This reduces the overall cost per capita to the economy, adding o the sustainability of providing education and learning to society. Virtual labs and AR technologies align with workforce needs and industry demands, offering learners hands-on experience and practical skills that are relevant to their fields of study.

Today, as in other industries, in the social sectors such as healthcare are deploying AR to simulate key processes for training purposes. It is important for educational institutions to integrate AR

9 Malik, 2022 [full reference to be provided once format is agreed]
10 Howarth, 2024; Kamińska et al., 2023 [full reference to be provided once format is agreed]

technologies into their curricula for improved learning outcomes. Through their ability to simulate real-world situations, these technologies offer highly interactive, experiential learning that surmount physical restrictions, ensuring access to quality education for all. Moreover, these immersive technologies promote inclusivity by accommodating diverse learning needs and styles, which promotes a supportive learning environment. Counting on their cost-effectiveness and scalability, the contribution of these innovative technologies will continue to grow offering sustainable solutions that improve education quality and support better preparation of students for the challenges of tomorrow.

4. Other Digital Technologies in Education

Other EdTech solutions include Gamification and Game-Based Learning platforms, that aim at making learning more engaging, interactive, and competitive, which fosters active participation, better comprehension, and knowledge retention in their learning endeavours.

There are also OER ('Open Educational Resources') that offer free or low-cost access to learning resources such as textbooks, educational simulations, educational videos, etc. This promotes affordability and therefore more equitable access to education. There are Mobile Learning Apps such as Udemy, Kahoot, and StudyBlue that offer interactive learning tools that offer highly personalized, on-the-go learning. There are Voice Assistants and Chatbots that are powered by AI, which offer learners instant access to information facilitating learning. Other emerging EdTech solutions include Social Media Learning which leverages connectivity and interactivity offered by social networking sites such as Facebook and LinkedIn to facilitate communication, collaboration, and knowledge sharing among educators and learners. Furthermore, there is increasing application of Blockchain technology in education by offering block-based credentials and digital verification of digital certificates, which enhances the security, transparency, and authenticity of the certificates and credentials offered after completing online courses.

Generally, following the rapid adoption of EdTech during the pandemic, this is now primarily driven by the need to enhance learning outcomes, adapt to the ever-evolving pedagogical approaches and learning methods, and prepare learners for success in this rapidly changing digital working environment.

II. Benefits of digital solutions in the education sector

Digital technologies have emerged as powerful tools in addressing the evolving needs of the education sector enhancing education quality among other learning outcomes worldwide. Adoption of these digital technologies needs large commitments of financial resources. Therefore, governments, international organizations, and non-governmental organizations have stepped in to partner with learning institutions to finance digital solutions in education, and this section highlights some cases where such initiatives have helped drive a positive impact on educational and learning outcomes across the globe.

Digital solutions have enhanced access and inclusivity in education by breaking down the barriers to quality education by providing access to learning materials and resources to learners overcoming the limitations of geographical location, and socio-economic background. To achieve this objective, PPPs are initiatives that combine resources from both the public and private sectors, aiming to harness financial support, technological skills, and digital educational content. One of the major

PPPs involves the VUP ('Virtual University of Pakistan') which was established by the government of Pakistan as a not-for-profit, world-class education center for learners all over the country.

Case Study: *Virtual University of Pakistan – See Annex 2.*

Digital solutions in education foster collaboration and knowledge sharing among learners, educators, and communities, providing a favourable environment through learning can be supported. This is demonstrated through sponsored initiatives such as UNICEF's "Learning Passport" enabling grade 1 to 8 children from troubled areas such as Sudan to access their entire learning and national curricula.

Case Study: *UNICEF's Learning Passport – See Annex 2.*

Digital solutions help in creating highly personalized learning experiences that are tailored to meet the needs of each learner. Most EdTech solutions are highly interactive helping to foster learner engagement and achieve a better understanding of the concepts taught.

Case Study: *Rwanda's Smart Classroom Initiative – See Annex 2.*

Digital solutions offer a wide range of learning tools, resources, and professional development opportunities for educators, thus enhancing their instruction delivery skills and empowering them to offer high-quality learning and support for improved learner outcomes. By focusing on teacher training, such initiatives contribute significantly towards improving the quality of education by instilling effective instructional approaches. Overall, initiating digital technologies has had a positive impact on learning outcomes across the world. By leveraging digital solutions and innovative learning instruction delivery approaches, stakeholders in education can collaboratively work towards building inclusive, equitable, and high-quality education systems that will transform learning in this digital era.

Digital technologies offer immense opportunities for personalized learning, collaboration, and engagement thereby significantly contributing to accessibility, inclusivity, and sustainability of learning and education practices. With the rapidly increasing accessibility of digital resources, tools, and platforms, educators and stakeholders have no option but to keep on leveraging technology to create innovative learning environments, that provide the diverse needs of learners and foster lifelong learning skills that are important for the 21st-century workforce.

c. Long-Term Care

I. Overview of digital solutions in the long-term care sector

The objective of long-term care is: to promote healthy ageing; to minimise the impact of Non Communicable Diseases and provide access to health and social care services, which help people live longer, healthier lives. The social determinants of health have a major impact on ageing populations health, well-being, and quality of life. As the Sustainable Development Goals are achieved, it can be anticipated that that populations will live longer and the need for long-term care

will increase. It is difficult to anticipate changes in patients' health conditions, which makes strategic planning difficult.

Ageing Populations have varying support needs. They can be broadly categorised as follows

- Community Living:
    - At home: living independently, possibly, supported by informal care (family etc);
    - Sheltered: living independently, supported by professional social care;
    - Medically supported: living independently, supported by professional medical care, usually primary healthcare givers.
- In patients:
    - Under treatment: in a secondary or tertiary healthcare facility receiving medical and/or rehabilitation treatment, possibly waiting discharge, supported by professional medical care;
    - Under continuous care: in a social care facility, supported by professional social care.

These are not hard boundaries and often individuals will straddle categories or frequently move between categories as their individual circumstances change. As ageing populations increase, both in absolute numbers and as a percentage of any population it will be increasingly challenging to meet the needs of everyone requiring care. The extent to which individual requirements are met often may be driven by cost and ability to pay rather than need. The traditional approach to delivery of long-term care is very labour intensive. Across the UNECE member states, the vast majority of the burden falls on informal caregivers, particularly family members. While saving direct costs to governments, this burden creates indirect economic costs as caregivers are diverted away from employment and other economic activity.

Managing ageing populations with long-term care needs is challenging, with a high incidence of cognitive and functional impairment. Cognitive impairment refers to a decline in cognitive abilities, including memory, attention, language, executive function, and problem-solving skills. It can range from mild impairment to severe dementia. Functional impairment covers difficulties in performing activities of basic self-care (eg, bathing, dressing, toileting), to complex activities (eg, managing finances, meal planning & preparation and social interaction).

Successful management involves the collaboration of government, healthcare providers, community organizations, and the individuals themselves. The collaboration required lends these activities to Public Private Partnership structures. Management strategies may include:

- Promoting healthy lifestyles: this includes initiatives like exercise programs, access to nutritious food, and preventative primary and secondary healthcare measures;
- Encouraging social inclusion: older adults should be encouraged to remain active and engaged in their communities. This can include social programs and activities, volunteering, and access to public transportation;

- Assist retirement planning: provide support and education to help people plan for retirement and manage their lives in their later years;
- Provide long-term care services: providing access to affordable long-term care facilities and services, including nursing homes and in-home care;
- Design age-friendly cities and communities: designing communities that are accessible, safe, and supportive for people of all ages, including older adults.

  Digital and AI solutions can contribute to the delivery of more efficient, proactive, and personalized care experiences that improve outcomes, while reducing the challenges of providing traditional log term care. To ensure the most benefit, it is vital to address issues raised by digital solutions including technology obsolescence, data ownership, privacy, interoperability, and social acceptance.

1. Remote monitoring and management

Digital platforms enable remote monitoring of patients' vital signs, activities of daily living, and medication adherence. Real-time access to patient information, care plans, and communication channels ensures efficient coordination across multidisciplinary teams, leading to better outcomes and reduced medical errors.

- **Well-being Monitoring:** Wearable devices equipped with sensors can continuously monitor vital signs such as heart rate, blood pressure, and oxygen saturation levels. This real-time data allows caregivers to track user's health status more effectively than periodic checks and when coupled with AI analysis pre-emptively intervene, preventing medical emergencies.
- **Medication Management:** remote management can be integrated with medication management systems to provide reminders and notifications for medication adherence. By delivering timely reminders, these devices help residents stay on track with their medication schedules and reduce the risk of medication errors or missed doses.
- **Care Coordination Platforms:** Digital platforms facilitate seamless communication and collaboration among healthcare professionals, patients, and family caregivers. When integrated into the healthcare system, telemedicine facilitates virtual consultations with healthcare providers, reducing the need for in-person visits while still enabling timely interventions. It also allows non-medical caregivers to reach back, virtually, to general or specialist medical support.

It should be borne in mind that there is considerable interface between long-term care and healthcare. This should be reflected in the structuring of remote monitoring and management systems.

2. Wearables

Wearables are sensors embedded in the environment or integrated into wearable devices can record real time individual data. AI algorithms can analyse this data to detect abnormalities, monitor health trends, and provide personalized recommendations for lifestyle modifications. In long-term care settings wearables offer a range of benefits for both users and caregivers. Typical use cases are:

- **Event detection and reporting:** Wearables with built-in accelerometers and motion sensors can detect events such as falls or abnormal activity patterns. These devices automatically alert caregivers when an event occurs, enabling prompt assistance.
- **Safeguarding:** Wearables can incorporate tracking and geofencing technology to enhance safeguarding for users, especially those with cognitive impairment. Caregivers can receive alerts if a user strays outside a designated area, enabling prompt intervention and ensuring their safety.

3. Roster Management

Long-term care is a sector which is subject to high levels of staff turnover. Digital platforms facilitate seamless communication and collaboration among healthcare professionals, patients, and family caregivers. These platforms centralize patient information, care plans, and communication channels, improving continuity of care. These systems can deliver the following capabilities:

- **Efficient Scheduling:** Digital roster management systems enable administrators to create and manage staff schedules efficiently. They can coordinate staff availability, work preferences, and skill sets, allowing for more appropriate and fair scheduling. These systems often include features automated scheduling algorithms to optimize staffing levels and minimize gaps or overlaps in coverage.
- **Real-time Updates:** Digital roster management systems provide real-time visibility into staff schedules, allowing administrators and staff members to access up-to-date information. This ensures that everyone is aware of their assigned shifts, time-off requests, and any changes to the schedule, reducing confusion and miscommunication.
- **Staff Communication:** Many digital roster management systems include built-in communication tools such as messaging or notification features. This enables teams to communicate important updates, announcements, or shift changes directly to team members, facilitating seamless communication and reducing reliance on traditional methods such as phone calls or email.
- **Regulatory Compliance:** Digital roster management systems can help ensure compliance with regulatory requirements by automating rule-based scheduling and tracking qualification validity. They can also generate reports and analytics to fulfil regulatory reporting requirements.

4. Other Digital Technologies in long-term care

Many consumer technologies can be applied to the long-term care sector. These will require appropriate regulation to ensure that the user's interests are not compromised. Examples of technologies are:

- **Chatbots and Virtual Assistants:** AI-powered chatbots and virtual assistants offer round-the-clock support for users and caregivers, answering inquiries, providing educational resources, and scheduling appointments. Natural language processing enables these virtual agents to understand and respond to users' needs effectively.

- **Virtual Reality (VR) Therapy:** VR technology offers immersive experiences that can alleviate pain, reduce stress, and improve cognitive function in long-term care settings. VR simulations also provide training opportunities for caregivers and enhance the mental well-being of users through virtual travel and recreational activities, which may be beyond their physical capabilities.

II. Benefits of digital solutions in the long-term care sector

Populations are ageing across the UNECE member states. This will create a growing requirement for long-term care. Digital solutions, especially those enhanced by Artificial Intelligence, have the potential to address the intrinsic challenges of providing effective long-term care. They offer improved efficiency, personalized care, and enhanced quality of life for both users and care providers. It is important to stress that the maximum benefits comes from employing solutions as part of an integrated system, where each individual solution or approach is part of a layered health and social care system.

The key benefits of effective digital care services are:

- Provide timely access to information about the needs of users and the care they have received across the system, so they can be provided with integrated person-centred support
- Generate systemic operational and individual insights to allow the delivery of proactive care.
- Improve the accuracy and security of individual records.
- Maximise the effective use of limited resources.

4. Policy options and recommendations

It is crucial to recognize the dynamic and rapidly evolving nature of emerging digital technologies in the Social Sector. It emphasizes the need for a supportive regulatory framework, stakeholder engagement, transparency, knowledge sharing, incentives for private sector involvement, and capacity building for effective implementation. These recommendations are designed to create a robust ecosystem for digital Social Sector PPPs, where innovation flourishes, stakeholders collaborate effectively, and social outcomes are significantly improved. By addressing these key areas, governments and their private sector partners can navigate the complexities of modern technology, ultimately delivering more efficient, accessible, and personalized services to populations.

a. Key policy recommendations

I. Enhancing the regulatory / legal framework

Objective: To create a conducive environment for digital service innovations while ensuring users safety, data privacy, and ethical considerations.

In sectors outside regulated domains like healthcare, innovations, particularly those involving AI, often progress rapidly from concept to market due to fewer regulatory barriers. These sectors prioritize speed to market, consumer engagement, and iterative improvements based on user

feedback. Regulatory frameworks, where they exist, generally focus on data security and consumer protection without the need for proving service efficacy.

Contrasting sharply with mainstream sectors, innovations in regulated sectors such as healthcare, education and long-term care, especially those employing AI for decision support, undergo rigorous scrutiny before they can be deployed. This is due to the direct impact these technologies have on e.g. patient health outcomes, delivery of curriculum and effectiveness of monitoring of elderly patients. Innovations in such regulated sectors must navigate a complex landscape of regulatory approvals, including. In the many countries, AI-based clinical decision support tools must often receive medical device approval, demonstrating not only their safety and privacy compliance but also their clinical efficacy. This process involves comprehensive clinical trials designed to rigorously evaluate the technology's impact on patient care, which can be both time-consuming and resource-intensive.

Unlike mainstream tech products, healthcare innovations must undergo clinical trials to validate their effectiveness and safety. These trials are critical in ensuring that the technology improves patient outcomes without introducing unintended harm, adhering to the principle of "do no harm" in medicine. stakeholders can facilitate the responsible and effective integration of AI in healthcare. This ensures that while innovation thrives, it does so with a foundational commitment to enhancing patient care, safety, and privacy.

Actions:

- Develop clear, flexible regulations that can adapt to technological advancements.
- Establish open standards for data interoperability, privacy, and security, facilitating seamless and secure information exchange.
- Promote regulatory harmonization across jurisdictions to enable the scalable implementation of digital service solutions.
  - To address the unique challenges of healthcare innovation, especially in the domain of AI and clinical decision support, regulatory bodies and policymakers must consider several key factors:
    - Adaptive Regulations: Developing adaptive regulatory frameworks that can keep pace with the rapid advancements in AI technology, allowing for timely market entry while ensuring patient safety.
    - Clear Guidelines for AI Integration: Establishing clear guidelines for the integration of AI technologies in clinical settings, including standards for data handling, algorithm transparency, and outcome reporting.
    - Collaborative Regulatory Pathways: Encouraging collaborative pathways for regulatory approval, involving ongoing dialogue between innovators, regulators, clinicians, and patient advocacy groups. This collaboration can help identify practical, evidence-based criteria for the deployment of AI in healthcare.

- Adopt innovation-Friendly Policies: Implementing policies that incentivize innovation in digital services and AI applications, such as expedited review processes for technologies that address urgent needs or demonstrate potential for significant service impact.

II. Advocating stakeholder engagement

Objective: To ensure the inclusivity and effectiveness of digital health initiatives by involving all relevant parties in the planning and implementation phases.

Actions:

- Create platforms for continuous dialogue between governments, technology providers, service professionals, and users.
- Incorporate user and provider feedback into the development and refinement of digital tools.
- Facilitate multi-sectoral and international collaborations to align goals, leverage resources, and address service challenges comprehensively.

III. Encouraging transparency and accountability

Objective: To build trust and ensure the integrity of PPPs in digital healthcare.

Actions:

- Implement open procurement processes for PPP projects, ensuring fair competition and value for money.
- Establish clear metrics and benchmarks for project performance, with regular reporting and public disclosure of outcomes.
- Create oversight bodies or mechanisms to monitor PPP agreements, ensuring compliance with contractual obligations and ethical standards.

IV. Promoting knowledge sharing and collaboration

Objective: To accelerate the adoption of digital technologies through shared experiences and best practices.

Actions:

- Establish forums, workshops, and online platforms for stakeholders to exchange knowledge and innovative practices.
- Support cross-border collaborations to achieve improved performance, explore and adopt international best practices in digital social services.

V. Incentives to private sector involvement

Objective: To attract and sustain private sector investment and innovation in digital social services.

Actions:

- Offer tax incentives, grants, or subsidies for research and development in digital technologies.
- Provide a clear path to market for digital service solutions, including streamlined approval processes and pilot testing opportunities.
- Establish risk-sharing mechanisms to mitigate private sector apprehension regarding investment in innovative but unproven technologies.

VI. Building capacity for effective implementation

Objective: To empower public sector entities to be effective partners in PPPs, ensuring projects are managed efficiently and aligned with public health goals.

Actions:

- Invest in training programs for public sector officials on managing PPPs, digital service technologies, and data governance.
- Develop frameworks for project management, financial oversight, and partnership governance within public institutions.
- Foster a culture of innovation within the public sector, encouraging openness to new technologies and collaborative approaches to social challenges.

Conclusion

a. The path forward for PPPs in digital transformation

The integration of public-private partnerships (PPPs) with digital service innovations represents a transformative approach to modernizing service delivery. This strategic alliance is poised to tackle existing service challenges head-on, promising to make social service systems more resilient, accessible, and equipped to offer superior outcomes. The insights provided herein serve as foundational guidance for harnessing the potential of PPPs in the digital service landscape, advocating for an ongoing evolution of strategies to maximize their impact.

The trajectory of all services is increasingly digital, with PPPs playing a pivotal role in this evolution. The successful fusion of digital solutions and PPPs is crucial for the future of social services, offering a blueprint for public entities to effectively engage with the complexities of digital initiatives. This guide emphasizes strategic planning, comprehensive stakeholder engagement, and the development of flexible policy frameworks as cornerstones for navigating the digital transformation in society through PPPs. By following this roadmap, public and private sectors can collaborate more effectively, leveraging digital technologies to enhance service delivery and population outcomes.

b. Further developments and refinements for the guide

As the digital social service sectors continue to evolve, driven by rapid technological advancements and shifting global social priorities, this guide will need to be periodically updated to stay relevant. Future versions should incorporate new insights from emerging digital technologies, best practices

gleaned from successful PPP projects, and feedback from the global social service community. These refinements will ensure that the guide remains a vital and practical resource for stakeholders involved in PPPs, facilitating the ongoing digital transformation of healthcare. The commitment to continuously update this guide reflects the dynamic nature of digital social services and the necessity of adaptive strategies to meet the changing needs of the UNECE member states.

The ultimate goal is to foster a partnership environment where digital solutions, powered by effective PPPs, can thrive and expand access to quality services for all. By remaining adaptable and forward-thinking, the global social service community can unlock the full potential of digital innovations, ensuring that health, education and long-term care systems around the world are prepared to meet the challenges and opportunities of the 21st century and beyond.

Annexes

Annex 1: Glossary of terms

Annex 2: Case studies

Annex 1 - Glossary

The following definitions are used in this guide:

Term	Definition
AI	Artificial Intelligence – System programming approach in which systems are taught to learn for themselves and remember their mistakes, instead of simply executing predetermined instructions. As the technology develops, the more systems will be able to 'understand' and read situations, and determine their response as a result of the totality of data that they acquire.
AL	Adaptive Learning - Delivering learning using data-driven instruction and insights to tailor learning experiences to the individual needs of each student.
AR	Augmented Reality – using technology to overlay information over real world views
CAGR	Compound Annual Growth Rate - is the mean annual rate of return over a number of years, smoothing out fluctuations in individual years.
CRISPR	is a genetic engineering technique by which the genomes of living organisms may be modified.
DNA	DeoxyriboNucleic Acid- the basic building blocks of living organisms.
ECE	United Nations Economic Commission for Europe - also known as UNECE
EdTech	Education Technology – Collective description of the provision of technology in the field of education
EHR	Electronic Health Record - also known as an Electronic Medical Record (EMR)
Genome	A pattern of DNA that describes a living organism
IoT	Internet of Things – Collective description of autonomous devices able to communicate over the internet.
Machine Learning	The training of AI systems through the automated analysis of very large sets of data.
MedTech	Medical Technology – Collective description of the provision of technology in the field of healthcare.
MOOC	Massive Online Open Course – Training and education delivered online to large numbers of, usually remote, students.
NHS	National Health Service – The public healthcare service of the United Kingdom

Term	Definition
Out of Pocket	Paid by the individual receiving the service.
PBC	Process Based Care – the traditional episodic approach to care where conditions are treated separately in a process of diagnosis and treatment according to established pathways and protocols. Providers are incentivised and rewarded based on the volume of services provided.
PPPs for the SDGs	“PPPs for the SDGs” can be perceived as a type of Public-Private Partnerships (PPPs) designed to implement the Sustainable Development Goals and thereby to be “fit for purpose”. It is defined as an enhanced approach for PPPs that overcomes some of the weaknesses in the way the traditional PPP model has been implemented. PPPs are contract delivery tools for public infrastructure provision involving initial private financing. They include two types: “government-pay PPPs” which are primarily funded by taxpayers and “concessions” which are primarily funded by the users of the infrastructure
RPA	Robotic Process Automation – the automation of repetitive processes
SDGs	The United Nations’ 2030 Sustainable Development Goals
Social Sector	The domain of industry for which historically governments have developed infrastructures and delivered services to citizens. In most countries (if not all), citizens are entitled to these amenities and services under the constitution or the “social contract”. This includes healthcare and associated facilities such as residences for care workers, diagnostic centres, laboratories, research institutions, nursing colleges, specialised treatment centres (e.g., oncology, dialysis); education covering schools, kindergartens and teacher training colleges; higher education and associated facilities such as student accommodation, research institutions, playing grounds, and administrative buildings; log-term care covering the full spectrum from assisted living to elderly homes; affordable & social housing; public sports facilities; government buildings and services such as court houses, and so on
UNECE	United Nations Economic Commission for Europe - also known as ECE
VBC	Value Based Care – an approach to care that focusses on delivering outcomes, ‘the value’, rather than the volume of services provided. This approach necessitates significant shifts in policy, payment structures, and provider incentives to reward outcomes rather than procedures.
VR	Virtual Reality – A system of interaction that creates a simulated artificial space to interact in.
Wearable	Sensors and other devices embedded in the environment or integrated into clothing or carried by a person.

Annex 2 - Case Studies

This annex contains overviews of the case studies referred to in the main guide.

I. Healthcare – Estonia: Electronic Health Record

Estonia's journey towards digital healthcare has involved collaboration between the government and various technology providers to develop, implement, and manage its national EHR and e-Health systems. While the specific details of the agreements and partnerships that facilitated Estonia's EHR system's rollout may vary and involve multiple contracts and collaborations, the overarching strategy aligns with the PPP model. This model leverages both public oversight and governance and private sector innovation and efficiency to achieve public health goals.

Estonia's digital health ecosystem, known for its e-Health Record system, integrates data from different healthcare providers, giving patients and doctors access to medical histories, prescription information, and test results online. This system has improved efficiency, reduced duplication of tests, and enhanced patient outcomes.

Estonia stands out as a global leader in digital healthcare, having implemented a comprehensive e-Health system that includes digital health records accessible to all citizens and healthcare providers.

This initiative has significantly enhanced the efficiency of healthcare delivery, patient safety, and data security. According to the Estonian e-Health Foundation, the system has led to a 30% reduction in duplicate testing, saving time and resources.[11]

II. Healthcare – United States: Project ECHO (Extension for Community Healthcare Outcomes)

Project ECHO is an innovative telemedicine model that began in New Mexico, to improve care for patients with Hepatitis C in rural areas.

Through tele-mentoring, it connects primary care physicians with specialists in real-time, enhancing access to speciality care. Evaluations of Project ECHO have shown it significantly improves patient outcomes and expands the capacity of the healthcare system to treat complex conditions.

This PPP model uses telemedicine to connect primary care doctors with specialists in regular virtual clinics. Originating in New Mexico, ECHO has expanded globally, demonstrating how digital platforms can scale specialist knowledge, improve care quality, and enhance primary care providers' capabilities in managing complex conditions.

III. Healthcare – United Kingdom: Artificial Intelligence

The collaboration between Google's DeepMind and the UK's NHS (‘National Health Service’) on improving eye disease detection through AI technology exemplifies the successful application of PPPs in healthcare. This project focused on utilizing AI to analyze eye scans for conditions like diabetic retinopathy and age-related macular degeneration, traditionally diagnosed by specialists. By leveraging DeepMind's AI capabilities to interpret optical coherence tomography (OCT) scans, the partnership aimed to enhance the speed and accuracy of diagnoses. The AI system developed was trained on a vast dataset of de-identified OCT scans provided by Moorfields Eye Hospital, part

11 (https://www.oecd.org/health/Development-of-Estonian-Health-System-Performance-Assessment-Framework.pdf).

of the NHS, and demonstrated the ability to identify signs of eye diseases as accurately as leading experts. The outcomes of this collaboration include improved diagnostic efficiency, relief for healthcare specialists through automation, and the potential for scaling AI solutions across the healthcare system for better patient outcomes. This case study underscores the transformative potential of PPPs in leveraging technology to address healthcare challenges.

IV. Healthcare - Italy: Remote Patient Access San Raffaele Hospital

San Raffaele Hospital in Milan, has implemented RPA to streamline administrative processes, such as appointment scheduling and patient data management. This has led to a 60% reduction in processing times and a significant improvement in patient satisfaction, showcasing how automation can free healthcare professionals to focus on patient care. Technology Overview: This encompasses telemedicine and remote patient monitoring technologies, which have been crucial, especially during the COVID-19 pandemic, in delivering healthcare services to remote areas. Case Study: Amwell, a telehealth platform, has played a significant role in expanding access to care during the pandemic, demonstrating how digital platforms can support healthcare systems in crisis.

V. Healthcare - Estonia: Blockchain technology health records

Estonia’s Blockchain-Based Health Records System. Estonia has implemented a blockchain-based system to secure patient health records across the country. This initiative is part of a broader digital transformation in Estonia's public sector. The Estonian government partnered with Guardtime, a private company specializing in blockchain technology, to develop and implement this system. The use of blockchain has enhanced the security and integrity of health data, improved patient trust, and streamlined access to health information for both patients and healthcare providers.

VI. Healthcare – United States: The Da Vinci Surgical System in Veterans Health Administration

The Veterans Health Administration (VHA), the largest integrated healthcare system in the United States, partnered with Intuitive Surgical, the maker of the Da Vinci Surgical System, to introduce robotic-assisted surgery across its hospitals. This PPP aimed to improve surgical care for veterans by incorporating advanced robotic technology into various surgical specialties as the integration of such advanced systems posed challenges, including the need for substantial investment in equipment and training for healthcare professionals. The partnership focused on deploying the Da Vinci Surgical System across VHA hospitals, providing comprehensive training for surgical teams, and conducting joint research to optimize surgical outcomes. Intuitive Surgical supplied the robotic systems and training, while the VHA provided the clinical environment and patient population for implementation and study. The introduction of the Da Vinci Surgical System led to more precise and less invasive surgeries, contributing to better patient outcomes, shorter hospital stays, and quicker recoveries as well as expanded access to Robotic Surgery.

VII. Healthcare - Rwanda: Babyl - a Mobile Health Application for Comprehensive Healthcare Access

In Rwanda, the partnership between the Rwandan Ministry of Health and Babyl, a digital healthcare provider, represents a groundbreaking PPP aimed at leveraging mobile health technology to enhance healthcare delivery and patient empowerment across the nation. Launched to address the

challenges of healthcare accessibility and the burden of chronic diseases, Babyl Rwanda employs mobile health applications to offer remote medical consultations, prescription services, and health information to Rwandan citizens. Through a mobile app, patients can register, book doctor appointments, receive digital prescriptions, and access medical advice. The service operates on a subscription model, making it accessible to a broad segment of the Rwandan population, with the government supporting the integration of this service into the national healthcare system. The Babyl mobile app has significantly increased access to healthcare services, particularly for individuals in remote areas, by providing a reliable platform for medical consultations and health management. The app enhances patient engagement and empowers patients to take an active role in their health management, from tracking vital signs and medication adherence to accessing tailored health advice, fostering a culture of preventive care and self-management, leading to improved health outcomes for patients, reducing the need for emergency care and hospital admissions. By effectively leveraging technology to address key healthcare challenges, this PPP has not only enhanced healthcare accessibility and efficiency but also empowered patients to take charge of their health, setting a precedent for similar initiatives globally.

VIII. Healthcare - [xx] : Project BRAVR - Bridging Realities in Anatomy through Virtual Reality

Project BRAVR is a collaborative initiative between a leading medical university, a VR technology startup, and a government health department aimed at integrating Augmented Reality (AR) and Virtual Reality (VR) technologies into medical education and patient care. The project focuses on enhancing the anatomy learning experience for medical students and providing virtual simulation training for surgical procedures, as well as developing VR-based therapeutic modules for patient rehabilitation. Project BRAVR leveraged AR and VR technologies to create a comprehensive educational and therapeutic platform. For medical students, the platform offered an immersive, interactive anatomy learning experience, allowing them to explore human anatomy in 3D space, perform virtual dissections, and simulate surgical procedures in a risk-free environment. For patients, it provided VR-based rehabilitation exercises designed to be more engaging and tailored to individual recovery goals, enhancing motivation and treatment effectiveness. The VR startup provided the technological expertise and innovative solutions, developing AR/VR content and software tailored to medical education and rehabilitation needs and led to educational curriculum enhancement. The government health department offered financial support and regulatory guidance, facilitating the project's implementation within public health institutions, and ensuring compliance with educational and medical standards. Medical students reported a deeper understanding of anatomy and improved surgical skills from practicing in a virtual environment, leading to better preparedness for real-life clinical scenarios and patients engaging in VR-based rehabilitation exercises showed faster recovery times and higher satisfaction with the treatment process, indicating the potential of VR in enhancing therapeutic outcomes. Project BRAVR demonstrated a successful model of integrating AR/VR technologies in medical education and treatment that could be replicated across other institutions and healthcare settings.

IX. Healthcare – [xx]: CRISPR

CRISPR-Cas9 Gene Editing Partnership for Sickle Cell Disease Treatment. A landmark PPP between Vertex Pharmaceuticals and CRISPR Therapeutics, in collaboration with select academic

medical centers and public health agencies, embarked on pioneering the use of CRISPR-Cas9 gene-editing technology to develop a potentially curative treatment for sickle cell disease (SCD) and beta-thalassemia. These genetic blood disorders affect millions worldwide, causing severe pain, organ damage, and shortened lifespan. The partnership leveraged CRISPR-Cas9, a revolutionary gene-editing technology, to develop a treatment known as CTX001. This therapy involves editing a patient's hematopoietic stem cells to produce high levels of fetal hemoglobin, which can ameliorate the symptoms of SCD and beta-thalassemia. The process requires precise collaboration between biotech firms for technological development, public health agencies for regulatory guidance and clinical trial oversight, and medical institutions for patient recruitment and study execution. Early clinical trials have shown promising results, with treated patients experiencing significant reductions in disease symptoms and improvements in quality of life. The partnership has navigated complex regulatory landscapes, achieving fast-track designations that underscore the therapy's potential and expediting its path to patients. Collaborative efforts have extended to developing educational programs for healthcare providers and patients, alongside ethical frameworks addressing the novel implications of gene editing in humans. This PPP serves as a model for addressing other genetic diseases, demonstrating how collaboration can accelerate the development and deployment of gene therapies.

X. Healthcare – United Kingdom: The NHS COVID-19 app

The NHS COVID-19 app development serves as a standout example of how PPPs can swiftly address urgent public health challenges through digital innovation. This partnership involved the National Health Service in the UK collaborating with technology firms such as VMware and Zuhlke Engineering, alongside academic contributions from Oxford University, to create a contact tracing and health advisory application aimed at curbing the spread of COVID-19. The project capitalized on private sector agility and technological expertise, supported by public health insights and regulatory frameworks provided by the NHS. The resulting app utilized Bluetooth technology to facilitate anonymous contact tracing, notifying users of potential exposure to the virus and advising on necessary precautions, thereby playing a crucial role in the UK's pandemic response efforts. This case illustrates the power of PPPs in marrying innovation with public health priorities, ensuring rapid development and deployment of a critical digital health tool. It underscores the importance of collaboration between the public and private sectors in leveraging technology to tackle health emergencies, emphasizing trust, regulatory compliance, and widespread accessibility.

XI. Education – Pakistan: Virtual University of Pakistan (VUP):

With a network of over 200 campuses across Pakistan, over 30 campuses are owned and operated by private partners who provide the infrastructure and digital facilities while the public provides the course material, examinations, and certifications[12]. Other initiatives include corporates in the digital space such as Microsoft Corporation entering into international PPPs in education. Through the Partners in Learning (PiL) programs, Microsoft partners with schools and governments to offer inclusive digital learning programs that serve well to prepare learners for today’s digital workplace, and teachers to develop innovative digital strategies for delivering learning.

12 Sarvi, Balaji & Pillay, 2015 [full reference to be provided once format is agreed].

XII. Education – Multi-national: UNICEF's Learning Passport:

It was projected that up to 3.6 million students could benefit from the Learning Passport[13]. Furthermore, UNICEF's giga-initiative that was launched in 2019 aims to connect over 1 billion children that learned without access to internet connectivity in schools across the world. In this program, the schools become the anchor points for the surrounding communities, connecting businesses and services. The UNICEF Giga program helps to address the problem of digital exclusion for vulnerable learners in poor communities, girls, and learners with disabilities1.

XIII. Education – Rwanda: Smart Classroom Initiative

Rwanda's Smart Classroom Initiative aims to equip classrooms with digital learning resources and tools that could help to improve education quality and achieve better outcomes for learners. Consequently, learners under these initiatives have demonstrated improved learning outcomes due to the effectiveness offered in the personalized learning approach offered by digital solutions.

XIV. Long-Term Care - [xx]: [To follow]

[To Follow]

XV. Long-Term Care - [xx]: [To follow]

[To Follow]

13 UNICEF, n.d. [full reference to be provided once format is agreed].