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Gap analysis for standardization on sustainable and human-centred societies enabled with cyber physical systems

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

International Workshop Agreement IWA 39 was approved at a series of workshops hosted by the Japanese Industrial Standards Committee (JISC), in association with Japanese Standards Association (JSA), held virtually in February 2021, May 2021, September 2021 and February 2022.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The seventeen UN Sustainable Development Goals (SDGs) provide a shared blueprint for peace and prosperity for people and the planet, now and into the future. ISO, IEC and other standards development organizations (SDOs) are making efforts to contribute to SDGs through the development of international standards and deliverables.

Sustainability is important for many reasons including environmental quality; to have healthy communities, clean air, natural resources, and a nontoxic environment. Sustainability is most often defined as meeting the needs of the present without compromising the ability of future generations to meet theirs. It has three main pillars: Economic, Environmental, and Social. These three pillars as shown in Figure 1 are informally referred to as people, planet and profit. However, it refers to four distinct areas: Human, Social, Economic and Environmental.

Three overlapping circles model   Triple nested dependency model
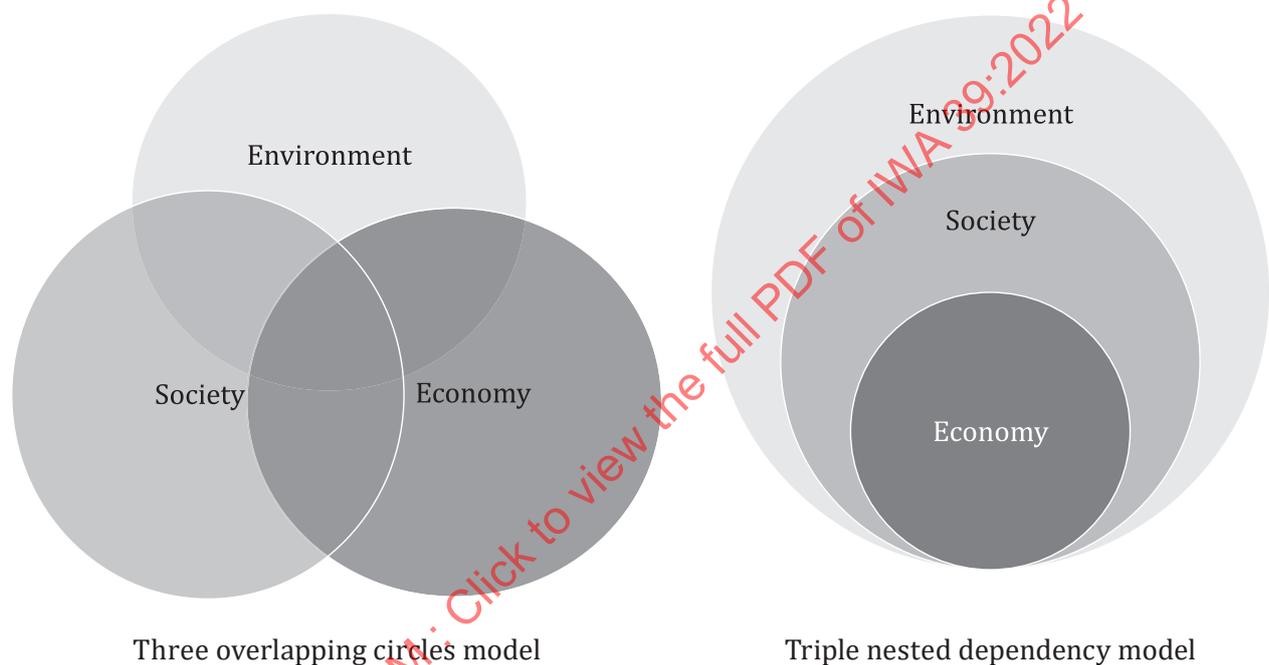
Figure 1 — The triple nested dependency model of sustainability

In this triple nested dependency model, the three sectors are co-dependent and it is recognized that the economy is a wholly owned subsidiary of the society which in turn is a wholly owned subsidiary of the environment. They not only co-exist but interact. Rather than the three sectors competing, this model reminds us that without clean water, fresh air and healthy ecosystems the society and the economy cease to function.

The importance of environmental issues (e.g., climate action) is widely recognized around the world, and many international standardization and international initiatives are trying to resolve these issues. This, however, does not expand quickly since it requires fundamental behavioural changes which are difficult to scale beyond individuals, and across organizations and nations. One of the major reasons for this difficulty is that some of the actions for achieving sustainability goals have conflicts with each other, which are called issue linkages, typically between human-centred aspects and environmental sustainability aspects which need to be resolved and harmonized.

Human needs are a powerful explanation of human behaviour and social interaction. All individuals have needs that they strive to satisfy.

Technologies such as Cyber-Physical Systems (CPS) and Internet of Things (IoT) have the potential to help create a society in which people enjoy their lives without feeling any restrictions, while contributing to the improvement of social, environmental and economic sustainability.

However, there is a concern that CPS can have adverse effects, which is an issue to be considered when a CPS is introduced into society.

Issues related to human-centred aspects and other sustainability aspects have been discussed in documents developed by ISO/TC 207, *Environmental management,* in International Standards such as ISO 26000, and in initiatives led by international organizations such as the World Business Council for Sustainable Development (WBCSD) and the World Economic Forum (WEF). However, there is no current area of standardization which addresses a holistic view of this landscape and how to resolve those issues enabled by CPS, which also consider any adverse impacts.

Humans need to radically change our relationship, not just with the planet, but with the objects with which we fill our lives to advance the progress we can make towards sustainability. We need to change how we think about technology and innovation. Rather than allowing technological advancement to steer our narratives, innovation and technology should help us build bridges between the worlds we inhabit now and the ones we imagine for tomorrow.

This document was developed at a series of workshops whose participants conducted a gap analysis between the existing areas of standardization and the goal of achieving human-centred sustainability.

This document is the result of an open and transparent multi-stakeholder process involving experts from different countries representing a variety of different perspectives. It is a voluntary guidance document intended for global use.

Gap analysis for standardization on sustainable and human-centred societies enabled with cyber physical systems

1   Scope

This document provides a gap analysis between existing areas of standardization and the needs of human-centred sustainable societies enabled by cyber physical systems. This document does not cover the technical requirements of cyber physical systems.

2   Normative references

There are no normative references in this document.

3   Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
cyber physical system
CPS
system with digital, analogue, cyber, physical and human components interacting with each other, engineered to function through integrated physics and logic

3.2
system of systems
SoS
set of operationally and managerially independent systems that coordinate their work together to achieve one or more common stated purposes

Note 1 to entry: Each constituent is a useful system by itself, having its own management, goals, and resources, and coordinates within the SoS to provide the unique capability of the SoS.

[SOURCE: IEC Electropedia, IEV 871-05-03, modified — The words "are operated together for a period of time" have been replaced by "coordinate their work together" and the word "common" has been added in the definition; the original Note 1 to entry has been replaced by a new Note 1 to entry adapted from ISO/IEC/IEEE 24748-1:2018, 3.56.]

3.3
issue linkage
conflict between some of the actions for achieving different sustainability goals

3.4
human-centred sustainable society
society that is highly sustainable supporting human well-being and dignity

Note 1 to entry: In this document, the state of a human-centred sustainable society is referred to as "human-centred sustainability". Sustainability in a broader sense can include a part of human-centred aspects, however, it does not cover all of them, and includes *issue linkages* (3.3) between human-centred aspects and others. For this reason, the term "human-centred sustainability" is used in this document.

4 Overview

4.1 General

The society envisioned in this document is a human-centred sustainable society contributing to UN SDGs and other relevant issues. This document focuses specifically on how human-centred sustainability and other sustainability (e.g. environmental sustainability) is enabled or impacted by CPS (both beneficially and adversely), and on how the issue linkages between SDGs and other relevant issues can be resolved and harmonized by CPS.

Interactions between a physical (or real) space and cyberspace, beneficial or adverse, are intrinsic properties of CPS. On the contrary, feedback from the real space to CPS in terms of human-centred and other sustainability aspects are investigated in this document. If the CPS has a beneficial impact, the feedback should be positive to enhance the impact even more, but if the impact is adverse, the feedback should be negative to suppress the impact (see Figure 2).
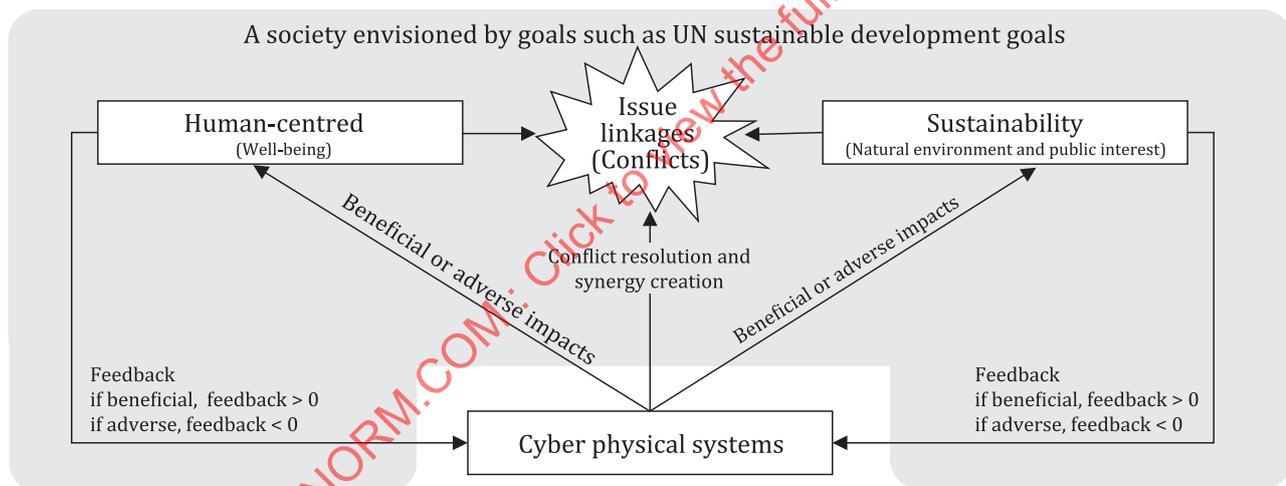
Figure 2 — Perspectives of the gap analysis

This document outlines issues and practices and provides lists of related standards, based on the following four perspectives:

— how human-centred aspects are impacted by CPS (see Clause 5);

— how sustainability (environment and society) is impacted by CPS (see Clause 6);

— what the issue linkages are and how CPS can help (see Clause 7);

— how CPS can be implemented to resolve the identified issues (see Clause 8).

Table 1 list issues and practices related to human-centred sustainability together with their relevance to SDGs, indicating beneficial impacts or adverse impacts. Referenceable documents for subjects of each perspective are listed in the subsequent tables, indicating the relevant SDGs and type of standards defined in 4.3.

4.2 Existing standardization

A number of international standards have already been published by ISO, IEC and ITU-T on human-centred sustainability and CPS. In addition to the published standards, this document also cites work items under development for reference.

4.3 Categories of standardization

In this document, international standards published by ISO, IEC and ITU-T are categorized as follows (see Figure 3).

— Type 1: Standardization addressing human-centred sustainability which apparently has a potential relevance to CPS.

— Type 2: Standardization addressing CPS which apparently has a potential relevance to human-centred sustainability.

— Type 3: Standardization addressing both human-centred sustainability and CPS.
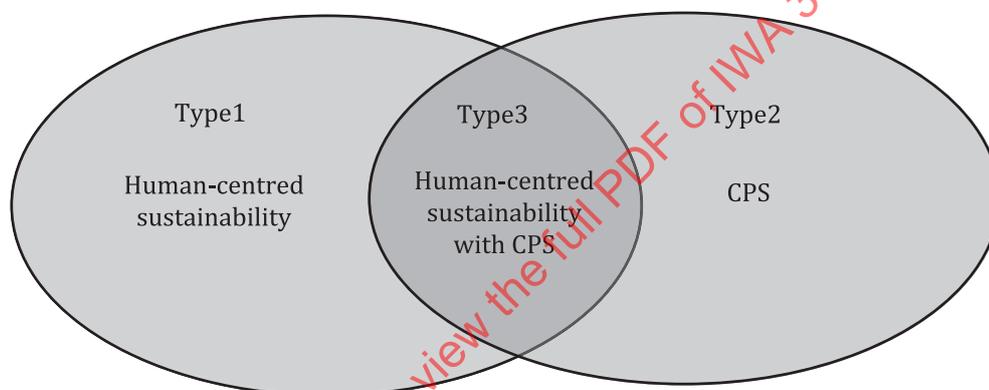
Figure 3 — Existing standardization mapping on human-centred sustainability with CPS

The results of the gap analysis between fields of existing standardization and the goals of pursuing sustainability and improvement for human-centred aspects are given in Clause 9.

5 How human-centred aspects are impacted by CPS

5.1 Relevant issues and practices

Human-centred aspects constitute a broad concept that includes many aspects of our daily lives. It encompasses financial well-being, relationships with family and friends, harmony with nature, emotional and physical health and spiritual wealth. It is relevant to activities at work and recreation, how people feel about their community and personal safety.

By using a variety of technologies, e.g. Artificial Intelligence (AI) and IoT sensors, CPS supports the automation of repetitive and cognitively difficult tasks across several activities, while also being focused on delivering an improved society.

The new society envisioned is not intended to simply replace human beings with automation, but also to create new and higher quality jobs. Automation is not intended to take the place of human beings but to support them, using robots and other intelligent technology that interacts with people to prevent them from carrying out activities that are dangerous or burdensome to the mental and physical health of the individual.

In addition to protecting human beings from harmful activities, CPS allows the accumulation of societal knowledge which can be used to establish a collective intelligence and be made available to society for the purpose of solving various problems.

While CPS has a great potential to be beneficial to human-centred aspects in society, it also creates concerns because of its adverse impacts or issues related to basic human rights.

Table 1 shows examples of how human-centred aspects are impacted by CPS. Even though the CPS issues and practices can be seen to deliver beneficial impact for the SDGs listed below, the CPS perspective also gives a holistic view of the impact and issues of technology in terms of both beneficial and adverse effects on other SDGs.

— SDG 3   Good health and well-being

— SDG 4   Quality education

— SDG 5   Gender equality

— SDG 7   Affordable and clean energy

— SDG 8   Decent work and economic growth

— SDG 9   Industry, innovation and infrastructure

— SDG 10   Reduced inequalities

— SDG 12   Responsible consumption and production

— SDG 16   Peace, justice and strong institutions

Ethical concerns and the impact on privacy are also included in the CPS perspective. This is important as ethical concerns and any unintended consequences which can result are not explicitly included in the seventeen SDGs but will have a social impact on how human-centred sustainable initiatives are impacted by CPS.

Table 1 — Issues and practices impacted by CPS

Issues/practices	SDGs with beneficial impact	SDGs with adverse impact
Avatars With the declining birth-rate and increasing aging population, it is expected that the growth of the working population will decline in the future. By utilizing avatars, it is possible to carry out dangerous work or manage labour shortages. In addition, it is expected that AI will improve performance across economies. Robots can use AI without any human intervention, whilst the use of avatars is a human-centred approach which it is hoped will extend or enhance human capabilities. Currently society is restricted to using technology which depends on physical locations where people live, but avatars can be used to access any location. The presence of avatars in the Metaverse has the potential to overcome gender differences, the presence or absence and degree of disabilities.	SDG 3 Good health and well-being SDG 5 Gender equality SDG 8 Decent work and economic growth	SDG 16 Peace, justice and strong institutions
Cyborgs Cyborg technology (e.g., next-gen prosthesis) can benefit humans (SDG 3 and SDG 8) because it can restore/enhance/complement the body's functions.	SDG 3 Good health and well-being	

Table 1 *(continued)*

Issues/practices	SDGs with beneficial impact	SDGs with adverse impact
Brain machine interface The level that a brain machine interface can alter the data in the brain. Brain machine interface can boost education by installing new knowledge (SDG 4.), but overuse of it can cause an altered personality.	SDG 4 Quality education	SDG 3 Good health and well-being
Proton Beam Therapy The new particle accelerator for Proton Beam Therapy (PBT) will be smaller than the synchrotron already in use in healthcare. It will be connected to a mechanical structure that allows the proton beams to rotate around the patient and to remove a tumour from multiple directions. Utilizing sensing data from multiple installed devices as well as 3D real-time modelling of the precise shape of the target tumour, this treatment is particularly suitable for tumours that are inoperable or that are located near delicate organs and structures such as the brain, heart, head, neck, prostate and spinal cord.	SDG 3 Good health and well-being	
Measurement of happiness A large amount of data related to body movements replaced by 0s and 1s was collected from thousands of people. Various questions were asked to determine if they were experiencing happiness. AI was used to analyse the correlation between the data on body movements and happiness. As a result, a complex but unique array of 0s and 1s which appears to show how people experience happiness was discovered.	SDG 3 Good health and well-being	
AI service for mental health This is a new approach to using the new provisions for Age-Appropriate Design under the UK General Data Protection Regulation (GDPR) to create an AI service which helps young people understand the impact on their mental health. They are designing the service using regulations not applying the regulations after the technology is built. Building in safety into an AI service which has the concerns and the safety of the citizens at the core.	SDG 3 Good health and well-being	
Estate and Building service with CPS This service uses CPS technology to ensure buildings are Covid safe, including protecting arriving visitors and personnel working within buildings on all floors, and in meeting rooms. It can be directly connected to all building management and room booking systems to always ensure the safety and well-being of all visitors and occupants.	SDG 9 Industry, Innovation and Infrastructure	
CPS to protect human rights A considerable amount of the world's economies are still exploiting forced labour, child labour, human trafficking and modern slavery. Key reasons for this are the pressure to compete on price for products, the lack of visibility of the entire value chain and in particular the multiple jurisdictions that are used to 'hide' these practices. Information transfer to support eradication of these practices has been difficult but CPS can help. CPS can support collaboration across nations using the data created in a CPS enabled value chain to provide transparent and trustworthy information exchanges across multiple jurisdictions. CPS can be used to identify victims and support investigations and prosecutions. An example use case - The use of AI to find signatures of trafficking with the CPS value chain. Often these are images which contain particular objects with the addition of a specific tattoo that traffickers use to brand their victims.	SDG 3 Good health and well-being SDG 10 Reduced inequalities SDG 16 Peace, justice and strong institutions	

Table 1 *(continued)*

Issues/practices	SDGs with beneficial impact	SDGs with adverse impact
Blockchain Traceability Platform to combat child labour This Platform equips businesses and other stakeholders with tools to trace their supply chains by blockchain technology, thereby supporting the business sector's efforts to source materials untainted by child labour.	SDG 8 Decent work and economic growth	SDG 12 Responsible consumption and production
Hearing aid used as connected device The Hearing Aid not only compensates the hearing ability of persons with hearing difficulties but provides them with more convenience in their life than persons without hearing difficulties; with the Hearing Aid, for example, they can connect wirelessly to any modern smartphone and get access to our wide range of accessories with direct streaming of stereo sound.	SDG 3 Good health and well-being	
Côte d'Ivoire data system for traceability A pilot project aimed at building data systems that are owned by the cooperatives themselves, provide important information about where their cocoa comes from, and strengthen their position as trading partners.	SDG 8 Decent work and economic growth	
There is a gap between advanced economies and developing countries. This gap suggests the need to address the following issues. — How will the transition of societies like the ones of developing countries take place and how much resource will it take? — Millions of people in the developing world will be left without jobs and incomes as they are mainly groups of manual workers, unskilled farmers and unskilled industrial workers. — Will they be trained? Will they be subsidized? How will they adapt so that they can cope? — How policymaking will be affected by the human-centred sustainability enabled by CPS?	SDG 8 Decent work and economic growth	

5.2 Existing documents

Tables 2 to 7 list existing documents related to following topics, categorized as follows:

a)   Human and organizational aspects (see Table 2)

b)   Health and well-being (see Table 3)

c)   Education (see Table 4)

d)   Water service (see Table 5)

e)   Industry and innovation (see Table 6)

f)   Ethical concerns and trustworthiness (see Table 7)

The documents that are not, for the moment, directly relevant to CPS are included if their subjects can potentially be impacted by CPS in the future (i.e. Type 1).

Table 2 — Existing documents related to Human and organizational aspects

Document	Title	Committee	SDG	Type
ISO 27501:2019	*The human-centred organization — Guidance for managers*	ISO/TC 159/SC 1	SDG 8 Decent work and economic growth	1

Table 2 *(continued)*

Document	Title	Committee	SDG	Type
ISO 22301:2019	*Security and resilience — Business continuity management systems — Requirements*	ISO/TC 292	SDG 8 Decent work and economic growth	1
ISO 26000:2010	*Guidance on social responsibility*	ISO	Basic human rights and ethical concerns	1
ISO 30414:2018	*Human resource management — Guidelines for internal and external human capital reporting*	ISO/TC 260	SDG 8 Decent work and economic growth	1

Table 3 — Existing documents related to Health and well-being

Document	Title	Committee	SDG	Type
ISO 9169:2006	*Air quality — Definition and determination of performance characteristics of an automatic measuring system*	ISO/TC 146/SC 4	SDG 3 Good health and well-being	3
ISO/TR 11633-2:2021	*Health informatics — Information security management for remote maintenance of medical devices and medical information systems — Part 2: Implementation of an information security management system (ISMS)*	ISO/TC 215	SDG 3 Good health and well-being	3
ISO/IEEE 11073 (all parts)	*Health informatics — Personal health device communication*	ISO/TC 215	SDG 3 Good health and well-being	3
IEC 80601-2-77: 2019	*Medical electrical equipment — Part 2-77: Particular requirements for the basic safety and essential performance of robotically assisted surgical equipment*	IEC/TC 62	SDG 3 Good health and well-being	3
ITU-T H.810 (all parts)	*Interoperability design guidelines for personal health systems*	ITU-T/ SG 16	SDG 3 Good health and well-being	3

Table 4 — Existing documents related to Education

Document	Title	Committee	SDG	Type
ISO 29994:2021	*Education and learning services — Requirements for distance learning*	ISO/TC 232	SDG 4 Quality education	1

Table 5 — Existing documents related to Water service

Document	Title	Committee	SDG	Type
ISO/TS 24541:2020	*Service activities relating to drinking water supply, wastewater and stormwater systems — Guidelines for the implementation of continuous monitoring systems for drinking water quality and operational parameters in drinking water distribution networks*	ISO/TC 224	SDG 6 Clean water and sanitation	3

Table 6 — Existing documents related to Industry and innovation

Document	Title	Committee	SDG	Type
ISO 56002:2019	*Innovation management — Innovation management system — Guidance*	ISO/TC 279	SDG 9 Industry, innovation and infrastructure	1
ISO/TS 24082:2021	*Service excellence — Designing excellent service to achieve outstanding customer experiences*	ISO/TC 312	SDG 9 Industry, innovation and infrastructure	1
ISO/CD 32111 [Under development]	*Transaction assurance in e-commerce — Principles and framework*	ISO/TC 321	SDG 9 Industry, innovation and infrastructure	1

Table 7 — Existing documents related to Ethical concerns and trustworthiness

Document	Title	Committee	SDG	Type
ISO/IEC TR 24028:2020	*Information technology — Artificial intelligence — Overview of trustworthiness in artificial intelligence*	ISO/IEC JTC1/SC 42	Ethical concerns and trustworthiness	3

6 How sustainability (environmental and social) is impacted by CPS

6.1 Relevant issues and practices

Table 8 shows how sustainability (environmental and social) is impacted by CPS with a focus on the SDGs listed below, in terms of beneficial contribution and adverse side-effects on other SDGs.

— SDG 10 Reduced inequalities

— SDG 11 Sustainable cities and communities

— SDG 12 Responsible consumption and production

— SDG 13 Climate action

— SDG 14 Life below water

— SDG 15 Life on land

— SDG 16 Peace, justice and strong institutions

— SDG 17 Partnerships for the goals

In addition to these SDGs, ethical concerns such as privacy are included, though they are not explicitly included in SDGs.

Table 8 — Relevant issues and practices

Issues/practices	SDGs with beneficial impact	SDGs with adverse impact
General CPS's adverse impact on ethical, legal and social issues There are significant ethical, legal and social issues related to the deployment of CPS technology which need to be considered.		SDG 10, 12, 13, 14, 15, 16, 17, and ethical concerns

Table 8 *(continued)*

Issues/practices	SDGs with beneficial impact	SDGs with adverse impact
Energy harvesting To ensure universal access to affordable, reliable and modern energy services, human beings continue to need an increasing supply of energy, which increases climate impact and results in climate change. The need to implement IoT devices which do not require batteries in society is a necessary action to prevent the increase of energy consumption. Sensing technology to enable infrastructure monitoring to facilitate a resilient society also requires battery-less IoT devices.	SDG 7 Affordable and clean energy	
AI and CO_2 emissions using computing power AI consumes a huge amount of electricity in the compute power it uses, which leads to a large amount of CO_2 emissions.	SDG 9 Industry, innovation and infrastructure	SDG 12 Responsible consumption and production SDG 13 Climate action
Cryptocurrency CO_2 emission A particular cryptocurrency has a carbon footprint comparable to that of New Zealand, producing 36,95 megatons of CO_2 annually. Cryptocurrency consumes more electricity than the entire annual energy consumption of the Netherlands.	SDG 8 Decent work and economic growth	SDG 13 Climate action
Energy systems transition towards green energy Climate change, the need for decarbonization, as well as increasing energy demand, together with the massive penetration of renewable energy resources, are creating many challenges for the current and future systems. A major challenge is the difficulty to maintain the stability in the power grid due to a large fluctuation of renewable power sources. In general, the integration of intelligent CPS in energy systems can improve their design and operation as well as contribute to their transition in many ways; examples of such intelligent CPS benefits include energy efficiency enhancements, operational flexibility in a dynamic environment, resilience of critical infrastructure, supply and demand matching, and the stability enhancement of the total grid. However, changes in production and consumption result in different flows of energy within the smart grid. Furthermore, the grid structure itself can be physically changed through reconfiguration. Different flows also result in different currents, voltage levels and differences in the physical operation of the grid and its assets.	SDG 9 Industry, innovation and infrastructure SDG 11 Sustainable cities and communities SDG 13 Climate action	
Circular economy A circular economy aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital.	SDG 12 Responsible consumption and production SDG 13 Climate action	

Table 8 *(continued)*

Issues/practices	SDGs with beneficial impact	SDGs with adverse impact
Sharing economy The sharing economy is an economic model that creates opportunities to match individuals and/or organizations with unused assets and skills with those who want to use them through digital platforms. It enables services and products to reach a wider range of consumers, supports entrepreneurship, and creates new business opportunities with a flexible working style. In addition, the shift from owning assets to sharing them through this model enables better resource optimization and is expected to contribute to the resolution of environmental issues. However, monetization of data has led to significant ethical, legal and social issues.	SDG 8 Decent work and economic growth SDG 11 Sustainable cities and communities SDG12 Responsible consumption and production	SDG 10 Reduced Inequalities
Food tech While the world's population continues to grow, the world produces approximately 4 billion tons of food each year. One-third of that production is discarded. AI can be used to solve the food waste problem. For example, by utilizing various data such as weather, day of the week, and temperature, it is possible to deliver demand forecasting which would reduce food loss.	SDG 12 Responsible consumption and production	
Food Trust - food safety Improving food safety across the supply chain. A platform looks to achieve new levels of trust and transparency, making food safer and smarter from farm to fork. This is Blockchain for the food system which requires significant energy to deliver the service.	SDG 2 Zero hunger SDG 3 Good health and well-being	SDG 12 Responsible consumption and production
Biodiversity and ecosystems There have been conventions on biological diversity led by UN which pursue the current overarching framework, Strategic Plan for Biodiversity 2011-2020 and its Aichi Biodiversity Targets. Governments are in the process of developing a post-2020 global biodiversity framework that will guide actions in the decades to come. There are already existing relevant documents published by UN, OECD, and WBCSD. ISO has recently started its new TC on biodiversity (ISO/TC 331). These issues regarding the degradation of biodiversity and ecosystems will be largely mitigated and adapted using CPS.	SDG 14 Life below water SDG 15 Life on Land	
The demand adjustment service of renewable energy supply The service controls the amount of electricity used nationwide according to the amount of electricity generated by power sources whose output fluctuates depending on the weather conditions and time of day, such as solar power generation and wind power generation. Specifically, the service automatically and accurately ascertains the quantity and status of operation of the equipment of large electric power for consumers nationwide and power generation equipment (solar panels, windmill turbines, etc.) through the IoT network.	SDG 7 Affordable and clean energy SDG 11 Sustainable cities and communities SDG 13 Climate action	

Table 8 *(continued)*

Issues/practices	SDGs with beneficial impact	SDGs with adverse impact
Local district energy management The distributed micro grid application of energy management has great potential for enhancing resilience against natural disasters as well as utilizing renewable energy sources such as photovoltaic generators. It is also expected to utilize fully the storage capacity of electric cars. The implementation of this future scenario is highly dependent on CPS enablement.	SDG 7 Affordable and clean energy SDG 11 Sustainable cities and communities SDG 13 Climate action	
Personal Electric Vehicle(PEV) The use of Personal Electric Vehicle (PEV) would significantly contribute to the creation of a more sustainable transportation system that is affordable, convenient, addresses air pollution, and reduces greenhouse gas emissions. Compared to purchasing an automobile, which usually costs more than 10k USD, or daily payment of public transportation fees, using PEVs as a means of transportation is more affordable for the user, because the cost of the PEVs is about equal to a year of public transportation fees. In addition, PEVs can shorten the time of transportation compared to public transportation, as users can directly travel to their destinations without any waiting time for changing the transports. PEVs will not emit greenhouse gasses but they also have 2-3 times higher energy efficiency than electric cars and are therefore more environmentally friendly. Legalization of the PEVs is currently being discussed in Japan, but some oppose it because PEVs can cause more traffic accidents. However, standardization of the PEVs friendly society is desired to achieve SDGs.	SDG 11 Sustainable cities and communities SDG 13 Climate action	SDG 15 Life on land

6.2 Existing documents

Tables 9 to 12 list existing documents related to following topics, categorized as follows:

a)   Environment (see Table 9)

b)   Food (see Table 10)

c)   Smart cities and communities (see Table 11)

d)   Energy supply (see Table 12)

The documents that are not, for the moment, directly relevant to CPS are included if their subjects can potentially be impacted by CPS in the future (i.e. Type 1).

Table 9 — Existing documents related to Environment

Document	Title	Committee	SDG	Type
ISO/WD 59010 [Under development]	*Circular economy — Guidelines on business models and value chains*	ISO/TC 323	SDG 12 Responsible consumption and production SDG 13 Climate action	1
ITU-T L.1300- L.1399	*Energy efficiency, smart energy and green data centres*	ITU-T SG5	SDG 13 Climate action	3

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Table 9 *(continued)*

Document	Title	Committee	SDG	Type
ITU-T L.1400- L.1499	*Assessment methodologies of ICTs and CO2 trajectories*	ITU-T SG 5	SDG 13 Climate action	3

Table 10 — Existing documents related to Food

Document	Title	Committee	SDG	Type
ISO/TS 26030:2019	*Social responsibility and sustainable development — Guidance on using ISO 26000:2010 in the food chain*	ISO / TC 34	SDG 12 Responsible consumption and production	1

Table 11 — Existing documents related to Smart cities and communities

Document	Title	Committee	SDG	Type
ISO 37101:2016	*Sustainable development in communities — Management system for sustainable development — Requirements with guidance for use*	ISO/TC 268	SDG 11 Sustainable cities and communities	1
ISO 37120:2018	*Sustainable cities and communities — Indicators for city services and quality of life*	ISO/TC 268	SDG 11 Sustainable cities and communities	1
ISO 37122:2019	*Sustainable cities and communities — Indicators for smart cities*	ISO/TC 268	SDG 11 Sustainable cities and communities	1
ISO 37123:2019	*Sustainable cities and communities — Indicators for resilient cities*	ISO/TC 268	SDG 11 Sustainable cities and communities	1
ISO/TS 37107:2019	*Sustainable cities and communities — Maturity model for smart sustainable communities*	ISO/TC 268	SDG 11 Sustainable cities and communities	1
ISO 22328-1:2020	*Security and resilience — Emergency management — Part 1: General guidelines for the implementation of a community-based disaster early warning system*	ISO/TC 292	SDG 11 Sustainable cities and communities	1

Table 12 — Existing documents related to Energy supply

Document	Title	Committee	SDG	Type
IEC TS 62600-2:2019	*Marine energy — Wave, tidal and other water current converters — Part 2: Marine energy systems — Design requirements*	IEC/TC 114	SDG 7 Affordable and clean energy SDG 13 Climate action	1
IEC TS 61724-3:2016	*Photovoltaic system performance — Part 3: Energy evaluation method*	IEC/TC 82	SDG 7 Affordable and clean energy SDG 13 Climate action	1

Table 12 *(continued)*

Document	Title	Committee	SDG	Type
IEC 61400-25-1:2017	*Wind energy generation systems — Part 25-1: Communications for monitoring and control of wind power plants — Overall description of principles and models*	IEC/TC 88	SDG 7 Affordable and clean energy SDG 13 Climate action	3
ISO 9060:2018	*Solar energy — Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*	ISO/TC 180/SC 1	SDG 7 Affordable and clean energy SDG 13 Climate action	3

7 What issue linkages are and how CPS can help

7.1 Relevant issues and practices

Conflicts are intrinsically embedded in SDGs such as between the ones related to human-centred aspects and the others related to environmental and other sustainability as shown in Figure 4. Some conflicts are not necessarily limited to SDGs but include other well-being or social issues such as an ethical concern.
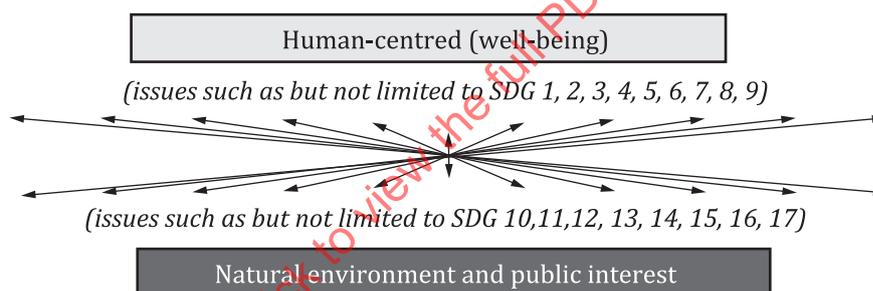

Human-centred (well-being)

(issues such as but not limited to SDG 1, 2, 3, 4, 5, 6, 7, 8, 9)

(issues such as but not limited to SDG 10,11,12, 13, 14, 15, 16, 17)

Natural environment and public interest

Figure 4 — Intrinsic issue linkages in SDGs

Table 13 shows relevant issues and practices with conflicting SDGs or other issues.

Table 13 — Relevant issues and practices

Issues/practices	SDGs with beneficial impact	SDGs with adverse impact
Autonomous vehicles Autonomous vehicles will open new business opportunities. It will change ownership models, with people opting to buy mobility when they need it – allowing vehicle assets to be used more efficiently, thereby reducing transport costs and carbon emissions in the transportation sector. It will help to unlock the full potential of the sharing economy in the automotive sector. It will also pose interesting challenges for town planners, including safety with the current technology, followed by its impact on employment. However, autonomous vehicles potentially include concerns on safety, ethics and liability as well as widening the gap between advanced economies and developed economies.	SDG 9 Industry, innovation and infrastructure SDG 11 Sustainable Cities and Communities	SDG 3 Good health and well-being SDG 10 Reduced Inequalities
When we increase the food supply, it can be expected that food loss will increase as well. CPS can detect demand/supply gaps and match them, minimizing the loss as well as providing an accurate forecast of natural phenomena, such as drastic weather changes, bad harvests and associated famine.	SDG 2 Zero Hunger	SDG 12 Responsible consumption and production

Table 13 *(continued)*

Issues/practices	SDGs with beneficial impact	SDGs with adverse impact
There has been a long dispute between economically developing countries and developed ones regarding Global Warming Potential (GWP) emission reduction. This is because industrial and economic growth naturally leads to increased CO_2 emissions. CPS, including smart grid technologies, are expected to resolve this coupling between economic development and CO_2 emission through demand-supply matching and stabilized renewable energy supply in a power grid, as well as introducing energy efficient business models.	SDG 1 No poverty	SDG 13 Climate action
Sustainable finance and ESG investment Finance can result in an environmental burden due pursuing economic growth exclusively. The use of IoT technologies to create trust and lower risk perceptions for sustainable finance market participants can result in more confidence, enhanced decision-making and the creation of win-win results. In addition, financial incentives can be used based on the improved environmental performance of equipment and infrastructure. As a result, control system technologies are being deployed to better operate equipment and infrastructure driven by these incentives.	SDG 8 Decent work and economic growth Other SDGs	SDG13 Climate action
Sustainability is transforming infrastructure and today there are already challenges in operating it. This is due to the interdependence of the operation of infrastructure projects. Where these are not well balanced, the desired outcomes cannot be achieved. Individual projects can appear to be positive at the design and early operation stages but over time uncertainties can arise due to the necessary evolution of the infrastructure. One example of this effect is the electrification of heat and transport together with the decarburization of electricity. CPS can improve planning and operation via recommendations or automation, based on the data accumulated representing an up-to-date model of existing infrastructure and the intelligence to identify the best way to operate system of systems interdependent infrastructure and to identify the right place, size and capabilities needed for future projects to be carried out and assets to be installed.	SDG 9 Industry, innovation and infrastructure SDG 11 Sustainable Cities and Communities	SDG 12 Responsible consumption and production

7.2 Existing documents

Tables 14 to 16 list existing documents related to following topics, categorized as follows:

a) Sustainable/green finance (see Table 14)

b) Sharing economy (see Table 15)

c) Smart grid (see Table 16)

The documents that are not, for the moment, directly relevant to CPS are included if their subjects can potentially be impacted by CPS in the future (i.e. Type 1).

Table 14 — Existing documents related to Sustainable/green finance

Document	Title	Committee	SDG	Type
ISO/DIS 32210 [Under development]	*Sustainable finance- Principles and guidance*	ISO/TC 322	SDG 8 Decent work and economic growth; and SDG 13 Climate action	1

Table 14 *(continued)*

Document	Title	Committee	SDG	Type
ISO 14097:2021	*Greenhouse gas management and related activities — Framework including principles and requirements for assessing and reporting investments and financing activities related to climate change*	ISO/TC 207/SC 7	SDG 8 Decent work and economic growth; and SDG 13 Climate action	1
ISO 14030 (all parts)	*Environmental performance evaluation — Green debt instruments*	ISO/TC 207/SC 4	SDG 8 Decent work and economic growth; and SDG 13 Climate action	1

Table 15 — Existing documents related to Sharing economy

Document	Title	Committee	SDG	Type
ISO/DTS 42501	*Sharing economy — General trustworthiness and safety requirements for digital platforms*	ISO/TC 324	SDG 8 Decent work and economic growth	3

Table 16 — Existing documents related to Smart grid

Document	Title	Committee	SDG	Type
IEC 61850 (all parts)	*Communication networks and systems for power utility automation*	IEC/TC 57	SDG 7 Affordable and clean energy; and SDG 13 Climate action	3
IEC TR 63097:2017	*Smart grid standardization roadmap*	IEC/SyC Smart Energy	SDG 7 Affordable and clean energy; and SDG 13 Climate action	3

8 How CPS can be implemented to resolve the identified issues

8.1 Relevant issues and practices

Implementing innovative technologies of CPS can enable human-centred sustainable societies and resolve issue linkages.

Table 17 shows practices where CPS can be implemented for this purpose.

Table 17 — Relevant issues and practices

Practice	SDGs in focus
Reference architecture In a number of fields it is seen as necessary to define a reference architecture to promote the social implementation of CPS by sharing it with stakeholders. Examples of reference architecture: — Reference Architectural Model Industry 4.0 (RAMI4.0) — GAIA-X Target Architecture (GAIA-X: Driver of digital innovation in Europe)	SDG 9 Industry, innovation and infrastructure
Agile governance In a society where a high degree of integration exists between cyber space and physical space, this can promote economic development and manage social problems that societies around the world face. It is imperative that there is appropriate governance which considers the characteristics of cyber physical systems. CPS implemented in society are complex, change rapidly, and pose difficulties in understanding and controlling risks. This will require new governance models. Rather than implementing governance where rules and procedures are defined and fixed in advance, agile governance models are required, and are designed to continuously, and rapidly run cycles of conditions and risks analysis, goal setting, system design, operations, evaluation, and improvements with multi-stakeholders in various governance mechanisms, such as corporate governance, regulations, infrastructures, markets, and social norms.	SDG 16 Peace, justice and strong institutions SDG 10 Reduce inequality
Data trading system Human-centred sustainable societies enabled by CPS requires Data Free Flow with Trust (DFFT). Data trading systems have been considered as an indispensable infrastructure to realize this, and the study of international standardization is underway at IEEE. (Project number P3800 of IEEE Standards Association).	SDG 9 Industry, innovation and infrastructure SDG 16 Peace, justice and strong institutions
Social contract A social contract is an implicit agreement among members of a society for social benefits. An example of a CPS social contract would be between the curators of data, the creators of data and the citizen.	SDG 16 Peace, justice and strong institutions
Nudge technology Utilizing nudge technology enables public transportation users to change their behaviour. When users search for a route using a web application, the application recommends several routes, provides additional information on how to travel combined with participant preferences and traffic congestion forecasts. Additionally, web applications can consider the weather, real-time congestion information and commercial data. This technology aims to promote user behaviour change and bring benefits to participants, transportation companies, and commercial services in the vicinity.	SDG 9 Industry, innovation and infrastructure Ethical and human-centred aspects
Virtual evacuation drills Detailed models inside buildings are constructed by utilizing the data of BIM (Building Information Modelling). Virtual space seamlessly connecting indoors and outdoors is constructed by the integration between the BIM model and a 3D city model, for example, to simulate the movement of people in the event of a disaster to plan evacuation drills.	SDG 11 Sustainable cities and communities
Social risk management platform for weather disasters A social risk management platform for meteorological disasters aims to develop a transportation plan that allows everyone to evacuate a wide geographical area by simulating the method of millions of residents on a digital twin. The platform allocates means of transportation to be used according to the age, gender, physical strength, health condition, and whereabouts, family structure, desired evacuation destination, etc. of each resident, and provides guidance through smartphones.	SDG 11 Sustainable cities and communities

Table 17 *(continued)*

Practice	SDGs in focus
Inter-corporation information exchange platform Secure and traceable data transfer platform for exchanging business information including customer's Know Your Customer (KYC) information. This can be a data exchange platform for companies like a Social Networking Service without the risk of invoking data protection concerns.	SDG 9 Industry, innovation and infrastructure Ethical human-centred aspects
Sustainability Collaboration Platform A platform and various software products for sustainability, vertically orientated to specific stakeholders and specializing in the management of particular needs. Both the platform and the products are characterized by a common approach: to equip cities, businesses and citizens with measurement tools, but above all with communication and sharing with stakeholders and guidance towards highly sustainable products and services.	SDG 9 Industry, innovation and infrastructure SDG 11 Sustainable cities and communities
An Application Ecosystem An application ecosystem designed to connect people, things and services. An app does not reside on your device but on the cloud service. This means that you can access it anywhere and, in any way, connect it with any compatible object or service and take advantage of the functions of your objects in a completely new way every time you open one.	SDG 9 Industry, innovation and infrastructure SDG 11 Sustainable cities and communities
Smart Food System In order to reduce food loss, it is important to reduce food loss at each phase of production, distribution, and consumption. However, in many developed countries, there are many primary products that are disposed because their quality is not guaranteed to meet a certain standard as a result of being mishandled. Thus, it would be crucial to take an overview of the processes from production to consumption, and to establish standards to ensure the smoothness of these processes. For example, one of the Japanese Cabinet Office SIP (Cross-ministerial Strategic Innovation Promotion Program) projects is focusing on freshness and is studying a new CPS scheme to certify the quality of food products through production, processing, distribution, and consumption (Physical system) by continuously tracking the temperature, humidity, vibration, etc. during the process using various ICT technologies (Cyber system).	SDG 12 Responsible consumption and production
The gap between urban communities and rural ones It is possible that rural communities are less likely to have a safe and secure IT system.	SDG 11 Sustainable cities and communities
Edge AI technologies If all of AI becomes cloud computing-based, only countries with specific computing capability and the supporting national infrastructure will be able to deliver the technology transformation required. All data spread over time and space can be localized. Consequently, inequalities both within and among countries can be increased. Edge AI can mitigate this adverse impact. Currently, this issue is being addressed by some individual national regulations. Edge AI can also improve the technology carbon footprint because it is usually more energy efficient than cloud-based AI.	SDG 9 Industry, innovation and infrastructure SDG 10 Reduced inequalities SDG 12 Responsible consumption and production

8.2 Existing documents

Tables 18 to 23 list existing documents related to following topics, categorized as follows:

a)   System (see Table 18)

b)   Cyber security (see Table 19)

c)   Governance (see Table 20)

d) Smart cities and communities (see Table 21)

e) Manufacturing (see Table 22)

f) Mobility (see Table 23)

Table 18 — Existing documents related to System

Document	Title	Committee	SDG	Type
ISO/IEC 30161:2020	*Internet of things (IoT) - Requirements of IoT data exchange platform for various IoT services*	ISO/IEC JTC1/SC 41	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC AWI 30172 [Under development]	*Digital Twin — Use cases*	ISO/IEC JTC1/SC 41	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 19770-1:2017	*Information technology — IT asset management — Part 1: IT asset management systems — Requirements*	ISO/IEC JTC1/SC 7	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 17789:2014	*Information technology — Cloud computing — Reference architecture*	ISO/IEC JTC 1/SC 38	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 30141:2018	*Internet of Things (IoT) — Reference Architecture*	ISO/IEC JTC 1/SC 41	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 20547-3:2020	*Information technology — Big data reference architecture — Part 3: Reference architecture*	ISO/IEC JTC 1/SC 42	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 19941:2017	*Information technology — Cloud computing — Interoperability and portability*	ISO/IEC JTC 1/SC 38	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 19944-1:2020	*Cloud computing and distributed platforms — Data flow, data categories and data use — Part 1: Fundamentals*	ISO/IEC JTC 1/SC 38	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 19944-2	*Cloud computing and distributed platforms — Data flow, data categories and data use — Part 2: Guidance on application and extensibility*	ISO/IEC JTC 1/SC 38	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC TR 23188:2020	*Information technology — Cloud computing — Edge computing landscape*	ISO/IEC JTC 1/SC 38	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 23751	*Information technology — Cloud computing and distributed platforms — Data sharing agreement (DSA) framework*	ISO/IEC JTC 1/SC 38	SDG 9 Industry, innovation and infrastructure	2
IEC 62853:2018	*Open systems dependability*	IEC/TC 56	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC/IEEE 21839:2019	*Systems and software engineering — System of systems (SoS) considerations in life cycle stages of a system*	ISO/IEC JTC 1/SC 7	SDG 9 Industry, innovation and infrastructure	2

Table 18 *(continued)*

Document	Title	Committee	SDG	Type
ISO/IEC/IEEE 42010	*Systems and software engineering — Architecture description*	ISO/IEC JTC 1/SC 7	SDG 9 Industry, innovation and infrastructure	2
IEEE P 3800	*Standard for a data-trading system: overview, terminology and reference model*	IEEE	SDG 9 Industry, innovation and infrastructure	2
ISO 9241-210:2019	*Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems*	ISO/TC 159/SC 4	SDG 3 Good health and well-being SDG 9 Industry, innovation and infrastructure	3
ISO/TS 15066:2016	*Robots and robotic devices — Collaborative robots*	ISO/TC 299	SDG 8 Decent Work and Economic Growth SDG 9 Industry, innovation and infrastructure	3
ISO 19731:2017	*Digital analytics and web analyses for purposes of market, opinion and social research — Vocabulary and service requirements*	ISO/TC 225	SDG 8 Decent Work and Economic Growth SDG 9 Industry, innovation and infrastructure	3
ITU-T Y.3013	*Socio-economic assessment of future networks by tussle analysis*	ITU-T	SDG 8 Decent Work and Economic Growth SDG 9 Industry, innovation and infrastructure	3
ISO/IEC CD 42001 [Under development]	*Information Technology — Artificial intelligence — Management system*	ISO/IEC JTC1/SC 42	SDG 9 Industry, innovation and infrastructure SDG 3 Good health and well-being	3

Table 19 — Existing documents related to Cyber security

Document	Title	Committee	SDG	Type
ISO 13492:2019	*Financial services — Key-management-related data element — Application and usage of ISO 8583-1 data elements for encryption*	ISO/TC 68/SC 2	SDG 8 Decent work and economic growth SDG 16 Peace, justice and strong institutions	2

Table 19 *(continued)*

Document	Title	Committee	SDG	Type
ISO/TS 23029:2020	*Web-service-based application programming interface (WAPI) in financial services*	ISO/TC 68/ SC 9	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 27102:2019	*Information security management — Guidelines for cyber-insurance*	ISO/IEC JTC 1/SC 27	SDG 8 Decent Work and Economic Growth SDG 9 Industry, innovation and infrastructure	3
ISO/IEC 27014:2020	*Information security, cybersecurity and privacy protection — Governance of information security*	ISO/IEC JTC 1/SC 27	SDG 9 Industry, innovation and infrastructure Ethical and human-centred aspects	3
ISO/IEC 27017:2015	*Information technology — Security techniques — Code of practice for information security controls based on ISO/IEC 27002 for cloud services*	ISO/IEC JTC 1/SC 27	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 27018:2019	*Information technology — Security techniques — Code of practice for protection of personally identifiable information (PII) in public clouds acting as PII processors*	ISO/IEC JTC 1/SC 27	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 27400:2022	*Cybersecurity — IoT security and privacy – Guidelines*	ISO/IEC JTC 1/SC 27	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC CD 27402 [Under development]	*Cybersecurity — IoT security and privacy — Device baseline requirements*	ISO/IEC JTC 1/SC 27	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC CD 27403 [Under development]	*Cybersecurity — IoT security and privacy — Guidelines for IoT-domotics*	ISO/IEC JTC 1/SC 27	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC PWI TS 5689 [Under development]	*Cybersecurity — Security frameworks based on the conceptual model of cyber-physical systems*	ISO/IEC JTC 1/SC 27	SDG 9 Industry, innovation and infrastructure	2
ISO/IEC 19395:2015	*Information technology — Sustainability for and by information technology — Smart data centre resource monitoring and control*	ISO/IEC JTC1/ SC 39	SDG 9 Industry, innovation and infrastructure SDG13 Climate action	3

Table 20 — Existing documents related to Governance

Document	Title	Committee	SDG	Type
ISO/IEC 38500:2015	*Information technology — Governance of IT for the organization*	ISO/IEC JTC 1/SC 40	SDG 9 Industry, innovation and infrastructure	2

Table 21 — Existing documents related to Smart cities and communities

Document	Title	Committee	SDG	Type
IEC SRD 63235:2021	*Smart city system — Methodology for concepts building*	IEC/SyC Smart Cities	SDG 11 Sustainable cities and communities	3
IEC 63205 [Under development]	*Smart Cities Reference Architecture (SCRA)*	IEC/SyC Smart Cities	SDG 11 Sustainable cities and communities SDG 9 Industry, innovation and infrastructure	3
IEC SRD 63188 [Under development]	*Systems Reference Deliverable — Smart Cities — Smart Cities Reference Architecture Methodology (SCRAM)*	IEC/SyC Smart Cities	SDG11 Sustainable cities and communities SDG 9 Industry, innovation and infrastructure	3
IEC SRD 63301-1 [Under development]	*Use Case Collection and Analysis: Water Systems in Smart Cities — Part 1: High Level Analysis*	IEC/SyC Smart Cities	SDG 11 Sustainable cities and communities SDG 6 Clean water and sanitation	3
IEC 60050-831 [Under development]	*International Electrotechnical Vocabulary (IEV) — Part 831: Smart city systems*	IEC/SyC Smart Cities	SDG 9 Industry, innovation and infrastructure SDG 11 Sustainable cities and communities	3
ISO 37106:2021	*Sustainable cities and communities — Guidance on establishing smart city operating models for sustainable communities*	ISO/TC 268	SDG 11 Sustainable cities and communities	3
ISO TS 37151:2015	*Smart community infrastructures — Principles and requirements for performance metrics*	ISO/TC 268/SC 1	SDG 11 Sustainable cities and communities	3
ISO 37153:2017	*Smart community infrastructures — Maturity model for assessment and improvement*	ISO/TC 268/SC 1	SDG 11 Sustainable cities and communities	3
ISO 37156:2020	*Smart community infrastructures — Guidelines on data exchange and sharing for smart community infrastructures*	ISO/TC 268/SC 1	SDG 11 Sustainable cities and communities	3
ISO 37160:2020	*Smart community infrastructure— Electric power infrastructure — Measurement methods for the quality of thermal power infrastructure and requirements for plant operations and management*	ISO/TC 268/SC 1/	SDG 11 Sustainable cities and communities	3
ISO/DIS 7817 [Under development]	*Building Information modelling — Level of Information Need — Concepts and principles*	ISO/TC 59/SC 13	SDG 11 Sustainable cities and communities	3

Table 22 — Existing documents related to Manufacturing

Document	Title	Committee	SDG	Type
IEC TS 62872-1:2019	*Industrial-process measurement, control and automation — Part 1: system interface between industrial facilities and the smart grid*	IEC/TC 65	SDG 9 Industry, innovation and infrastructure	2
IEC/CD 63339 [Under development]	*Unified reference model for smart manufacturing*	IEC/TC 65 & ISO/TC 184 JWG 21	SDG 9 Industry, innovation and infrastructure	2
ISO 14649-17:2020	*Industrial automation systems and integration — Physical device control — Data model for computerized numerical controllers — Part 17: Process data for additive manufacturing*	ISO/TC 184/SC 1	SDG 9 Industry, innovation and infrastructure	2
ISO/TR 22100-4:2018	*Safety of machinery — Relationship with ISO 12100 — Part 4: Guidance to machinery manufacturers for consideration of related IT-security (cyber security) aspects*	ISO/TC 199	SDG 9 Industry, innovation and infrastructure	2
ISO/TR 23455:2019	*Blockchain and distributed ledger technologies — Overview of and interactions between smart contracts in blockchain and distributed ledger technology systems*	ISO/TC 307	SDG 9 Industry, innovation and infrastructure	2
ISO 13482:2014	*Robots and robotic devices — Safety requirements for personal care robots*	ISO/TC 299	SDG 9 Industry, innovation and infrastructure SDG 3 Good health and well-being	3

Table 23 — Existing documents related to Mobility

Document	Title	Committee	SDG	Type
ISO/TR 10992:2011	*Intelligent transport systems — Use of nomadic and portable devices to support ITS service and multimedia provision in vehicles*	ISO/TC 204	SDG 11 Sustainable cities and communities	3
ISO/TS 5255-1:2022	*Intelligent transport systems — Low-speed automated driving system (LSADS) service — Part 1: Role and functional model*	ISO/TC 204	SDG 11 Sustainable cities and communities Safety concerns	3
ISO 37165:2020	*Smart community infrastructures — Guidance on smart transportation with the use of digitally processed payment (d-payment)*	ISO/TC 268/SC2	SDG 8 Decent work and economic growth SDG 11 Sustainable cities and communities	3

9 Gap analysis

As listed in Clause 5, there are diverse issues and practices relevant to human-centred aspects and CPS. However, most documents addressed in SDOs are categorized as Type 1 and do not focus on utilizing