

IEEE Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems on Human Well-Being

IEEE Systems, Man, and Cybernetics Society

Developed by the
Standards Committee

IEEE Std 7010™-2020

IEEE Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems on Human Well-Being

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of the
IEEE Systems, Man, and Cybernetics Society

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IEEE SA Standards Board

Abstract: The impact of artificial intelligence or autonomous and intelligent systems (A/IS) on humans is measured by this standard. The positive outcome of A/IS on human well-being is the overall intent of this standard. Scientifically valid well-being indices currently in use and based on a stakeholder engagement process ground this standard. Product development guidance, identification of areas for improvement, risk management, performance assessment, and the identification of intended and unintended users, uses and impacts on human well-being of A/IS are the intents of this standard.

Keywords: artificial intelligence, autonomous and intelligent system, IEEE 7010™, well-being indicators, well-being metrics

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Introduction

This introduction is not part of IEEE Std 7010-2020, IEEE Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems on Human Well-Being

This is a recommended practice for the assessment of the impact of autonomous and intelligent systems on human well-being. It was prepared by Working Group IEEE 7010 (SMC/SC/Well-being for Ethical AI) for the IEEE Systems, Man, and Cybernetics Society/Standards Committee (SMC/SC).

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IEEE Recommended Practice for Assessing the Impact of Autonomous and Intelligent Systems on Human Well-Being

1. Overview

1.1 Scope

This recommended practice provides specific and contextual well-being metrics that facilitate the use of a Well-Being Impact Assessment (WIA) process in order to proactively increase and help safeguard human well-being throughout the lifecycle of autonomous and intelligent systems (A/IS).

1.2 Purpose

This recommended practice provides A/IS creators (designers, developers, engineers, programmers, and others) with impact-related insights that should be taken into account throughout the lifecycle of any A/IS to increase and help safeguard human well-being at the individual, population, and societal levels.

1.3 About IEEE Std 7010

IEEE Std 7010 is intended for use by A/IS creators in order to help in the following:

- a) Establishing a concept of human well-being in relation to A/IS
- b) Establishing a means to assess the impacts of A/IS on human well-being from conception to end of A/IS life
- c) Guiding A/IS development
- d) Identifying areas for improvement
- e) Informing risk mitigation strategies
- f) Assessing performance
- g) Identifying intended and unintended users, uses, and impacts on human well-being of A/IS

This recommended practice is intended for use in all sectors where A/IS are developed to guide the conception, design, development, assessment, monitoring, management, and improvement of A/IS impacts on human well-being. This includes business, academic, government, and nongovernmental organizations.

A/IS creators who do not have a methodology or means to understand or evaluate the intended and unintended impacts on human well-being by A/IS on users and other stakeholders are directly provided such a means with this recommended practice. It is grounded in the principle that businesses, governments, and individuals should aim to promote human well-being. While profit, economic growth, and personal wealth are instrumental to this goal, they should be placed inside a broader conception of well-being. Additionally, this recommended practice incorporates the notion of sustainability such that the well-being of future generations is considered. The overall intent is that IEEE Std 7010 supports the outcome of A/IS having positive impacts on human well-being.

A/IS creators should recognize that well-being measurement is a developing area of research, and that attributing impacts to specific A/IS is a complex effort. A/IS creators should be aware that there are likely to be many factors impacting the well-being of users or stakeholders when using A/IS (see 1.9). Nevertheless, this recommended practice should be used by A/IS creators to understand how to engage and work with users and stakeholders to assess, forecast, manage, and prepare for mitigation of the impacts on human well-being of A/IS.

A successful application of IEEE Std 7010 will have the following effects on A/IS creators:

- An increased awareness about well-being concepts and indicators for A/IS
- An increased capacity to monitor, evaluate, and address the well-being impacts from A/IS
- The ability to evaluate the ongoing well-being impacts of A/IS on users and stakeholders
- The ability to evaluate the ongoing well-being impacts of A/IS for continual improvement of the A/IS in helping to safeguard and improve human well-being
- Greater ability to avoid unintentionally harming the well-being of users and stakeholders

IEEE Std 7010 is composed of a WIA that results in a well-being indicators dashboard for use by A/IS creators in designing, developing, deploying, monitoring, and iteratively improving A/IS that help safeguard or improve human well-being. Core to IEEE Std 7010 is an iterative process that encompasses adaptation and continual improvement. When it is adopted, the IEEE 7010 WIA shall be conducted as an iterative process at every phase from conception, design, and development, to the ongoing assessment and management of A/IS.

This recommended practice is applicable to any stage of the lifecycle of an A/IS. Before an A/IS is deployed, IEEE Std 7010 helps shape ideation and guide development. After deployment, it helps the assessment of well-being impacts and guide improvement of an A/IS. IEEE Std 7010 is provided for use alone or in tandem with or as part of a life cycle processes or other processes already in place. It is possible to implement IEEE Std 7010 through integration of holistic engineering practices already in place, such as human-centered design, computational sustainability, and systems-thinking, or as a new practice undertaken by A/IS creators using routine engineering practices. It is possible to use IEEE Std 7010 in conjunction with other standards, such as ISO's quality management standards. It is also possible to use it as part of a quality circle/plan/do/check/act standard or other process or standard. See [Annex C](#) for ideas and examples for using IEEE Std 7010 as part of another process, system, framework, or other effort. Use of IEEE Std 7010 as part of another process does not preclude the use of best practices, guidelines, standards, regulations, or other guidance regarding data privacy, bias, nudging, transparency, etc.

NOTE 1—One use of IEEE Std 7010 is as part of existing processes, such as with the system life cycle processes of ISO/IEC/IEEE 15288 [B42]¹ and documentation within gate life cycle information item contents of ISO/IEC/IEEE 12207:2017 [B41]. For example, the use of IEEE Std 7010 to supplement the requirements definition process by explicitly addressing well-being indicators in the process of requirements capturing and analysis. Another use of indicators is to assess the impact of the developed product on well-being as part of the validation process. See [Annex D](#) for some notional examples for integrating IEEE Std 7010 into existing processes.²

¹The numbers in brackets correspond to those of the bibliography in [Annex G](#).

²Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

This recommended practice is intended for use by A/IS creators, however, in some cases, A/IS creators do not have the authority to adopt IEEE Std 7010. Decision makers include managers, organizational executives, acquirers, clients, or customers. To encourage the adoption and acceptance of IEEE Std 7010 within an organization, raising awareness about the recommended practice and the relevance of well-being indicators to A/IS is often beneficial. See [Annex C](#) for values statements for the use of IEEE Std 7010 as suggestions and starting places for raising awareness. Other resources for raising awareness include, IEEE Global Initiative on Ethics of Autonomous and Intelligent System’s *Ethically Aligned Design* [B36] and the Organization for Economic and Co-operation’s (OECD) Going Digital website [B60]. It is recommended that IEEE Std 7010 is integrated into the organizational and institutional process of the business, agency, organization, etc., including (but not limited to) the design, assessment, and marketing of AI/S. [Annex F](#) contains information for managerial adoption of IEEE Std 7010 also as suggestions and starting places for integrating it into organizational and institutional processes.

NOTE 2—IEEE Std 7010 presents a new concept and process, and as such there are not existing case studies, example well-being dashboards in use, or other evidence of its use. As it is used, it is expected that case studies will emerge, as well as examples and lessons to improve future iterations of this standard. To this end, it is expected that the user will adapt it to their circumstances and needs when they use it.

1.4 Iterative approach

This recommended practice is based on an iterative approach to measuring, improving, or helping to safeguard human well-being. It is important to emphasize that an iterative WIA process should facilitate continual feedback from AI/S implementations, resulting in a continuous cycle of assessment and improvement that is responsive to well-being impacts.

Use of this recommended practice does not imply that A/IS creators will have full knowledge of the well-being impacts on users. Moreover, it is assumed that the full range of well-being impacts on humans will not be known during any phase of the lifespan of an A/IS. Iterations of the WIA should help identify unknown impacts throughout the lifecycle of an A/IS project, with the well-being indicators dashboard being used as a guide for positively increasing human well-being from A/IS. See [A.1](#) for dashboard resources.

Most of the time, A/IS creators do not fully know how users will use a technology before the technology is in use, nor do they know the full range of impacts on human well-being by the A/IS. It is expected that the first iteration of the WIA will be rudimentary, and that repeated iterations allow for feedback loops and continual improvement. [A.1](#) lists resources describing iterative approaches.

1.5 Stakeholder engagement

Use of this recommended practice does not imply that A/IS creators are expected to solve all well-being problems related to A/IS in isolation. Integral to the recommended practice is a stakeholder engagement process in which A/IS creators engage stakeholders. See [A.1](#) for stakeholder engagement resources. IEEE Std 7010 is not intended to be a product used only for or with ISO products, so references added are not normative references.

1.6 Outside the scope of IEEE Std 7010 but important to its use

IEEE Std 7010 is limited to well-being impacts on humans as defined and delineated by subjective and objective well-being indicators. It encompasses consideration of individual and collective well-being, as well as the linkages and connections between individual and collective well-being including but not limited to human rights, economic fairness and equality, social equality, ecological health, stable and full employment, honest and trustworthy governments, and other interlinked and connected dimensions of individual and collective well-being. There are many aspects of collecting and using data that are related to well-being, but are not the subject of this standard, some of which are identified in this clause. It should be noted with particular emphasis

that measures should be taken to address these issues in order to help safeguard human well-being in the course of data collection for IEEE Std 7010.

Moreover, it is conceivable that the collection and management of data for the use of this recommended practice itself has an impact on the well-being of A/IS users and stakeholders. For this reason, the European Parliament Regulation 2016/679 General Data Protection Regulation (GDPR) [B17] is recommended as an informative reference when using IEEE Std 7010. However, there are other aspects of data collection and use not addressed by GDPR. In [Annex A](#), [A.2](#) provides some resources (e.g., codes, guidelines, standards) that relate to data use, but are outside the scope of IEEE Std 7010.

In addition, there are many aspects of the use of A/IS that might negatively impact human well-being. A non-exclusive list of potential negative impacts is described in the well-being section of the IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems document, *Ethically Aligned Design* [B36] as:

“...economic and labor impacts, including labor displacement, unemployment, and inequality; accountability, transparency, and explainability; surveillance, privacy, and civil liberties; fairness, ethics, and human rights; political manipulation, deception, nudging, and propaganda; human physical and psychological health; environmental impacts; human dignity, autonomy, and human vs. A/IS roles; and security, cybersecurity, and autonomous weapons.” (page 85)

Other emerging standards in the IEEE 70xx series may address some of these negative impacts and matters related to data use/collection and A/IS that fall outside the scope of IEEE Std 7010. The issues the IEEE 70xx series may address are: algorithmic bias considerations; child and student data governance; data privacy processes; employer data governance; ethical concerns during system design; ethically driven nudging for robotic A/IS; fail-safe design of autonomous and semi-autonomous systems; inclusion and application standards for automated facial analysis technology; machine readable personal privacy terms; ontological standard for ethically driven robotics and automation systems; personal data AI agents; processes of identifying and rating the trustworthiness of news sources; and transparency of autonomous systems (see [A.3](#)).

The scope of A/IS is vast, the stakeholders are diverse, and only recently have governments, NGOs, and businesses begun to study the impact of these technologies on human well-being. As of the publication of IEEE Std 7010-2020, there is no widely accepted set of recommendations, standards, best practices, guidelines, or regulations for contributing to or helping safeguard or improve human well-being. Therefore, in addition to using IEEE Std 7010, users should periodically do the following:

- a) Assess the applicability of the IEEE Std 7010
- b) Gather and employ new best practices and standards as they become available and as are applicable
- c) Formulate codes or procedures for their entities in an effort to prevent potential harms to human well-being
- d) Implement and monitor compliance with codes or procedures

This process should include assessing new data collection technologies and procedures. See [A.2](#) for resources.

1.7 Measuring well-being

Well-being can be reliably measured (IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems [B36]; Diener (2009) [B12]; Helliwell, Layard, and Sachs [B31]). Well-being indicators measure both what is good for well-being and what is detrimental to well-being as well as that for which the impact on well-being is not necessarily clear. The current way of measuring success for A/IS endeavors is predominantly economic value, sometimes without consideration of or at the expense of human well-being. Measuring what is good and bad for well-being allows A/IS creators to manage positive and negative impacts on well-being. Measuring the

impact on well-being when one does not know if the impact will be good or bad allows A/IS creators to know what the impact is and manage it as well.

Subjective indicators are used to gather data for how people perceive their state of well-being. Subjective indicators include measurement for satisfaction with life, affect, psychological well-being, satisfaction with earnings, sense of safety, sense of loneliness, satisfaction with the domains of well-being, etc. Research supports the use of subjective indicators, such as those based on questionnaires, surveys, polls or other means of gathering data from subjective experience. Subjective indicators that meet rigorous scientific standards are considered valid and reliable measures within the scientific community (OECD [B64]; Pavot and Diener, 1993 [B69]; Frey and Luechinger, [B25]; Ovaska and Takashima, [B67]). Subjective indicators are being used by national and international institutions and governments to better understand well-being within countries and country sub-populations and to understand people's satisfaction in specific domains of life. Examples of surveys that include subjective well-being indicators include the European Social Survey [B18], Eurostat's statistics on income, social inclusion and living conditions (Eurostat Income and Living standards [B21]) and the UK Office for National Statistics' well-being program [B87].

Objective indicators are used to gather data for observable phenomena. Objective indicators include measurement for income, productivity, employment status, education, life expectancy, hours per week worked, etc. Well-being is measured using objective indicators such as income, consumption, health, education, crime, housing, etc. These indicators have been used to understand conditions enabling well-being of countries' populations. Objective well-being indicators are also used by some companies to measure their performance. Examples of objective indicators in use are the OECD's Better Life Index [B58], the World Happiness Reports [B106] (both of which also include subjective indicators), and United Nations Sustainable Development Goals (SDG) indicators [B91], as well as, for business, the Global Reporting Initiative [B28], and B-Laboratory's Certified B-Corporations [B9].

Multiple indicators can be combined or aggregated into a single index. An index often uses a combination of subjective and objective measures. While aggregation sometimes helps to provide an overall snapshot of a person's or population's well-being, there are also downsides. High scores in one aspect of well-being sometimes hide low scores in another, and averages sometimes hide low scores for the majority of a population. Examples of aggregate or composite indices are the United Nations Development Programme's Human Development Index [B95], the Social Progress Index [B82] and the UK's Office of National Statistics Measures of National Well-being [B87]. (The OECD Better Life Index [B58] and the World Happiness Reports [B106] also use composite metrics).

Certain social mediums can be other potential tools to understand the well-being of a geographic region or demographic group, based on analysis of publicly available data. Examples include the Hedonometer [B54] and the World Well-being Project [B112].

Well-being should not be reduced to a single dimension. IEEE Std 7010 considers both direct indicators of well-being, such as an indicator for satisfaction with life or indicators for psychological well-being, and indirect indicators of well-being, such as indicators for poverty levels, commute time, sense of belonging to community, good governance, etc.

IEEE Std 7010 comprises well-being indicators from a variety of sources that capture impacts in a wide variety of domains (e.g., health, environment, community, etc.). Which indicators an A/IS creator should use depends on the nature of the A/IS in question and the circumstances of persons or populations potentially impacted.

Well-being refers to what is directly or ultimately good for a person or population and depends on what is indirectly good for a person or population as well. Direct indicators for well-being capture people's reflection of how satisfied they are with their lives, their perceptions of their well-being, etc. While indirect indicators capture many important contributors and circumstances that lead to well-being, a direct indicator of well-being helps to understand overall well-being. Direct indicators of well-being are used to understand relationships between other well-being indicators, and, hence, to explore and understand impacts on well-being.

What is directly or indirectly good for a person or population depends on context. However, this context is bound by indispensable principles such as human rights and ecological harmony. IEEE Std 7010 should not be used to justify harming human well-being, abusing human rights, mistreating non-human animal life and ecosystems, or perpetuating systems of inequality and exploitation.

Indicators that have been tested to help ensure they measure what they intend to measure are scientifically validated. The indicators in [Clause 6](#) are drawn from publicly available indices that are composed of scientifically validated indicators. Scientifically validated indicators are used to gather reliable data, subject to the means by which the data is gathered. When indicators are adapted or changed, they should be tested to help ensure they measure what is intended to be measured. For subjective indicators, the *OECD Guidelines for Measuring Subjective Well-being* [B64] is a useful guide. For objective indicators, von Shirndling’s chapter “Construction of Indicators” in *Health in Sustainable Development Planning: The role of indicators* [B102] is a useful guide. The OECD report *How’s Life in the Digital Age? Opportunities and Risks of the Digital Transformation for People’s Well-being* [B62], issued in 2019, contains a set of 33 indicators across the domains of education and skills, ICT access and use, health, environmental quality, governance and civic engagement, income and wealth, jobs and earnings, personal security, social connections, subjective well-being, and work-life balance that should be useful to users of IEEE Std 7010 in selecting indicators.

While the fulfillment of strategies with respect to particular indicators may lead to goal tension at times, IEEE Std 7010 should not be used to justify harming the well-being of any one person, group of people, or the environment for the well-being of others. The various indicators should be understood to exist within a larger effort to help safeguard and improve well-being. As such, the protection of human rights, avoidance of exploitation and abuse, and environmental harmony should be used to guide the selection and application of indicators.

NOTE—IEEE Std 7010 does not include a scoring or evaluation tool that would allow users to definitively gauge whether the A/IS had a positive impact on human well-being. IEEE Std 7010-2020 Working Group members encourage exploring the feasibility and utility of such a tool. Suggested frameworks for such a tool include the triple bottom line, a well-being domain assessment, the IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems’ Happiness Screening Tool for Business Product Decisions (in *Ethically Applied Design* [B36]), or a scoring system based on changes over time for indicators used within a well-being indicators dashboard. Prior to the deployment of an evaluation tool, trade-offs, no-go indicators, and potential misuse of a scoring or evaluation tool should be thoroughly considered and addressed in any development of a scoring or evaluation system or tool. The use of a scoring or evaluation tool should include processes and instructions that do not allow it to be used to justify harm to human well-being or for greenwashing.

[Annex B](#) contains indicators for various A/ISs for use as examples and starting places, but that should not be used to replace the WIA process.

1.8 Relationship of well-being and sustainability

For the purposes of IEEE Std 7010, it should be understood that an important factor in helping safeguard and improve human well-being is ecological health, access to nature, safe climate and natural environment, biosystem diversity and other aspects of a healthy sustainable natural environment. Not only is a healthy and sustainable natural environment instrumentally important to the well-being of the current generation, but integral to the well-being of future generations. This understanding of well-being for the purposes of IEEE Std 7010 also encompasses sustainable development or “meeting the needs of the present without compromising the ability of future generations to meet their needs” (World Commission on Environment and Government [B105]).

1.9 Data considerations

IEEE Std 7010 entails the analysis of data. A/IS creators who are not familiar or comfortable with data analysis are encouraged to learn about data analysis or otherwise develop the capacity for data analysis. A few resources and examples of analyzing well-being data are in [Annex A](#).

Data gathered for an individual reflects that individual's well-being. For example, data for an individual's, income, sense of safety, or average time spent in commute reflects that individual person's well-being for those areas of well-being measured by those indicators.

Data gathered for a population generally reflect that population's well-being. When data is gathered for a population, such as a geographic area or region, it is possible to use it to reflect the well-being for that population, albeit care should be taken to help ensure averages or aggregation does not hide high or low scores for segments of a population or other anomalies. For example, average satisfaction with life for a population, average gross domestic product (GDP), average sense of safety for a population, or average commute time for a population reflects the well-being of a population for those areas of well-being measured by those indicators. Data gathered through random sampling to reflect a population is often relied upon to reflect the well-being of the entire population. Data gathered through convenience samplings whereby people opt-in to provide data sometimes reflects a population, and should be analyzed and compared to similar data collected through random samples before assumptions are made about its reliability for a population.

Collecting data for satisfaction with life or any other subjective indicator should be done independently from any A/IS to help ensure the data collected is not biased. For example, a satisfaction with life indicator should not be phrased as: "How does this A/IS impact your satisfaction with life?" as phrasing a question like this or in any similar way could bias the data. Instead, data should be gathered for all subjective indicators independently. For example, the indicator should be phrased as: "Overall, how satisfied are you with your life?"

Many of the well-being indicators in [Clause 6](#) indirectly rather than directly measure the well-being of an individual, community, or population. Most of the indicators are useful for gathering data to determine whether impacts on well-being are positive, negative, or neutral impacts. All of the indicators, by themselves, capture only a dimension of the well-being of an individual, community, or population. The indicators in [Clause 6](#) are intended to be used in conjunction with each other as part of a well-being indicators dashboard (see [Clause 4](#) and [Clause 5](#)) to capture a holistic picture of well-being.

NOTE—Changes in data collected for indicators measuring the impact on human well-being are likely not to be exclusively the result of A/IS use. Other life events and influences, in part or in whole, also explain changes in data. A dramatic example is the death of a loved one or getting a new job between times data is collected. These and less dramatic events are likely to impact the data collected.

Difficulty in measuring the impact of the A/IS does not mean that the data should not be gathered or used. It is suggested that A/IS creators or others investigate reasons outside the use of the A/IS for changes in data and use this information for more advanced statistical analysis of data to better understand the links and other relationships between use of their A/IS and the well-being impacts measured. While clear demonstration of causal effects is not a requirement of this recommended practice, it is recommended that efforts are made to improve the well-being of human lives when possible through learning from iterations and analysis.

2. Definitions, acronyms, and abbreviations

2.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.³

affect: Feelings felt by humans. Positive affect comprises positive feelings such as feeling calm, contented, happy, joyful, pleasant, etc. and negative affect comprises negative feelings such as feeling afraid, angry, bad, unpleasant, stressed, etc.

NOTE—The term **affect** is similar but not the same as the use of the term affect in Affective Computing or A/IS that can recognize, interpret, and simulate human emotions and related affective phenomena. Affective Computing is computing that relates to, arises from, or deliberately influences emotion or other affective phenomena (Picard [B75]).

A/IS creator: Person or entity that designs, develops, engineers, programs or similarly creates an A/IS.

artificial intelligence (AI): The capacity of computers or other machines to exhibit or simulate intelligent behavior.

autonomous/intelligent system (A/IS): A semi-autonomous or autonomous computer-controlled system programmed to carry out some task with or without limited human intervention capable of decision making by independent inference and successfully adapting to its context. An example is an A/IS that refers to a computer system instantiated in a product or service.

NOTE—For the purposes of IEEE Std 7010, A/IS encompasses AI and information systems (IS).

baseline data: Data collected at the beginning of a process and used for comparison to subsequently collected data.

domain: An aspect or area of knowledge or activity characterized by a set of concepts and terminology understood by practitioners in that area.

NOTE—The Organization for Economic Cooperation and Development (OECD) Better Life Index [B58] uses the term “conditions of life,” which include jobs and earnings, environmental quality, social connects, and many others.

index: A composite set of measures that reflect a concept such as well-being. An example of an index is the OECD Better Life Index [59]. Some use the term indicator and index synonymously.

NOTE—For the purposes of IEEE Std 7010, the terms should not be used synonymously.

indicator: A measure of a discrete element of a domain. One domain can have one or more indicators.

intended user: A person by whom an A/IS creator intends an A/IS to be used.

life cycle: Evolution of a system, product, service, project, or other human-made entity from conception through retirement.

NOTE—See IEEE 1517-2010 [B37].

primary data: Data that is collected directly from a subject.

³IEEE Standards Dictionary Online is available at: <http://dictionary.ieee.org>. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

secondary data: Data that has already been collected from various sources, such as governmental census or statistical bureaus, nonprofits, academic institutions and consultancies.

stakeholder: Anyone or any organization that is a) meaningfully or potentially meaningfully be impacted by the A/IS and/or b) meaningfully or potentially meaningfully impacts the A/IS.

unintended user: A person who an A/IS creator does not intend an A/IS to be used by, but who nonetheless interacts with the A/IS.

user: A person who interacts with an A/IS. A user is a type of stakeholder.

well-being: The continuous and sustainable physical, mental, and social flourishing of individuals, communities and populations where their economic needs are cared for within a thriving ecological environment.

well-being metrics: Subjective and objective indicators—indicators measuring both internal phenomena and external factors—encompassing the capabilities and subjective well-being approaches, and including but not limited to the domains of a) affect, b) community, c) culture, d) education, e) economy, f) environment, g) human settlements, h) health, i) government, j) psychological well-being/mental well-being, k) satisfaction with life, and l) work.

2.2 Acronyms and abbreviations

AI	artificial intelligence
A/IS	autonomous/intelligent systems
AV	autonomous vehicles
WIA	Well-Being Impact Assessment

3. Roadmap and process checklist for IEEE Std 7010

[Clause 4](#) introduces the WIA and the well-being indicators dashboard, while [Clause 5](#) provides more detailed guidance on implementation of the WIA and the well-being indicators dashboard. The WIA is the process by which one identifies potential well-being impacts through stakeholder engagement, measures said impacts through data collection and analysis, and modifies an A/IS based on the insights derived from stakeholder engagement and data analysis. This process is an iterative process that should be repeated throughout the A/IS's lifecycle. The WIA is composed of five activities, as follows:

- a) Internal analysis and stakeholder/user engagement
- b) The creation of the well-being indicators dashboard
- c) The creation of a data collection process and the collection of data
- d) Data analysis and the use of said data to improve the A/IS in question
- e) Iteration

The well-being indicators dashboard is a proposed tool for organizing information related to the WIA. This dashboard may take many different forms depending on the needs and resources of the user of IEEE Std 7010. In some cases, the dashboard may be an interactive application that collects, analyzes, and surfaces data related to the well-being indicators; while in other cases it may simply be a collection of documents and spreadsheets used to organize information related to the WIA.

Table 1 is the IEEE Std 7010 process checklist. When all activities are completed, the process for implementing the recommended practice is complete.

Table 1—IEEE Std 7010 general checklist

		Yes/No
1	Completed internal analysis for WIA	
2	Engaged users for WIA	
3	Engaged stakeholders for WIA	
4	Developed well-being indicators dashboard	
5	Gathered baseline data	
6	Gathered post-baseline data	
7	Engaged in A/IS improvement	
8	Engaged in well-being indicators dashboard improvement	

4. Well-Being Impact Assessment (WIA) and Well-Being Indicators Dashboard Activities and Steps

This clause lists the activities and tasks of the WIA process. Figure 1 provides a visualization of the WIA process and creation the well-being indicators dashboard.

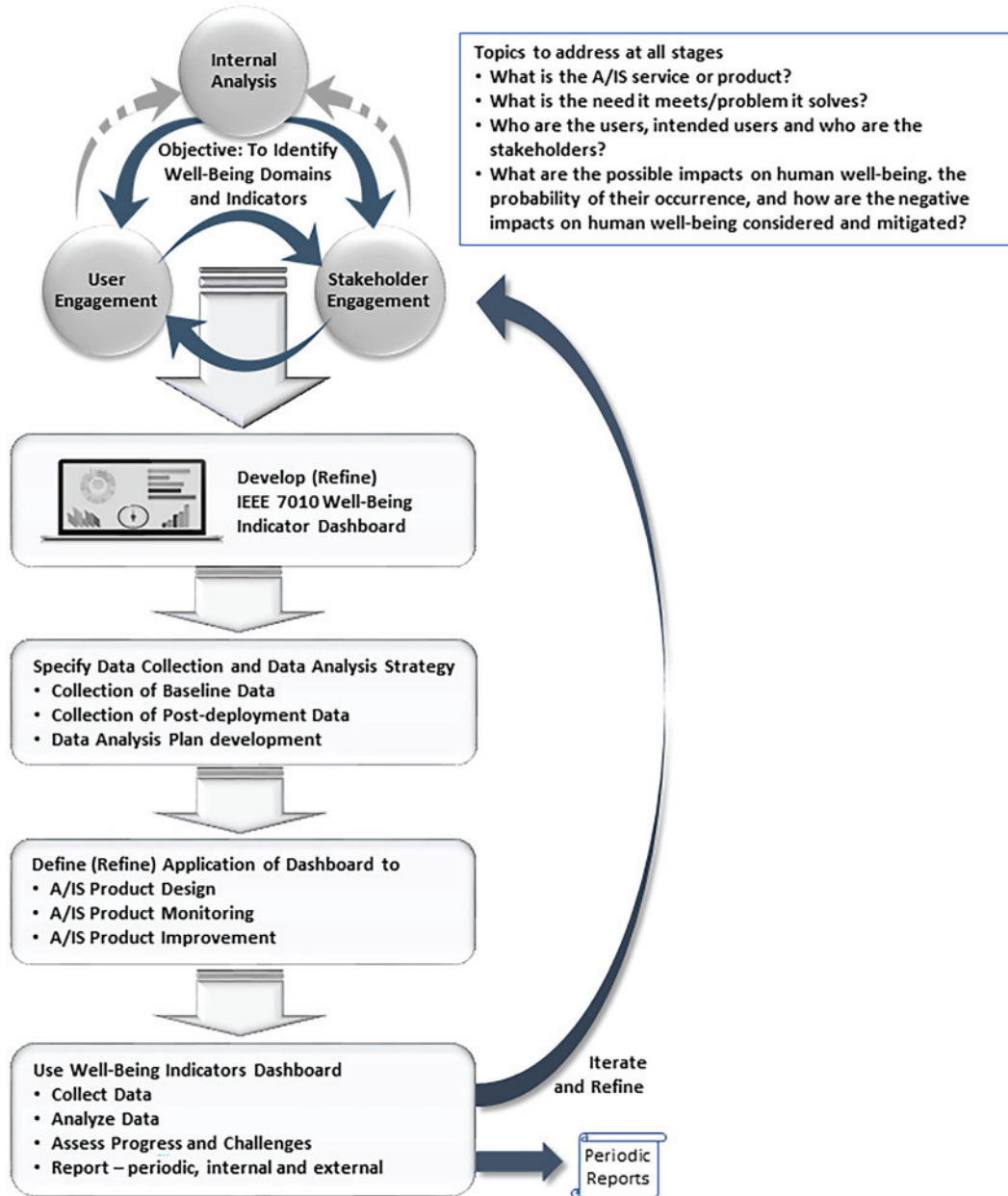


Figure 1—Flowchart of the iterative and adaptive nature of the WIA

4.1 WIA Activity 1: Internal, User, and Stakeholder Impact Assessment

4.1.1 Activity 1 Task 1: Internal Analysis

In Task 1, the following four questions should be asked:

- What is the A/IS?
- What are the needs it meets/problems it solves?
- Who are the intended users, unintended users, and who are the stakeholders?
- What are the possible impacts on human well-being, the probability of their occurrence, and how are negative impacts on human well-being considered and mitigated?

The impact assessment should begin with consideration for all of the domains in [Clause 6](#). These domains of well-being are the following: satisfaction with life, affect, psychological well-being, community, culture, education, economy, environment, government, health, human settlements, and work. [Clause 6](#) contains indicators that may be selected to reflect the well-being impacts on humans. Indicators should first be selected from [Clause 6](#), and they may be adapted. When there are no indicators in [Clause 6](#) that reflect the impacts on human well-being, additional indicators can be found in [A.4](#) and [A.5](#).

Internal analysis should be a continual process.

4.1.2 Activity 1 Task 2: User Engagement

In Task 2 the following four questions should be asked:

- a) What are the benefits to the well-being of users?
- b) What are the harms to the well-being of users?
- c) What are the possible impacts on human well-being, the probability of their occurrence, and how are negative impacts on human well-being considered and mitigated?
- d) What are the unintended uses and impacts, the probability of their occurrence, and how are risks and negative impacts on human well-being considered and mitigated?

Indicators are refined to reflect the impacts on human well-being.

Additional indicators are first selected from [Clause 6](#). Other sources for indicators are in [A.4](#) and [A.5](#).

4.1.3 Activity 1 Task 3: Stakeholder Engagement

In Task 3 the following four questions should be asked:

- a) What are the benefits to the well-being of stakeholders?
- b) What are the harms to the well-being of stakeholders?
- c) What are the possible impacts on human well-being, the probability of their occurrence, and how are negative impacts on human well-being considered and mitigated?
- d) What are the unintended uses and impacts, the probability of their occurrence, and how are risks and negative impacts on human well-being considered and mitigated?

Indicators are refined to reflect the impacts on human well-being.

Additional indicators are first selected from [Clause 6](#). Other sources for indicators are in [A.4](#) and [A.5](#).

4.2 WIA Activity 2: Well-Being Indicators Dashboard

A dashboard based on the domains and indicators identified in Activity 1 should be created. The dashboard should include a way for current and future A/IS creators to easily access the following:

- a) The definition of each domain used
- b) The source of each indicator (where the indicator came from)
- c) An explanation of how each indicator was selected
- d) If appropriate, how each indicator was adapted
- e) How the data was collected

4.3 WIA Activity 3: Data Collection Plan and Data Collection

A plan for collecting data from users and stakeholders should be formed. Baseline data and data over time should be collected. The well-being indicators dashboard should be populated with data.

4.3.1 Activity 3 Task 1: Establishing a Data Collection Plan

The data collection plan should include the following descriptions:

- a) What data is to be collected
- b) How the data will be collected
- c) The frequency with which the data is collected
- d) How data will be time stamped and other means of identification when it is collected
- e) How baseline data is collected
- f) When baseline data is collected

It should include specific activities and details or be more general, as fits the circumstances. Secondary data for populations is available from the sources for indicators listed in [Clause 6](#), from [A.4](#) and [A.5](#) or from other sources for data, such as governments, nongovernmental organizations, education, and research organizations or businesses.

4.3.2 Activity 3 Task 2: Collect Data and Populate the Well-Being Indicators Dashboard

The activities for data collection and population of the well-being indicators dashboard should include the following:

- a) Collect baseline data for the users
- b) Collect baseline data for the stakeholders
- c) Collect baseline data for the population that reflects users and stakeholders (i.e., data for populations that are similar to users and stakeholders)
- d) Collect data for users over time
- e) Collect data for stakeholders over time
- f) Collect data for the population that reflects users and stakeholders over time
- g) Populate the well-being indicators dashboard with the data sets

Where there is not data for an indicator or indicators, it should be noted.

4.4 WIA Activity 4: Well-Being Data Analysis and Use of Well-Being Data

Activity 4 involves two tasks that are action based. The well-being data should be analyzed and used for design, development, deployment, monitoring, and iterative improvement of an A/IS to help safeguard and improve human well-being.

4.4.1 WIA Activity 4 Task 1: Well-Being Data Analysis

Well-being data analysis should include the following activities:

- a) Identify trends over time
- b) Use the data to understand the impacts the A/IS has on the well-being of users and stakeholders

- c) Use the data to illuminate unexpected uses, behaviors, outcomes, and impacts
- d) Document the implementation

4.4.2 Guidance for WIA Activity 4 Task 2: Use of Well-Being Data

WIA Activity 4 Task 2 use of well-being data should include the following activities:

- a) Improve the design, development, assessment, monitoring, management of A/IS to positively impact user and stakeholder well-being
- b) Improvement to well-being indicators dashboard
- c) Documentation of implementation as fits the A/IS creators process and organization

4.5 WIA Activity 5: Iterate

Iterative use of the well-being indicators dashboard and WIA process for continual improvement to the A/IS should be conducted through the following:

- a) Assess the of the WIA process and well-being indicators dashboard
- b) Improve the data collection and analysis strategy
- c) Improve the well-being indicators dashboard
- d) Report as helpful to users and stakeholders

5. Guidance for WIA and Well-Being Indicators Dashboard Activities and Steps

This clause provides guidance for implementing [Clause 4](#). The WIA is an iterative process that entails producing a well-being indicators dashboard and using it for the design, development, deployment, monitoring, and continual improvement of an A/IS in order to help safeguard and improve human well-being. The WIA is designed to be an iterative process whereby there is continual engagement, adaptation, and improvement. As noted in [1.7](#), [Annex B](#) provides notational examples of indicators for various A/IS as starting places, but notational examples should not be used to replace the WIA process.

NOTE—[Annex E](#) contains notional examples intended to help in understanding the application of IEEE Std 7010. They are for illustrative purposes only.

5.1 Guidance for WIA Activity 1: Internal, User, and Stakeholder Impact Assessment

Activity 1 of the WIA involves first identifying and later refining (through an iterative process) well-being domains and indicators to employ in a well-being indicators dashboard. This activity involves the following three tasks:

- Initial analysis
- User engagement
- Stakeholder engagement

The latter two tasks, user engagement and stakeholder engagement, should be conducted in parallel when it is effective to do so, and should inform iterative revisiting of internal analyses. All three tasks should be revisited as appropriate with each major iteration of the overall WIA process.

At the first iteration of the WIA, A/IS creators should begin with the assumption that human well-being in every domain is impacted. When going through WIA Activity 1 Task 1, Internal Analysis, A/IS creators should seek to understand what the impacts are in each domain and identify the indicators for each impact. In Task 2 and Task 3, User Engagement and Stakeholder Engagement, A/IS creators should seek to test their assumptions and identify other impacts for all the domains. If at the end of the tasks, no impacts are identified for a domain, that domain should be excluded from the well-being indicators dashboard for that iteration. Future iterations should include consideration of the domains that are not included in a well-being indicators dashboard if any domains are excluded.

A definition for each domain is in [Clause 6](#). The initial set of domains and indicators should be selected from [Clause 6](#) and adapted as needed to reflect the well-being impacts arrived at from the tasks in this activity. Additional indicators are in [A.5](#), and from other sources.

5.1.1 Guidance on WIA Activity 1 Task 1: Internal Analysis

Task 1 is an internal analysis conducted by A/IS creators and, when appropriate, others within the organization. Internal analysis should involve forecasting, hypothesizing, projecting, utilizing scenarios, or other means of internal analysis.

This task should be conducted in stages.

In this task, A/IS creators answer the following four questions to guide the indicator selection process:

- a) What is the A/IS?
- b) What is the need it meets/problem it solves?
- c) Who are the intended users, unintended users, and who are the stakeholders?
- d) What are the possible impacts on human well-being, the probability of their occurrence, and how are negative impacts on human well-being considered and mitigated?

The initial analysis should be conducted by A/IS creators alone then with involvement from other departments or functions of an organization for part or all of this task.

The first question entails describing the A/IS. Answering this question is prerequisite for assessing its impacts.

The second question involves specifying the purpose of the A/IS and the problems it is intended to address. This question is addressed in terms of specifying the goals and utility of a project. This question is designed to help understand the scope of the well-being impacts for users and stakeholders. A/IS creators should use the well-being domains in [Clause 6](#) as a starting point for brainstorming and articulating the need the A/IS meets or problems it solves.

The third question involves understanding the intended users, the unintended users and stakeholders. It is important to capture unintended users and stakeholders because they are positively or negatively impacted and it is possible that they suffer negative unintended harm. (See [A.1](#), for information about stakeholder engagement.) Impacts on users and stakeholders are direct or indirect, and actual or potential. When answering this question, it is necessary to determine which users and stakeholders to include in tasks 2 and 3 and which not to include.

When identifying users and stakeholders, special consideration should be given to children, vulnerable populations, and populations needing assistive technologies. With each iteration, the identification of users and stakeholders should be revised as users and stakeholders often change with new understanding from data or with changes in uses of an A/IS.

The fourth question involves understanding the possible impacts on human well-being. A/IS creators should be attentive to both positive and negative impacts. A/IS creators should acquaint themselves with [Clause 6](#) to understand the scope of well-being and possible well-being impacts. A/IS creators should keep in mind the Confucius saying, “Real knowledge is to know the extent of one’s ignorance,” in a continual effort to improve their understanding of well-being impact and indicators. For example, it is expected that autonomous vehicles would impact users’ and other stakeholders’ access to transportation, commute times, and household costs in terms of transportation, but using the domains and indicators in [Clause 6](#) suggests unintended impacts for positive or negative impacts, including getting less physical exercise or increasing resting or sleep time.

After answering these four questions, the A/IS creators and others engaged in this task should have both an understanding of well-being impacts and a grasp of the limits of their understanding. A/IS creators should select indicators to measure the impact identified if they have not already from [Clause 6](#), [A.5](#), or other sources. This task results in an initial set of domains and indicators.

NOTE—See [Annex E](#) for a notional example of this task.

[Table 2](#) is a checklist for Activity 1 Task 1.

Table 2—WIA Activity 1 Task 1 internal analysis checklist

	Yes/No
1	Has the A/IS been identified?
2	Have the needs it meets, and/or problems it solves been identified and defined?
3	Have users, unintended users, and stakeholders been identified?
4	Have possible impacts on human well-being been identified?
5	Did the impact on human well-being assessment begin with considering impact on all domains?
6	Did the assessment include brainstorming potential impacts within each domain?
7	Were indicators that measure the identified areas of impact selected from Clause 6 and if there were none, A.5 or other sources?
8	If there were no impacts identified within a domain(s), was it noted for Task 2 and Task 3?
9	Were unintended and unexpected issues considered, such as potential biases, negative impacts, and other unknowns considered, including how risks and negative impacts to human well-being can be mitigated?

5.1.2 Guidance on WIA Activity 1 Task 2: User Engagement

In this task, A/IS intended and unintended users (“users”) identified in Task 1 are engaged in order to further understand the direct and indirect impacts A/IS have and the well-being domains and indicators that reflect and measure those impacts. Assumptions and conclusions arrived at from the Task 1 internal analysis are tested, and the domains and indicators collected from Task 1 are revised. By engaging with users, this process should uncover additional unintended users and stakeholders at which point a decision should be made about whether to include them in this task.

This task involves clearly explaining A/IS to users and exploring the intended and unintended uses, as well as benefits, harms, and risks to human well-being. At the end of this task the A/IS creator should be able to answer the following questions:

- a) What are the benefits to the well-being of users?
- b) What are the harms to the well-being of users?

- c) What are the possible impacts on human well-being, the probability of their occurrence, and how are negative impacts on human well-being considered and mitigated?
- d) What are the unintended uses and impacts, the probability of their occurrence, and how are risks and negative impacts on human well-being considered and mitigated?

Means for engaging users include focus groups, surveys, experts, crowdsourcing, and other means. User engagement should mirror the demographics of the future users. Caution should be taken to help ensure that the engaged users are representative of the entire breadth of the user population, and that the needs of underrepresented demographics are also sufficiently identified. For example, if users are children, teachers, and parents from public and private schools, then the users engaged should reflect these six kinds of users. It is possible that some users are children, populations requiring assistive technologies, members of vulnerable populations, or others who have impairments. See [Annex A](#) for definitions of and information about working with vulnerable populations.

The methods for user engagement should be determined as fits the circumstances of the WIA process. Although IEEE Std 7010 does not offer recommendations for managing issues of trust, transparency, privacy, and similar issues when personal data is collected or used, A/IS creators should pay special attention to issues related to the collection and use of personal data (see [1.6](#)). When engaging with users, A/IS creators should use the domains in [Clause 6](#) to frame discussions and help identify impacts. The indicators identified in Task 1 should not be included in discussions with users during the engagement process as this could lead to bias. It is recommended that A/IS creators learn about processes and models for user engagement before conducting this task if user engagement processes are novel to them. (See [Annex A](#) for resources for user engagement.)

NOTE—A/IS creators should be aware of the risk that an WIA does not fully represent users or is inaccurate or misleading if the entire spectrum of users is not engaged, and make reasonable efforts to engage every spectrum of user. However, the level and scope of user engagement will vary depending on the size and resources of an organization, and it is up to the judgement of the A/IS creator to determine reasonable efforts. The level of user engagement will vary based on the size and capacity of an organization, the stage of development or market readiness of an A/IS, and other factors. In a very small organization, it is conceivable that user engagement can be conducted with a handful of users. In medium and large enterprises, it is conceivable that it be large scale and incorporated into market studies, focus groups, research projects, pilot studies, etc.

This task results in a refinement of Task 1 well-being domains and indicators to reflect the well-being impacts as identified through engagement with the users. After conducting the user engagement, A/IS creators should have a better understanding of the well-being impacts of their A/IS.

This task is complete when a saturation point has been reached. A saturation point is arrived at when further engagement results in the identification of the same impacts, domains, and indicators already found in prior engagements. A/IS creators should note that when the same information is revealed repeatedly in such a process, it often reinforces the importance of that feedback. This is the saturation point for any one iteration. It should be considered that future iterations will reveal new impacts, domains, and indicators. This phase should inform an iterative revisiting of the WIA Activity 1 internal analysis. All three tasks of WIA Activity 1 are interdependent and should be performed in an iterative manner until a saturation point is reached.

[Table 3](#) is a checklist for Activity 1 Task 2.

Table 3—WIA Activity 1 Task 2 user engagement checklist

		Yes/No
1	Where methods of user engagement identified?	
2	Have intended and unintended users identified in Task 1 been engaged?	
3	Have additional (current and potential future) benefits to the well-being of users been identified?	
4	Have additional (current and potential future) harms to the well-being of users been identified?	
5	Have additional (current and potential future) risks to the well-being of users been identified?	
6	Have additional unintended (current and potential future) uses and impacts been identified?	
7	Were the assumptions about the indicators that were identified in Task 1 tested and, when relevant, revised?	
8	Were additional indicators reflecting the impacts identified for all the domains identified in Task 1? (From Clause 6, A.5 , and other sources)	
9	Were indicators reflecting the impacts identified for any domains that were not identified in Task 1? (From Clause 6, A.5 , and other sources).	
10	Was a saturation point for domain and indicator identification reached?	
11	Were blind spots, potential biases, negative impacts, and other unknowns considered, including how risks and negative impacts to human well-being can be mitigated?	

5.1.3 Guidance of WIA Activity 1 Task 3: Stakeholder Engagement

Task 3 involves engaging stakeholders to expand the understanding of how the A/IS impacts the well-being of stakeholders. This process should mirror the process used in Task 2, for user engagement. At the end of this task the A/IS creator should be able to answer the following questions:

- a) What are the benefits to the well-being of stakeholders?
- b) What are the harms to the well-being of stakeholders?
- c) What are the possible impacts on human well-being, the probability of their occurrence, and how are negative impacts on human well-being considered and mitigated?
- d) What are the unintended uses and impacts, the probability of their occurrence, and how are risks and negative impacts on human well-being considered and mitigated?

Stakeholder engagement should be undertaken through focus groups, surveys, experts, crowdsourcing, or by other means. As with user engagement, the methods for stakeholder engagement should be determined as fits the circumstances of the A/IS creators' organizational setting, project scope, and other considerations. It is recommended that A/IS creators learn about processes and models for identifying and engaging stakeholders before conducting this task if stakeholder engagement processes are novel to them. (See [Annex A](#) for resources stakeholder engagement.)

Guidance for user and stakeholder selection

After identifying stakeholders, for practical reasons it is conceivable that it will be necessary to select which stakeholders to engage in the current iteration of the WIA, which to include in future iterations, which it is better not to engage, and how to consider the impacts for stakeholders who are not available for engagement. Some factors influencing these decisions are cost, feasibility, indicator or data overwhelm, degrees of control or influence, etc. The degree and nature of material impacts on stakeholders should be one basis for selecting stakeholders for engagement. Stakeholders who are particularly vulnerable or present a high degree of risk should be engaged. The rationale for selecting which stakeholders to engage should be documented for reference in future iterations of the WIA.

End of guidance

As with Task 2, this task is complete when a saturation point has been reached. A saturation point is arrived at when further engagement results in the identification of the same impacts, domains, and indicators already found in prior engagements. This is the saturation point for any one iteration. It should be assumed that future iterations will reveal new impacts, domains, and indicators.

NOTE—See [Annex E](#) for a notional example of this task.

[Table 4](#) is a checklist for Activity 1 Task 3.

Table 4—WIA Activity 1 Task 3 stakeholder engagement checklist

	Yes/No
1	Were methods of stakeholder engagement identified?
2	Have intended and unintended stakeholders identified in Task 1 been engaged?
3	Have additional (current and potential future) benefits to the well-being of stakeholders been identified?
4	Have additional (current and potential future) harms to the well-being of stakeholders been identified?
5	Have additional (current and potential future) risks to the well-being of stakeholders been identified?
6	Have additional unintended (current and potential future) uses and impacts been identified?
7	Were the indicators identified in Task 1 and Task 2 tested?
8	Were additional indicators reflecting the impacts identified for all the domains identified in Task 1 and Task 2? (From Clause 6, A.5 , and other sources).
9	Were indicators reflecting the impacts identified for any domains that were not identified in Task 1 and Task 2? (From Clause 6, A.5 , and other sources).
10	Was a saturation point for domain and indicator identification reached?
11	Were blind spots, potential biases, negative impacts, and other unknowns considered, including how risks and negative impacts to human well-being can be mitigated?

Guidance in how much stakeholder engagement is too much or too little?

Stakeholder engagement should not be undertaken in such a way to overwhelm a small organization. The scale of stakeholder engagement varies based on the stage of development of an A/IS, capacity of an organization and other factors. In some cases, it is conducted solely by an organization (of any size) or it is conducted with the participation of an external organization(s). For large organizations or high-impact projects, it involves the participation of policymakers, researchers, educators, the public, philosophers, and others.

End of guidance

5.2 Guidance on WIA Activity 2: Well-Being Indicators Dashboard

For Activity 2, a well-being indicators dashboard is formed based on the domains and indicators selected in Activity 1. The dashboard is expected to be used by the A/IS creators during all phases of A/IS life, including design, development, deployment, monitoring, and iterative improvement; hence, it should be formatted for usefulness. It should be a standalone tool or incorporated into a previously existing dashboard. The dashboard should be continuously improved as part of the iterative nature of the WIA.

The dashboard should be composed of well-being domains and well-being indicators, organized by their domains. The dashboard should include a way for current and future A/IS creators to easily access the following:

- a) The definition of each domain used
- b) The source of each indicator (where the indicator came from)

- c) An explanation of how each indicator was selected
- d) If appropriate, how each indicator was adapted
- e) How the data was collected

For example, for the domain of community, it should be easy to find that community is defined as a group of people who live, work, or recreate in a place or have common interests. (See [Clause 6](#) for definitions of domains).

For example, if the indicator for sense of belonging to a neighborhood had been selected through user engagement conducted as part of WIA Activity 1 Task 2, A/IS creators would be able to find this explanation easily: a) that it came from the UK’s Office of National Statistics Measuring National Well-being [B87] and b) that it was adapted to a question in a survey conducted monthly in which users are asked: “How would you describe your feeling of belonging to your local community?” (with answers on a scale from very strong to very weak).

The dashboard should be fashioned so that data is easily integrated to provide useful, relevant, timely, and reliable data. Above all, it should be useful. It should be provided in a visualization, such as activity streams, tabular overviews, or other visualization, or in another format.

The dashboard should display well-being indicators, as well as information about goals and activities to help safeguard and improve well-being, thereby supporting the iterative process of the WIA.

The well-being indicators dashboard should be used by others besides A/IS creators within an organization (such as management, public relations, legal, or other departments) or others outside an organization (such as the public, researchers, educators, the media, or philosophers), when it is appropriate.

NOTE—See [Annex E](#) for a notional example of this task.

[Table 5](#) is a checklist for Activity 2.

Table 5—WIA Activity 2 well-being indicators dashboard checklist

		Yes/No
1	Has a well-being indicators dashboard composed of indicators gathered in Activity 1 been formed?	
2	Is the definition of each domain provided and easily accessible?	
3	Is the source of each indicator provided and easily accessible?	
4	Is an explanation of how each indicator was selected provided and easily accessible?	
5	If appropriate, is an explanation of how each indicator was adapted provided and easily accessible?	
6	Is the well-being indicators dashboard fashioned to provide useful, relevant, timely and reliable data?	
7	Does the well-being indicators dashboard provide clear data that can be visualized (such as activity streams, tabular overviews, or other visualizations), as is appropriate and useful?	
8	Optional: Does the well-being indicators dashboard provide levels of detail in data?	
9	Optional: Does the well-being indicators dashboard include well-being goals, relate goals to indicators, and track progress toward the goals, to support the iterative process promoted by IEEE Std 7010?	

5.3 Guidance for WIA Activity 3: Data Collection Plan and Data Collection

For the WIA, Task 3 has two parts: a) forming a plan for collecting data from users, stakeholders, and populations reflecting users and stakeholders and b) collecting baseline data and data over time and populating well-being indicators dashboard. The two parts in this task should be conducted concurrently or separately with other tasks, as best fits circumstances. Once the well-being indicators dashboard is populated with data and in use, it should support continual improvement of the A/IS for human well-being and be an integral part of the management of the A/IS.

5.3.1 Guidance for WIA Activity 3 Task 1: Establishing a Data Collection Plan

In Activity 3 Task 1, a data collection plan is formed. Data should be collected for users, stakeholders, and the population that reflects users and stakeholders. Data collected for users and stakeholders should be used to assess the well-being impacts on them. Data collected for the population should be used for comparisons and other analysis. (It is conceivable that A/IS creators, in particular A/IS researchers, will decide to form a control group and collect data from the control group at their discretion.) The data collection plan should entail collecting data periodically or continually throughout the A/IS life.

The data collection plan should include descriptions of the following:

- a) What data is to be collected
- b) How the data will be collected
- c) The frequency with which the data is collected
- d) How data will be time stamped and other means of identification when it is collected
- e) How baseline data is collected
- f) When baseline data is collected

The description of the data collection process should be very detailed or more general, as fits the circumstance.

The methods for collecting primary data should be described. The methods for collecting secondary data should also be also described as part of the establishment of a data collection plan.

Data should be collected at a level of granularity useful for the purpose of helping to safeguard and improve human well-being. (Granularity of data is the level of detail of the data.)

Primary data should be collected from A/IS users and stakeholders as part of WIA Activity 1 Task 2 and Task 3 (user engagement and stakeholder engagement), as part of the use of an A/IS, as part of outreach (such as by asking potential users to provide data), or via other means. It should be collected from A/IS users and stakeholders ongoing through questionnaires directly answered by them, by other means (such as allowing access to repositories of data from employers, financial institutions, online repositories, other repositories for data), or by a combination of means. In some cases, it will not be possible or practical to collect data for all the indicators. In such cases, it should be noted that data could not be collected. Primary data should also be collected for the population at large.

Secondary data should be collected for A/IS users, stakeholders, or for populations reflecting the users for comparison purposes when it is helpful to do so. Secondary data should be accessed from various sources, such as national, regional, or local governments, non-governmental organizations, education and research institutions, or businesses.

NOTE—In some cases, the lack of data or insufficiency in data, such as data that are difficult to compare for various reasons, yields information it itself, and in other cases, the recording of lack of data is helpful in future data collection.

Table 6 is a checklist for Activity 3 Task 1.

Table 6—WIA Activity 3 Task 1 for data collection plan checklist

	Yes/No
1	Does the plan describe what data will be collected?
2	Does the plan describe how the data will be collected?
3	Does the plan describe the frequency with which the data will be collected?
4	Does the plan describe how data will be time stamped and other means of identification when it is collected?
5	Does the plan describe how baseline data is collected?
6	Does the plan describe when baseline data is collected?
7	Does the plan help ensure that data is collected continually throughout the A/IS life?
8	Is there a description of how data is collected continually throughout the A/IS life?
9	Have issues related to collection and use of data, such as ethics, transparency, data privacy, data governance, security, protection of data, nudging, coercion, algorithmic bias, asymmetry, and redundancy been considered and addressed?

5.3.2 Guidance for WIA Activity 3 Task 2: Collect Data and Populate the Well-Being Indicators Dashboard

In WIA Activity 3 Task 2, data is collected and used to populate the well-being indicators dashboard. Baseline data should be collected. Data should be collected with the frequency determined in the data collection plan.

Activities for data collection and population of the well-being indicators dashboard should include the following:

- a) Collect baseline data for the users
- b) Collect baseline data for the stakeholders
- c) Collect baseline data for the population that reflects users and stakeholders (i.e., data for populations that are similar to users and stakeholders)
- d) Collect data for users over time
- e) Collect data for stakeholders over time
- f) Collect data for the population that reflects users and stakeholders over time
- g) Populate the well-being indicators dashboard with the data sets

Baseline data provides a basis for comparison to data collected subsequently. It should be used to measure, analyze and understand the impact of an A/IS on the well-being of individuals and population. Ideally, to establish a baseline, primary data is collected from potential users of an A/IS prior to their use of it, as well as from potential stakeholders and for the general population reflecting potential users and stakeholders. This allows for comparisons before and after use of an A/IS for users and stakeholders and the general population. When secondary data is used for a baseline, it should be noted. When it is not possible to establish a baseline prior to use of an A/IS, data should be collected when it is possible to collect it and used to establish a baseline at that point. This should be noted as part of WIA Activity 3 Task 1 Establishing a Data Collection Plan. To measure differences between the well-being of users and stakeholders of an A/IS versus the population at large, baseline data should be collected for the population at large. For comparison purposes, the population for which the baseline data is collected should reflect the users and stakeholders.

Table 7 is a checklist for Activity 3 Task 2.

Table 7—WIA Activity 3 Task 2 collect data and populate the well-being indicators dashboard checklist

		Yes/No
1	Has baseline data been collected for users?	
2	Has baseline data been collected for stakeholders?	
3	Has baseline data been collected for the population that reflects users and stakeholders?	
4	Is data for users being collected over time?	
5	Is data for stakeholders being collected over time?	
6	Is data for the population that reflects users and stakeholders being collected over time?	
7	Has the well-being indicators dashboard been populated with the data sets?	

5.4 Guidance for WIA Activity 4: Well-Being Data Analysis and Use of Well-Being Data

Activity 4 involves two tasks that are action based. The first task is to analyze the data. The second task is to use the data for design, development, assessment, monitoring, management, and improvement of the A/IS to help safeguard and improve user and stakeholder well-being.

The frequency with which this activity is conducted should be determined by the A/IS creators or other decision makers as best fits the A/IS creators process and organization.

5.4.1 Guidance for WIA Activity 4 Task 1: Well-Being Data Analysis

Data analysis should include the following:

- a) Identify trends over time
- b) Use the data to understand the impacts the A/IS has on the well-being of users and stakeholders
- c) Use the data to illuminate unexpected uses, behaviors, outcomes, and impacts
- d) Document the implementation

This should be a dynamic process. It should include a process by which the A/IS creators identify the questions they are working to answer with refinement of the questions. The process should include a means for reflection about the data, such as investigation, brainstorming, etc. It should also include time and/or a facilitated process to allow for the emergence of insights and intuitions about the data. It should include analysis of the statistical relationships in the data. It should include a means for sensemaking of the data, such as workshopping, system mapping, or other means. Some resources for these processes are listed in [Annex A](#).⁴

[Table 8](#) is a checklist for Activity 4 Task 1.

⁴Quantitative and qualitative data analysis is performed to ultimately accept or reject each hypothesis in order to be able to meaningfully answer the questions asked in Activity 1 Task 1. Statistical, machine learning, and other data analysis methods may be employed, including data mining in order to investigate hidden statistical relationships in the data and their potential implications (Bruce and Bruce [B5]) or spurious correlations that need to be considered (Pearl and Mackenzie, [B73]) and statistical hypothesis testing (Lehmann and Romano [B46]).

Table 8—WIA Activity 4 Task 1 well-being data checklist

		Yes/No
1	Have trends over time been identified?	
2	Has the data been used to understand the impacts the A/IS has on the well-being of users and stakeholders?	
3	Has the data been used to explore unexpected uses, behaviors, outcomes, and impacts?	
4	Has documentation of analysis been done as fits the A/IS creators' process and organization?	

5.4.2 Guidance for WIA Activity 4 Task 2: Use of Well-Being Data

WIA Activity 4 Task 2 use of well-being data should include the following activities:

- a) Improve the design, development, assessment, monitoring, management of A/IS to positively impact user and stakeholder well-being
- b) Improvement to well-being indicators dashboard
- c) Documentation of implementation as fits the A/IS creators process and organization

This should be a dynamic process. It should not be onerous or overly bureaucratic. It should fit the circumstances, processes, and practices of the A/IS creators and organization.

Table 9 is a checklist for Activity 4 Task 2.

Table 9—WIA Activity 4 Task 2 use of well-being data checklist

		Yes/No
1	Have there been improvements to the design, development, assessment, monitoring, or management of A/IS to help safeguard and improve user and stakeholder well-being?	
2	Have there been improvements to the well-being indicators dashboard?	
3	Have analysis and results been documented?	

5.5 Guidance for WIA Activity 5: Iterate

Iterative use of the well-being indicators dashboard and WIA process for continual improvement to the A/IS should be conducted through the following:

- a) Assess the of the WIA process and well-being indicators dashboard
- b) Improve the data collection and analysis strategy
- c) Improve the well-being indicators dashboard
- d) Report as helpful to users and stakeholders

The WIA process aims to provide a new kind of infrastructure to allow for a multi-stakeholder engagement process that incorporates human well-being as a goal and measurement for the development, deployment, and maintenance of A/IS. The refinement and adaptation of the WIA and well-being indicators dashboard is achieved through iteration as described in WIA Task 5. The length, scope, and frequency of iteration of a WIA should be determined depending on the A/IS and its context.

During the iteration phase, progress is evaluated and challenges are identified (see WIA Task 4). This is done both individually and collectively for the well-being domains and indicators that have been included

in the most recent WIA iteration. As part of iteration, additional WIA internal analysis is performed along with further WIA user engagement and stakeholder engagement (see WIA Task 1), indicator and dashboard refinement (see WIA Task 2), and refinement of the data collection strategy and data collection (see WIA Task 3). The appropriate iterations needed for continuous improvement should be determined based on context.

IEEE Std 7010 does not require that a report is written. However, periodic reports for IEEE Std 7010 should be created, depending on the needs and circumstances of the organization. At each major iteration, the reports should include trend analysis of well-being indicators, changes made to the A/IS to improve impacts on user and stakeholder well-being, changes to the well-being indicators dashboard, and any other relevant information.

NOTE—See [Annex E](#) for a notional example of this task.

[Table 10](#) is a checklist for Activity 5.

Table 10—WIA Activity 5 iterations checklist

	Yes/No
1	Has the current progress and challenges with the WIA and A/IS been reviewed?
2	Has the A/IS design or implementation been refined or improved appropriately?
3	Has length, scope, and frequency of future iteration tasks been determined?
4	Optional: Has the identified intended, unintended users, and stakeholders been refined?
5	Optional: Has there been follow-up on user and stakeholder engagement?
6	Optional: Has there been engagement in further internal analysis, including lessons learned from the above?
7	Optional: Have the domains and indicators that reflect the possible impacts on human well-being been improved?
8	Optional: has the well-being indicators dashboard been updated?
9	Optional: Has the data collection and analysis strategy been improved?
10	Optional: Have the progress and challenge with the current iteration internally and/or externally been reported?

6. Well-being domains and indicators

6.1 General

The domains and indicators are drawn from well-being measurement instruments already in use and that have been proven to be accurate measurement instruments (i.e., scientifically valid). It should be noted that [Clause 6](#) represents a starting point for selecting indicators. Indicators should be adapted to fit the circumstances of measuring and gathering data about the well-being impacts for an A/IS on user(s). Moreover, A/IS creators should identify other indicators beyond those in [Clause 6](#) when needed. Links for accessing the source of the indicators in this clause are found in [6.14](#). Resources for identifying additional indicators are in [A.4](#). Information about well-being indicators are in [Clause 1](#).

Definitions for domains and aspects of domains provided in this clause are suggestions. Inclusion of the resources in this clause does not indicate endorsement or approval of any entity in any way.

It should be noted that there is overlap for aspects and indicators among many of domains, such as safety, for which there is overlap for the domains of community and government. A/IS creators have the option of determining that an indicator listed better fits in a different domain after going through the WIA. For example, after going through the WIA, A/IS creators find that the indicator for discrimination, listed in the domain of Culture in [Clause 6](#), fits in the domain of government for an A/IS providing governmental services.

6.2 Domain of satisfaction with life

Life satisfaction is defined as an overall assessment of feelings and attitudes about one's life at a particular point in time ranging from negative to positive (Diener, 1984 [B13]).

Indicators for satisfaction with life include the following:

- The sense that one's life is the best to worst possible life for them at the time (using Cantril's Self Anchoring Ladder from the OECD Better Life Index [B58] and OECD Guidelines for Measuring Subjective Well-being [B64])
- Satisfaction with life as a whole (from the World Values Survey Wave 6 [B111])
- How satisfied are you with your life today (from the UK ONS National Measures of Well-being [B87])

6.3 Domain of affect

The domain of affect is defined to include positive and negative feelings. The terms feelings, mood, or emotions are also used. The indicators used to measure affect in the moment, or how a person is feeling in the moment, or a lasting emotional experience, such as frequently feeling anxious or depressed.

Indicators for affect (adapted from the European Social Survey's Europeans' Personal and Social well-being [B19]) include the following:

- Positive affects: feeling happy, calm, peaceful, etc.
- Negative affects: feeling sad, depressed, anxious, etc.

6.4 Domain of psychological well-being

The domain of psychological well-being is "the experience of life going well. It is a combination of feeling good and functioning effectively" (Huppert [B34]). The terms flourishing or eudaimonia are also used.

Indicators for psychological well-being include the following:

- Sense that one leads a purposeful and meaningful life (adapted from the OECD Better Life Index [B58])
- Feeling that the things one does are worthwhile (from UK ONS Measuring National Well-being: Domains and Measures [B87])
- Sense one is capable and good at what they do (adapted from the European Social Survey's Europeans' Personal and Social Well-being [B19])

6.5 Domain of community

Community is defined as "a group of people living in the same place or having a particular characteristic in common" (Lexico, [B48]).

The domain of community encompasses sense of belonging, community participation, social support, safety, and discrimination.

6.5.1 Sense of belonging

Sense of belonging is defined as “a feeling that (people) matter to one another and to the group and a shared faith that (people’s) needs will be met through their commitment to be together” (McMillan [B52]).

Indicators for sense of belonging in community include the following:

- Sense of belonging to a neighborhood (from UK ONS Measuring National Well-being: Domains and Measures [B87])
- Sense that one sees oneself as part of a community (based on the World Values Survey Wave 6 [B111])

6.5.2 Community participation

Community participation includes activism, volunteerism, and donations.

Indicators for community participation include the following:

- Approximate total hours a month one was active in voluntary organizations (from the World Values Survey Wave 6 [B111])
- Donations to a charity in a month [adapted from (Smith, et al. [B80])]

6.5.3 Social support

Social support is defined as the assistance and help that people give and receive from each other (Seeman [B79]).

Indicators for social support include the following:

- Sense that if one were in trouble, they would have relatives or friends they can count on to help them whenever they need them, or not (from OECD Better Life Index [B58])
- Satisfaction with relationships (adapted from UK ONS Measuring National Well-being [B87])

6.5.4 Community safety

Community safety is defined as going about “daily life without fear or risk of harm or injury” (Safe Communities Foundation NZ [B78]).

Indicators for community safety include the following:

- Feeling safe walking alone around the area where one lives (from the UN SDG Indicators [B91])
- Sense that most people can be trusted or that one needs to be very careful in dealing with people (from the World Values Survey Wave 6 [B111])
- Crimes against the person per 1000 adults (from the UK ONS Measuring National Well-being: Domains and Measures [B87])

6.5.5 Discrimination

Discrimination is defined for any group as “any distinction, exclusion, restriction or preference...which has the purpose or effect of nullifying or impairing the recognition, enjoyment or exercise, on an equal footing, of human rights and fundamental freedoms in the political, economic, social, cultural or any other field of public life” (UNESCO [B84]).

Indicators for discrimination include the following:

- Proportion of persons who are victims of physical or sexual harassment, by sex, age, disability status and place of occurrence, in the previous 12 months (from UN SDG Indicators [B91])
- Sense of discrimination in one’s neighborhood or community (adapted from the World Values Survey Wave 6 [B111])

6.6 Domain of culture

Culture is defined as “that complex whole which includes knowledge, beliefs, arts, morals, laws, customs, and any other capabilities and habits acquired by [a human] as a member of society”(UNESCO, [B85]).

The domain of culture encompasses arts, customs, and other aspects of culture. An indicator for culture includes engagement with/participation in arts or cultural activity (from the UK ONS Measuring National Well-being [B87]).

NOTE—Indicators for values, such as tolerance, security, fairness, etc. are not included in IEEE Std 7010. The World Values Survey [B111] contains indicators for values.

6.7 Domain of education

The domain of education encompasses formal education and lifelong learning.

6.7.1 Formal education

Formal education is defined as “training typically provided by an education or training institution, structured (in terms of learning objectives, learning time or learning support) and leading to certification. Formal learning is intentional from the learner’s perspective”(UNESCO Glossary [B86]).

Indicators for formal education include the following:

- Average years of schooling (from the Human Development Index [B95])
- Satisfaction with educational systems or schools in area in which one lives [adapted from the General Social Survey (Smith, et al. [B80])]

6.7.2 Lifelong learning

Lifelong learning is defined by Eurostat Lifelong Learning [B22] as composed of people aged 25 or older in education and training.

Indicators for lifelong learning include the following (from the UN SDG Indicators [B91]):

- Access to opportunities to learn
- Extent to which a) global citizenship education and b) education for sustainable development (including climate change education) are part of teacher education; classroom curricula, and student assessment

6.8 Domain of economy

Economy is defined as local and extended networks of inputs of land, labor, and capital and enterprises (the four factors of production) and other human activities. (Johnson [B43]). Collins Dictionary [B10] defines economy as “the system according to which the money, industry, and trade of a country or region are organized.”

The domain of economy encompasses standard of living; economic equality and equity; jobs; natural resources, consumption, and production; and business and entrepreneurship.

6.8.1 Standard of living

Standard of living is defined as “the level of comfort and wealth which you have” (Collins Dictionary [B10]).

Indicators for standard of living include the following:

- Household Net Financial Wealth (from the OECD Better Life Index [B58])
- Satisfaction with the financial situation of one’s household (from the World Values Survey Wave 6 [B111])
- Average gross national income in purchasing power parity (from the United Nations Development Program Human Development Index [B95])
- Proportion of adults (15 years and older) with an account at a bank or other financial institution or with a mobile-money-service provider (adapted from the UN SDG Indicators [B91])

6.8.2 Economic equity and equality

Economic equity and equality is defined as “The situation in an economy in which the apportionment of resources or goods among the people is considered fair” (BusinessDictionary.com [B6]).

Indicators for economic equity and equality include the following:

- Income inequality or rich-poor gap or Gini index (from the CIA [B7])
- How often a family goes without enough food to eat (from the World Values Survey Wave 6 [B111])

6.8.3 Jobs

Jobs are defined as “a paid position of regular employment, a task or piece of work, especially one that is paid” (Lexico [B48]).

Indicators for jobs include the following:

- Unemployment rate, by sex, age, and persons with disabilities (from the UN SDG Indicators [B91])
- Degree to which one is worried about losing their job or not finding a job (from the World Values Survey Round 6 [B111])

6.8.4 Natural resources, consumption, and production

Sustainable consumption is “the use of services and related products which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardize the needs of future generations.” (Ofstad, Westly, and Bratelli [B56]). Sustainable consumption and production is “about promoting resource and energy efficiency, sustainable infrastructure, and providing access to basic

services, green and decent jobs, and a better quality of life for all” (United Nations Sustainable Development Programme [B89]).

Indicators for natural resources, consumption, and production include the following (adapted from the UN SDG indicators [B91]):

- Recycling rates
- Material consumption

6.8.5 Business and entrepreneurship

Business is “a project or venture undertaken for gain.” (OECD Glossary of Statistical Terms [B59]). Entrepreneurship is “the capacity and willingness to develop, organize and manage a business venture along with any of its risks in order to make a profit. The most obvious example of entrepreneurship is the starting of new businesses” (BusinessDictionary.com [B6]).

Indicators for business and entrepreneurship include the following (from the UN SDG indicators [B91]):

- Proportion of small-scale industries in total industry value added
- Sense that the area where one lives is a good place to live for entrepreneurs forming a new business

6.9 Domain of environment

Environment is defined as “climate, weather, and natural resources that affect human survival and economic activity” (Business Dictionary [B6]).

The domain of the environment encompasses the environment in general, climate change, air, water, soil, and biodiversity.

6.9.1 Environment general indicators

Indicators for general environment include the following:

- Satisfaction with efforts to preserve the environment (adapted from the Bhutan’s Gross National Happiness Index [B8])
- Non-compliance with environmental laws and regulations (from the Global Reporting Initiative [B28])
- Proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities (from the UN SDG Indicators [B91])

6.9.2 Climate change

Climate change is defined as “any change in climate over time, whether due to natural variability or as a result of human activity” (International Panel on Climate Change [B38]).

Indicators for climate change include the following:

- Reduction of greenhouse gas emissions (from the Global Reporting Initiative [B28])
- Reduction of energy consumption (from the Global Reporting Initiative [B28])

- Proportion of population with primary reliance on clean fuels and technology (from the UN SDG Indicators [B91])
- How much (people) know about global warming or climate change (adapted from the UN SDG indicators [B91])

6.9.3 Air

Air quality is determined from “levels of, and length of exposure to, pollution resulting in adverse effects on human health and well-being” (OECD Glossary of Statistical Terms [B59]).

Indicators for air quality include the following:

- Degree of satisfaction with the quality of air (from the World Values Survey Wave 6 [B111])
- Annual mean levels of fine particulate matter (from the UN SDG Indicators [B91])

6.9.4 Water

Water includes rivers, lakes, oceans, rain and aquifers and “is the basis of the fluids of living” (Lexico [B48]).

Indicators for water include the following:

- Change in water-use efficiency over time (from the UN SDG Indicators [B91])
- Satisfaction with quality of water (from the UN SDG Indicators [B91])
- Proportion of bodies of water with good ambient water quality (from the UN SDG Indicators [B91])
- Proportion of wastewater safely treated (from the UN SDG Indicators [B91])
- Percentage of households with year round access to water (from US Fanta Project [B99]).

6.9.5 Soil

Soil is the “upper layer of earth, a mixture of organic and inorganic matter, in which plants grow. It is a finite natural resource. On a human time-scale it is non-renewable” (United Nations World Soil Day [B92]).

Indicators for soil quality include the following (from the UN SDG Indicators [B91]):

- Crop yield gap: the actual yield as the percentage of attainable yield
- Nitrogen use efficiency in food systems
- Proportion of agricultural area under productive and sustainable agriculture

6.9.6 Biodiversity

Biodiversity is “the range of genetic differences, species differences and ecosystem differences in a given area.” (OECD Glossary of Statistical Terms [B59]). Biological diversity is “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems” (UN Convention on Biological Diversity [B94]).

Indicators for biodiversity include the following:

- Endangered and threatened species: IUCN Red List species and national conservation list species in areas affected by (company) operations (from the Global Reporting Initiative [B28])
- Habitats protected or restored (from the Global Reporting Initiative [B28])
- Forest area as a proportion of total land area (from the UN SDG Indicators [B91])

6.10 Domain of government

Government is defined as the “economic, political and administrative authority and comprises mechanisms, processes and institutions, through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences” (World Bank citing United Nations Development Programme [B95]).

The domain of government encompasses human rights, institutions, civil participation, and trust.

6.10.1 Human rights

Human rights are defined as “(1) civil and political rights, such as the right to life, equality before the law and freedom of expression; (2) economic, social and cultural rights, such as the rights to work, social security and education, or (3) collective rights, such as the rights to development and self-determination” (UN Human Rights Office of the High Commissioner [B97]).

Indicators for human rights include the following:

- Sense there is respect for individual human rights at present in one’s country (from the World Values Survey Wave 6 [B111])
- Sense there is freedom of assembly, demonstration, and open public discussion (from Freedom House [B24])
- Sense there is equality of opportunity and the absence of economic exploitation (from Freedom House [B24])
- Victims of human trafficking per 100 000 population, by sex, age, and form of exploitation (from the UN SDG Indicators [B91])
- Laws, policies, and practices that guarantee equal treatment of various segments of the population (from Freedom House [B24])
- Conditions in pretrial facilities and prisons and humane and respectful treatment of the human dignity of inmates (from Freedom House [B24])

6.10.2 Institutions

Institutions are “a complex of positions, roles, norms and values lodged in particular types of social structures and organising relatively stable patterns of human activity” (Stanford Encyclopedia of Philosophy [B81]). A government agency is an “organization in the machinery of government that is responsible for the oversight and administration of specific functions, such as an intelligence agency” (Wikipedia [B103]).

Indicators for institutions include the following:

- Satisfaction with one’s last experience of public services (from the UN SDG Indicators [B91])
- Rule of law prevailing in civil and criminal matters (from Freedom House [B24])

- Registration of voters and candidates conducted in an accurate, timely, transparent, and nondiscriminatory manner (from Freedom House [B24])
- Sense that elections are fair (adapted from the World Values Survey Wave 6 [B111])
- Citizens have the legal right and practical ability to obtain information about government operations and the means to petition government agencies for it (from Freedom House [B24])
- Defendants are given a fair, public, and timely hearing by a competent, independent, and impartial tribunal (from Freedom House [B24])
- Print, broadcast, and/or internet-based media are not directly or indirectly censored (from Freedom House [B24])
- Trade unions are allowed to be established and to operate free from government interference (from Freedom House [B24])

6.10.3 Civic engagement

Civic Engagement is defined as “working to make a difference in the civic life of our communities and developing the combination of knowledge, skills, values and motivation to make that difference. It means promoting the quality of life in a community, through both political and non-political processes” (Hoekema and Ehrlich [B32]).

Indicators for civic engagement include the following:

- Voter turnout (from the OECD Better Life Index [B58])
- Cultural, ethnic, religious, or other minority groups have full political rights and electoral opportunities (from Freedom House [B24])
- Attendance of peaceful demonstrations in the last year (from the World Values Survey Wave 6 [B111])
- Signing a petition(s) in the last year (from the World Values Survey Wave 6 [B111])
- People have the right to organize in different political parties or other competitive political groupings of their choice, and the system open to the rise and fall of these competing parties or groupings (from Freedom House [B24])

6.10.4 Trust in government

Trust in government is defined as “(citizens believing) the system and political incumbents to be responsive, honest, and competent, even in the absence of constant scrutiny.” (Manning and Wetzel [B50]).

Indicators for trust include the following (from World Values Survey Wave 6 [B111]):

- Sense of confidence in government—national, local, civil service, judicial system, police, political parties. etc.
- Sense that government is free from pervasive corruption

6.11 Domain of health

Health is defined as “a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity” (Constitution of the World Health Organization [B107]).

The domain of health includes physical health and mental health.

6.11.1 Physical health

Physical health is defined as “(relating) to the functioning of the physical body (Mental Health Commission New South Wales [B53]).

Indicators for physical health include the following:

- Healthy life expectancy (from UK ONS Measuring National Well-being: Domains and Measures [B87])
- Sense that one’s state of health is good (from the World Values Survey Wave 6 [B111])
- Sense of having enough energy to get things done (from World Health Organization 2002 WHOQOL-HIV instrument [B109])
- Satisfaction with quality of health care (from the World Values Survey Wave 6 [B111]).
- Obesity in adults and adolescents (from the World Health Organization Global Reference List of 100 Core indicators [B110])
- Out-of-pocket payment for health (from the World Health Organization Global Reference List of 100 Core indicators [B110])
- Coverage of essential health services: defined as the average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases, and service capacity and access among the general and the most disadvantaged population (from the UN SDG Indicators [B91])
- Proportion of women of reproductive age (aged 15 to 49 years) who have their need for family planning satisfied with modern methods (from the UN SDG Indicators [B91])

6.11.2 Mental health

Mental health is “a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community” (World Health Organization [B108]).

Indicators for mental health include the following:

- Coverage of services for severe mental health disorders (from the World Health Organization Global Reference List of 100 Core indicators, 2015 [B110])
- Suicide attempts (from the European Commission’s Minimum data set of European mental health indicators [B16])
- Number of persons who have seen a health professional during a year (from the European Commission’s Minimum data set of European mental health indicators [B16])
- Projects to support parenting skills (from the European Commission’s Minimum data set of European mental health indicators [B16])
- Lost workdays due to mental disorder or substance use (from the European Commission’s Minimum data set of European mental health indicators [B16])

6.12 Domain of human settlements

Human settlements are defined as geographical areas where people live.

The domain of human settlements encompasses housing, food, transportation, and information and communications technology.

6.12.1 Human settlement general indicators

Human settlements are defined geographically and include densely populated areas (cities), intermediate density areas (towns and suburbs), and thinly populated areas (rural areas) (Dijkstra and Poelman [B14]).

Indicators for general human settlement include the following:

- Area of public and green space as a proportion of total city space (from Helliwell and Sacks [B31])
- Satisfaction with beauty or physical setting (from the World Values Survey Wave 6 [B112])
- Proportion of population living in households with access to basic services (from UN SDG Indicators [B91])

6.12.2 Housing

Housing is defined as “a safe and secure home and community in which to live in peace and dignity” (United Nations Human Rights Right to Adequate Housing Toolkit [B96]).

Indicators for housing include the following:

- Satisfaction with quality of housing (from World Values Survey Round 6 [B111])
- Satisfaction with availability of good affordable housing (adapted from UN SDG indicators [B91])
- Proportion of urban population living in slums, informal settlements or inadequate housing (from UN SDG Indicators [B91])

6.12.3 Food

Food is defined in terms of food security as having at all times “physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life” (Food and Agriculture Organization (FAO) of the United Nations [B26]).

Indicators for food include the following:

- Prevalence of undernourishment (from the UN SDG Indicators [B91])
- Secure access to food (adapted from US Fanta Project [B99])

6.12.4 Transportation

Transportation is defined as “the provision of services and infrastructure for the mobility of people and goods—advancing economic and social development to benefit today’s and future generations—in a manner that is safe, affordable, accessible, efficient, and resilient, while minimizing carbon and other emissions and environmental impacts” (United Nations “Mobilizing Sustainable Transport for Development” [B88]).

Indicators for transportation include the following:

- Proportion of population that has convenient access to public transport, by sex, age, and persons with disabilities (from the UN SDG Indicators [B91])
- Satisfaction with transportation system in the city or area one lives (from the World Values Survey Wave 6 [B111])
- Death rate due to road traffic injuries (from UN SDG Indicators [B91])

6.12.5 Information and communications technology (ICT)

Information and communications technology (ICT) is defined as “the set of activities which facilitate by electronic means the processing, transmission and display of information” (Rodriguez and Wilson [B76]). ICTs “refer to technologies people use to share, distribute, gather information and to communicate, through computers and computer networks” (United Nations Conference on Trade and Development. [B93]).

Indicators for information and communications technology (ICT) include the following:

- Proportion of population covered by a mobile network, by technology (from UN SDG Indicators [B91])
- Proportion of population that has a cellular phone (adapted from the World Values Survey [B111])
- Proportion of population that has access to the internet at home (adapted from the World Values Survey [B111])
- Proportion of population that has a computer at home (adapted from the World Values Survey [B111])
- Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill (from the UN SDG Indicators [B91])

6.13 Domain of work

Work is defined as an “activity involving mental or physical effort done in order to achieve a purpose or result” (Lexico [B48]) and as including both paid and unpaid work, such as homemaker, volunteer, etc.

The domain of work encompasses workplace governance, workplace environment, and work life balance.

6.13.1 Workplace governance

Workplace governance is defined as “corporate governance broadly (referring) to the mechanisms, relations, and processes by which a corporation is controlled and is directed; involves balancing the many interests of the stakeholders of a corporation” (Business Dictionary.com [B6]).

Indicators for workplace governance include the following (from the Global Reporting Initiative [B28]):

- Diversity of governance bodies and employees
- Identifying and managing economic, environmental, and social
- Operations with local community engagement, impact assessments, and development programs
- Operations that have been subject to human rights reviews or impact
- Mechanisms for advice and concerns about ethics
- Communication and training about anti-corruption policies and procedures

6.13.2 Workplace environment

Workplace environment is the “physical conditions, such as office temperature, or equipment, such as personal computers. It can also be related to factors such as work processes or procedures” (MoneyZine.com [B54]).

Indicators for workplace environment include the following:

- Satisfaction with job (from Smith, et al. [B80])
- Sense that current work life is interesting (from Smith, et al. [B80])
- Sense that one’s supervisor has respect for and cares about one’s welfare (adapted from The Department of Health and Human Services [B11])
- Sense that one gets support and help from coworkers (European Social Survey Round 5 Work Family Well-being Module [B20])
- Satisfaction with opportunities for professional development and promotion in one’s current primary job (from the World Values Survey Wave 6 [B111])
- Sense that the conditions of one’s job allows one to be about as productive as one could be (from The Department of Health and Human Services [B11])
- Sense of independence one has in performing tasks at work (from the World Values Survey Wave 6 [B111])
- Workers representation in formal joint management–worker health and safety committees (from the Global Reporting Initiative [B28])
- Satisfaction with salary and benefits in current primary job (from the World Values Survey Wave 6 [B111])
- Ratio of basic salary and remuneration of women to men (from the Global Reporting Initiative [B28])
- Expected earnings loss, measured as the percentage of the previous earnings, associated with unemployment (from the OECD Better Life Index [B58])
- Percentage of employees receiving regular performance and career development reviews (from the Global Reporting Initiative [B28])
- Average hours of training per year per employee (from Global Reporting Initiative [B28])
- Types of injury and rates of injury, occupational diseases, lost days, and absenteeism, and number of work-related fatalities (from the Global Reporting Initiative [B28])

6.13.3 Work life balance

Work life balance is “a situation in which you are able to give the right amount of time and effort to your work and to your personal life outside work, for example to your family or to other interests.” (Lexico [B48]).

Indicators for work life balance include the following:

- Satisfaction with the balance between the time spent on the job and the time spent on other aspects of life (from the European Social Survey Round 5 [B20])
- Proportion of employed people working 50 hours or more a week (from OECD Better Life Index [B58])
- Average amount of time spent on leisure time out of doors, away from home in the previous 12 months (from the UK ONS Measuring National Well-being: Domains and Measures [B87])

6.14 Indicator sources

Indicators sources are in A.4 or online at: <http://tiny.cc/wellbeingindicators>.⁵

⁵The full URL for the online resource is: https://docs.google.com/spreadsheets/d/1Pg_mZOdixeW-Y0IATsoVARDU34MLiotgha9ergzGjnU/edit#gid=707202123

Annex A

(informative)

Resources

A.1 Additional sources for the implementation of IEEE Std 7010-2020

A.1.1 Annex resources for dashboards

Ericson, W., *Performance Dashboards: Measuring, Monitoring and Managaing Your Business*. Hoboken, NJ: John Wiley and Sons, 2011 [B15].

Kailas, A., C.-C. Chong, and F. Watanabe, “From Mobile Phones to Personal Wellness Dashboards.” *IEEE Pulse*, vol. 1, no. 1, Jul.–Aug. 2010, pp. 57–63 [B44].

Malik, S.. *Enterprise Dashboards: Design and Best Practices for IT*. Hoboken, NJ: John Wiley and Sons, 2005 [B49].

Verbert, K., E. Duval, J. Klerkx, S. Govaerts, and J. Santos, “Learning Analytics Dashboard Applications,” *American Behavioral Scientist*, vol. 57, no. 10, February 28, 2013. pp. 1500–1509 [B100].

Yigitbasioglua, O. and O. Velcu,. “A review of dashboards in performance management: Implications for design and research.” *International Journal of Accounting Information Systems*, vol. 13, no. 1, March 2012, pp. 41–59 [B113].

A.1.2 Annex resources for stakeholder engagement

AAA 1000 Stakeholder Engagement Standard.⁶

Adaptive Management.⁷

Ashmore, R., R. Calinescu and C. Paterson, “Assuring the Machine Learning Lifecycle: Desiderata, Methods, and Challenges,” May 2019.⁸

A.1.3 Annex resources for iterative processes

Evaluation of Corporate Compliance Programs, US Department of Justice.⁹

Getting Started Identifying Stakeholders.¹⁰

ISO 9241-210:2010: Ergonomics of human-system interaction—Human-centered design for interactive systems.¹¹

Minimum Viable Product (MVP) Agile process.¹²

⁶Available at: https://www.accountability.org/wp-content/uploads/2016/10/AA1000SES_2015.pdf and <https://www.accountability.org/standards/>

⁷Available at: <http://learningforsustainability.net/adaptive-management/>

⁸Available at: <https://arxiv.org/pdf/1905.04223.pdf>

⁹Available at: <https://www.justice.gov/criminal-fraud/page/file/937501/download>

¹⁰Available at: [https://www.agilealliance.org/glossary/mvp/#q=~\(infinite~false~filters~\(tags~\(~'.mvp\)\)~searchTerm~'~sort~false~sortDirection~'asc~page~1\)](https://www.agilealliance.org/glossary/mvp/#q=~(infinite~false~filters~(tags~(~'.mvp))~searchTerm~'~sort~false~sortDirection~'asc~page~1))

¹¹Available at: <https://www.iso.org/standard/52075.html>

¹²Available at: <https://www.agilealliance.org/agile101/>

A.1.4 Annex resources for values and ethics

Chief Ethics Officer Job Description: Bucklin, L, “Three main responsibilities of an Ethics Officer.”¹³

Chief Values Officer Job Description: Liozu, S.M, “Who is in Charge of Customer Value in Your Organization? The Emerging Role of Chief Value Officer.” *Journal of Processing Pricing*, Third Quarter 2016, pp. 20–25.¹⁴

Declaration on Ethics and Data Protection in Artificial Intelligence. 40th International Conference of Data Protection and Privacy Commissioners.¹⁵

Everyday Ethics for Artificial Intelligence. IBM, 2019.¹⁶

IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems. *Ethically Aligned Design*, First Edition. Piscataway, NJ: IEEE Standards Association, 2019 [B36].

A.2 Codes, guidelines and standards for aspects of data for implementation of IEEE Std 7010

Algorithmic Accountability: Applying the concept to different country contexts, World Wide Web Foundation, July 2017.¹⁷

Article 8 of the General Data Protection Regulation (EU) 2016/679, Conditions applicable to child's consent in relation to information society services, European Commission.¹⁸

Automated Facial Recognition in Public and Private Sectors (page 6–7) Office of Privacy Commission of Canada, March 2013.¹⁹

Babcock, J., J. Krmar, and R.V. Yampolskiy, “Guidelines for Artificial Intelligence Containment.”²⁰

Borenstien, J. and R.C. Arkin, “Nudging for good: robots and the ethical appropriateness of nurturing empathy and charitable behavior,” *Journal of Bionic Engineering*, 26 November 2016.²¹

Children’s Online Privacy Protection Rule (COPPA), Federal Trade Commission.²²

Data Governance Checklist, Privacy Technical Assistance Center.²³

Decent work indicators: Guidelines for producers and users of statistical and legal framework indicators.²⁴

Declaration on Ethics and Data Protection in Artificial Intelligence. 40th International Conference of Data Protection and Privacy Commissioners.²⁵

¹³ Available at: https://stchas.instructure.com/courses/5583/files/796126/download?download_frd=1

¹⁴ Available at: <http://stephanliozeu.com/wp-content/uploads/2017/11/Liozu-Baker-Role-of-CVO-JPP-Q3-2016.pdf>

¹⁵ Available at: https://www.privacyconference2018.org/system/files/2018-10/20180922_ICDPPC-40th_AI-Declaration_ADOPTED.pdf

¹⁶ Available at: <https://www.ibm.com/watson/assets/duo/pdf/everydayethics.pdf>

¹⁷ Available at: https://webfoundation.org/docs/2017/07/Algorithms_Report_WF.pdf

¹⁸ Available at: <https://gdpr-info.eu/art-8-gdpr/>

¹⁹ Available at: https://www.priv.gc.ca/media/1765/fr_201303_e.pdf

²⁰ Available at: <https://arxiv.org/pdf/1707.08476.pdf>

²¹ Available at: <https://link.springer.com/article/10.1007/s00146-016-0684-1>

²² Available at: <https://www.ftc.gov/enforcement/rules/rulemaking-regulatory-reform-proceedings/childrens-online-privacy-protection-rule>

²³ Available at: https://studentprivacy.ed.gov/sites/default/files/resource_document/file/Data%20Governance%20Checklist_0.pdf

²⁴ Available at: https://www.ilo.org/stat/Publications/WCMS_223121/lang--en/index.htm

²⁵ Available at https://www.privacyconference2018.org/system/files/2018-10/20180922_ICDPPC-40th_AI-Declaration_ADOPTED.pdf

DIN 31644, Information and documentation—Criteria for trustworthy digital archives.²⁶

Ethics Guidelines for Trustworthy AI, European Commission.²⁷

European Commission’s minimum data set of European mental health indicators, 1998 [B16].

Evaluate Sources, University of Texas Libraries.²⁸

Evaluation of Corporate Compliance Programs, US Department of Justice.²⁹

Everyday Ethics for Artificial Intelligence. IBM, 2019.³⁰

Federal Trade Commission Mobile Health Apps Interactive Tool.³¹

Federal Trade Commission Resources for Privacy and Security Implications of Tech Products.³²

General Data Protection Regulation (EU) 2016/679, European Union.³³

Global Approach to Software as a Medical Device: Possible IMDRF Framework for Risk Categorization of Software as a Medical Device.³⁴

Guidelines on Transparency under Regulation 2016/679. European Commission Article 20 Data Protection Working Party.³⁵

Health Insurance Portability and Accountability Act of 1996 (HIPAA) Resources for Mobile Health Apps Developers.³⁶

How product marketing verbiage relates to health and well-being and consumer trust relating to AI/AS systems: Federal Trade Commission Act (FTC Act).³⁷

IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems. *Ethically Aligned Design*, First Edition. Piscataway, NJ: IEEE Standards Association, 2019 [B36].

International Human Subject Research Standards, European Guidance, Social-Behavioral Research Standards, Ethical Codes and Research Standards and Equivalent Protections.³⁸

International Labour Organization Key Indicators of the Labour Market.³⁹

ISO 9001 Family: Quality Management Standard [B39].

ISO 9241-210:2010: Ergonomics of human-system interaction—Human-centered design for interactive systems.⁴⁰

²⁶ Available at: <https://www.din.de/en/getting-involved/standards-committees/nid/wdc-beuth.din21:147058907>

²⁷ Available at: <https://ec.europa.eu/futurium/en/ai-alliance-consultation>

²⁸ Available at: <https://guides.lib.utexas.edu/evaluate>

²⁹ Available at: <https://www.justice.gov/criminal-fraud/page/file/937501/download>

³⁰ Available at: <https://www.ibm.com/watson/assets/duo/pdf/everydayethics.pdf>

³¹ Available at: <https://www.ftc.gov/tips-advice/business-center/guidance/mobile-health-apps-interactive-tool>

³² Available at: <https://www.ftc.gov/tips-advice/business-center/privacy-and-security/tech>

³³ Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32016R0679>

³⁴ Available at: <https://www.fda.gov/MedicalDevices/DigitalHealth/SoftwareasaMedicalDevice/ucm587925.htm>

³⁵ Available at: https://iapp.org/media/pdf/resource_center/wp29-transparency-12-12-17.pdf

³⁶ Available at: <https://www.hhs.gov/hipaa/for-professionals/special-topics/developer-portal/index.html>

³⁷ Available at: <https://www.ftc.gov/tips-advice/business-center/advertising-and-marketing>

³⁸ Available at: <https://www.hhs.gov/ohrp/international/index.html>

³⁹ Available at: <https://www.ilo.org/global/statistics-and-databases/research-and-databases/kilm/lang--en/index.htm>

⁴⁰ ISO publications are available from the ISO Central Secretariat (<http://www.iso.org/>). ISO publications are also available in the United States from the American National Standards Institute (<http://www.ansi.org/>).

ISO 16363: 2012 Space Data and Information Transfer Systems—Audit and Certification of Trustworthy Data Repositories.

ISO/IEC/IEEE 12207:2017, Systems and software engineering—Software life cycle processes [B41].

Kern, P. The Workplace PERMA Profiler, 13 October 2014.⁴¹

The Legatum Prosperity Index 2019.⁴²

Machine Readable Privacy Policy Statements, US Department of Commerce.⁴³

NSPE Code of Ethics for Engineers, National Society of Professional Engineers.⁴⁴

Office for Human Research Protections US Department of Health and Human Services. “International Compilation of Human Research Standards.”⁴⁵

Principles for Accountable Algorithms and a Social Impact Statement for Algorithms, FAT/ML.⁴⁶

Renaud, K. and V. Zimmerman, “Guidelines for Ethical Nudging in Password Authentication” South African Institute of Electrical Engineers, vol. 109, no. 2, June 2018 pp. 102–118 (see pages 112–113).⁴⁷

Report on non-device software functions: Impact to health and best practices—December 2018 [Submitted Pursuant to Section 3060(b) of the 21st Century Cures Act], U.S. Food and Drug Administration.⁴⁸

United States Office for Human Research Protections, Includes Requirements and Guidelines for Institutional Review Board.⁴⁹

Wachter, S. and B. Mittelstadt, “A right to reasonable inferences: re-thinking data protection law in the age of big data and AI,” *Columbia Business Law Review*, May 1, 2019, pp. 494–620.⁵⁰

A.3 IEEE P70xx projects

The following in-process standards projects may address impacts and matters related to data use/collection and A/IS that fall outside the scope of IEEE Std 7010:

- IEEE P7000, Draft Standard for Model Process for Addressing Ethical Concerns During System Design
- IEEE P7001, Draft Standard for Transparency of Autonomous Systems
- IEEE P7002, Draft Standard for Data Privacy Process
- IEEE P7003, Draft Standard for Algorithmic Bias Considerations
- IEEE P7004, Draft Standard for Child and Student Data Governance
- IEEE P7005, Draft Standard for Employer Data Governance

⁴¹ Available at: http://www.peggykern.org/uploads/5/6/6/7/56678211/workplace_perma_profiler_102014.pdf

⁴² Available at: <https://www.prosperity.com>

⁴³ Available at: http://osec.doc.gov/webresources/policies/machine_readable_privcy_policy_statements.html

⁴⁴ Available at: <https://www.nspe.org/resources/ethics/code-ethics>

⁴⁵ Available at: <https://www.hhs.gov/ohrp/sites/default/files/2020-international-Compilation-of-human-research-standards.pdf>

⁴⁶ Available at: <http://www.fatml.org/resources/principles-for-accountable-algorithms>

⁴⁷ Available at: <http://www.scielo.org.za/pdf/arj/v109n2/02.pdf>

⁴⁸ Available at: <https://www.fda.gov/downloads/MedicalDevices/DigitalHealth/UCM628128.pdf>

⁴⁹ Available at: <https://www.hhs.gov/ohrp/>

⁵⁰ Available at: <https://journals.library.columbia.edu/index.php/CBLR/article/view/3424>

- IEEE P7006, Draft Standard for Personal Data AI Agent
- IEEE P7007, Draft Standard for Ontological Standard for Ethically Driven Robotics and Automation Systems
- IEEE P7008, Draft Standard for Ethically Driven Nudging for Robotic, Intelligent and Autonomous Systems
- IEEE P7009, Draft Standard for Fail-Safe Design of Autonomous and Semi-Autonomous Systems
- IEEE P7011, Draft Standard for the Process of Identifying and Rating the Trustworthiness of News Sources
- IEEE P7012, Draft Standard for Machine Readable Personal Privacy Terms
- IEEE P7014, Draft Standard for Ethical Considerations in Emulated Empathy in Autonomous and Intelligent Systems

A.4 Sources of well-being indicators in Clause 6

Cantril, H., *The Pattern of Human Concern*. New Brunswick, NJ: Rutgers University Press, 1965.⁵¹

Centre for Bhutan Studies. Gross National Happiness Indicators [B8].

European Social Survey. Personal and Social Well-Being (ESS3 2006, ESS6 2012) [B19].

European Social Survey Round 5 Work Family Well-being Module [B20].

European Social Survey. Final source questionnaire (Round 3, 2006/7) amendment 03. London, UK: Centre for Comparative Social Surveys, City University London.⁵²

European Commission’s minimum data set of European mental health indicators, 1998 [B16].

Freedom in the World 2016: The Annual Survey of Political Rights and Civil Liberties. New York: Freedom House, 2016 [B24].

Organisation for Economic Co-Operation and Development (OECD). “Better Life Index. [B58].

Smith, T., P. Marsden, M. Hout, and J. Kim, General social surveys, 1972–2012 [cumulative file]. Ann Arbor, MI: Inter-University Consortium for Political and Social Research, 2013 [B80].

Sustainable Development Solutions Network. Indicators and a Monitoring Framework for the Sustainable Development Goals, 2015.⁵³

Teaching and Learning International Survey (TALIS), Questionnaires.⁵⁴

UK. Office for National Statistics. Measuring national well-being: personal well-being in the UK, 2014 to 2015 [B86].

United Nations. “Sustainable Development Goals Indicators” [B91].

US Aid Food and Nutrition Technical Assistance (Fanta) Project, “Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide” [B99].

⁵¹ Available at: <https://ia801900.us.archive.org/27/items/in.ernet.dli.2015.139016/2015.139016.The-Pattern-Of-Human-Concerns.pdf>

⁵² Available at: http://www.europeansocialsurvey.org/docs/round3/fieldwork/source/ESS3_source_main_questionnaire.pdf

⁵³ Available at: <http://unsdsn.org/wp-content/uploads/2015/05/FINAL-SDSN-Indicator-Report-WEB.pdf>

⁵⁴ Available at: <https://nces.ed.gov/surveys/talis/questionnaire.asp>

World Values Survey. WVS Wave 6 (2010–2014) [B111].

World Health Organization. (2015). World health organization global reference list of 100 core indicators, 2015 [B110].

World Health Organization, WHOQOL-HIV instrument. Geneva, Switzerland, 2002 [B109].

A.5 Additional sources of indicators

Butler, J. and M.L.Kern, “The PERMA-profiler: a brief multidimensional measure of flourishing.” *International Journal of Well-being*, vol. 6, no. 3, pp. 1–48.⁵⁵

Centre for Bhutan Studies. Gross National Happiness Indicators [B8].

Diener, E., D. Wirtz, W. Tov, C. Kim-Prieto, D. Choi, S. Oishi, R. Biswas-Diener, “New measures of well-being: Flourishing and positive and negative feelings,” *Social Indicators Research*, vol. 39, pp. 247–266.

European Commission’s minimum data set of European mental health indicators, 1998 [B16].

Eurostat Quality of Life Indicators.⁵⁶

Gallup Sharecare Well-being Index.⁵⁷

Gallup World Poll. (2008). World Poll Questions.⁵⁸

Global Multidimensional Poverty Index.⁵⁹

Happiness Alliance’s Happiness Index.⁶⁰

Happy Planet Index.⁶¹

International Labour Organization Key Indicators of the Labour Market.⁶²

The Legatum Prosperity Index 2019.⁶³

Maryland Genuine Progress Indicator.⁶⁴

The Social Progress Imperative. “Social Progress Index.”

United Nations Development Programme. “Human Development Index (HDI)” [B94].

World Database of Happiness.⁶⁵

World Happiness Report [B106].

⁵⁵ Available at: <https://internationaljournalofwellbeing.org/index.php/ijow/article/view/526>

⁵⁶ Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php/Quality_of_life_indicators_-_measuring_quality_of_life

⁵⁷ Available at: <https://wellbeingindex.sharecare.com/>

⁵⁸ Available at: http://media.gallup.com/dataviz/www/WP_Questions_WHITE.pdf

⁵⁹ Available at: <https://ophi.org.uk/multidimensional-poverty-index/>

⁶⁰ Available at: <https://www.happycounts.org/for-researchers.html>

⁶¹ Available at: <http://happyplanetindex.org/>

⁶² Available at: <https://www.ilo.org/global/statistics-and-databases/research-and-databases/kilm/lang--en/index.htm>

⁶³ Available at: <https://www.prosperity.com>

⁶⁴ Available at: <http://dnr.maryland.gov/mdgpi/Pages/default.aspx>

⁶⁵ Available at: https://worlddatabaseofhappiness.eur.nl/hap_quer/hqi_fp.htm

Annex B

(informative)

Example indicators

The purpose of this annex is to provide example indicators intended to help A/IS creators consider various impacts that their A/IS have. They are starting places and are not definitive. They are intended to be preliminary educational examples of an output of the WIA for an A/IS. They should not replace the internal assessment, user and stakeholder engagement, and a robust indicator and domain selection process in the WIA. These example indicators are instead provided as materials for generating ideas for undergoing the WIA and should not be taken as prescriptive or to establish causality. (It should be noted that there is a great deal of complexity regarding identifying the impacts on well-being of A/IS. See [Clause 1](#) for some discussion. Consult [Clause 4](#) and [Clause 5](#) for recommended practices on selection of indicators.)

The indicators in this annex are presented in the following format:

- a) Name of indicators based on a specific A/IS application
- b) Short description of the A/IS application
- c) Three levels of impact for those impacted by the A/IS. The three levels of impact include:
 - 1) Direct impacts of the A/IS
 - 2) Indirect impacts of the A/IS
 - 3) Impacts at a societal or more general level

It should be noted that the identification of users, stakeholders, and societal impact is intended to be a starting place only.

NOTE—There is a body of pre-existing knowledge about the possible impacts of A/IS applications on well-being. Given the evolving nature of understanding of the impacts of A/IS, it is outside the scope of this annex to guide what needs to be considered for a specific use case. Instead, A/IS creators should learn about the issues particular to their A/IS through information gathering and research as part of the WIA process.

In this annex, 10 indicator sets are provided.

B.1 Advertisement

[Table B.1](#) contains example indicators for A/IS for marketing or advertising.

Table B.1—Marketing/Advertising indicator examples

Description of A/IS app	AI marketing automation in place by a corporation marketing and selling goods and/or services online via individual marketing. The goods or services include a) clothing/fashion, b) a book, c) a ticket to an entertainment experience, or d) an airline ticket or hotel reservation.		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Consumer	Seller	
Life Satisfaction			
	Satisfaction with life as a whole (from the World Values Survey Wave 6 [B111])		
Affect			
	Sense of feeling content in a given week (adapted from the European Social Survey’s Europeans’ Personal and Social well-being [B19])		
	Negative affects: feeling sad, depressed, anxious (adapted from the European Social Survey’s Europeans’ Personal and Social well-being [B19])		
Psychological Well-being			
	Sense that one leads a purposeful and meaningful life in a given week and month (adapted from the OECD Better Life Index [B58])		
Community			
	Sense that one sees oneself as part of a community (based on the World Values Survey Wave 6 [B111])		Sense of discrimination in one’s neighborhood or community (adapted from the World Values Survey Wave 6 [B111])
Culture			
	Engagement with/participated in arts or cultural activity at least 3 times in last year (from the UK ONS Measuring National Well-being: Domains and Measures [B87])		
Education			
	Access to opportunities to learn (from the UN SDG Indicators [B91])		
Economy			
	Satisfaction with the financial situation of one’s household (from the World Values Survey Wave 6 [B111])	Proportion of small-scale industries in total industry value added (from the UN SDG indicators [B91])	
	Net financial wealth (from the OECD Better Life Index [B58])	Sense that the area where one lives is a good place to live for entrepreneurs forming a new business (adapted from the UN SDG indicators [B91])	

Table continues

Table B.1—Marketing/Advertising indicator examples (continued)

Description of A/IS app	AI marketing automation in place by a corporation marketing and selling goods and/or services online via individual marketing. The goods or services include a) clothing/fashion, b) a book, c) a ticket to an entertainment experience, or d) an airline ticket or hotel reservation.		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Consumer	Seller	
Environment			
			Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP (from the UN SDG indicators [B91])
			Reduction of GNH Emissions (from the Global Reporting Initiative [B28])
Work			
			Mechanisms for advice and concerns about ethics (from the Global Reporting Initiative [B28])

B.2 Autonomous vehicles

Table B.2 contains examples of indicators for A/IS for autonomous vehicles.

Table B.2—Autonomous vehicle indicator examples

Description of A/IS app	AV delivery by a company		
Level	User	Stakeholder	Society
Indicators measure the impact on:	Users of AV systems	Transportation Industry representatives	
Community			
	Feeling safe walking in the area one lives (adapted from the UN SDG Indicators [B91])		
Economy			
	Sense that the area where one lives is a good place to live for entrepreneurs forming a new business (adapted from the UN SDG indicators [B91])		Unemployment rate, by sex, age and persons with disabilities (from there UN SDG Indicators [B91])
Environment			
			Reduction of GNH emissions (from the Global Reporting Initiative [B28])
			Reduction of energy consumption (from the Global Reporting Initiative [B28])

Table continues

Table B.2—Autonomous vehicle indicator examples (continued)

Description of A/IS app	AV delivery by a company		
Level	User	Stakeholder	Society
Indicators measure the impact on:	Users of AV systems	Transportation Industry representatives	
Health			
	Overweight and obesity in adults and adolescents (from the World Health Organization Global Reference List of 100 Core indicators, 2015 [B110])		
Human Settlements			
	Satisfaction with transportation system in the city or area one lives (from the World Values Survey Wave 6 [B111])		Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities (from the UN SDG Indicators [B91])
	Death rate due to road traffic injuries (from UN SDG Indicators [B91])		Proportion of population living in households with access to basic services (from UN SDG Indicators [B91])

B.3 Chatbot for stress reduction

Table B.3 contains example indicators for chatbots for stress reduction.

Table B.3—Stress reduction chatbot indicator examples

Description of A/IS app	A chatbot on the market for monthly subscriptions used for diagnosing the stress levels of its users through collection of feedback from biosensors. Chatbot recommends treatment methods and/or activities to reduce stress levels.		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Users/Subscribers	Healthcare providers (therapists, life coaches, medical care providers, etc.)	
Life Satisfaction			
	How satisfied are you with your life today?(from the UK ONS National Measures of Well-being [B87])		
Affect			
	Happiness in a given time period (adapted from the European Social Survey’s Europeans’ Personal and Social well-being [B19])		
	Stress level in a given time period (adapted from the European Social Survey’s Europeans’ Personal and Social well-being [B19])		

Table continues

Table B.3—Stress reduction chatbot indicator examples (continued)

Description of A/IS app	A chatbot on the market for monthly subscriptions used for diagnosing the stress levels of its users through collection of feedback from biosensors. Chatbot recommends treatment methods and/or activities to reduce stress levels.		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Users/Subscribers	Healthcare providers (therapists, life coaches, medical care providers, etc.)	
Psychological Well-being			
	Feeling that the things one does are worthwhile (from UK ONS Measuring National Well-being: Domains and Measure [B87])		
Community			
	Sense of belonging to a community (adapted from World Values Survey 6 [B111])		
Economy			
		Degree to which one is worried about losing their job or not finding a job (from the World Values Survey Round 6 [B111])	
Health			
	Sense that one's state of health is good (from the World Values Survey Wave 6 [B111])		Number of persons who have seen a health professional during a year (from the from the European Commission's Minimum data set of European mental health indicators [B16])
			Lost workdays due to mental disorder or substance use (from the European Commission's Minimum data set of European mental health indicators [B16])

B.4 Facial recognition

Table B.4 contains indicators for a facial recognition A/IS.

Table B.4—Facial recognition indicator examples

Description of A/IS app	Facial recognition A/IS used by police departments in government to surveil people's faces to identify threats to public order in high-density cities		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Police	People	
Life Satisfaction			
	Satisfaction with life as a whole (from the World Values Survey Wave 6 [B111])	Satisfaction with life as a whole (from the World Values Survey Wave 6 [B111])	
Affect			
	Sense of feeling angry or stressed in a given time period (adapted from the European Social Survey's Europeans' Personal and Social well-being [B19])	Sense of feeling angry or stressed in a given time period (adapted from the European Social Survey's Europeans' Personal and Social well-being [B19])	
Community			
		Feeling safe walking alone around the area they live (from the UN SDG Indicators [B91])	Crimes against the person (per 1000 adults) (from the UK ONS Measuring National Well-being: Domains and Measures [B87])
		Sense of discrimination in one's neighborhood or community (adapted from the World Values Survey Wave 6 [B111])	
Economy			
Jobs	Degree to which one is worried about losing their job or not finding a job (World Values Survey Round 6 [B111])		Unemployment rate, by sex, age and persons with disabilities (from there UN SDG Indicators [B91])
Government			
	Mechanisms for advice and concerns about ethics (from the Global Reporting Initiative [B28])	Sense of confidence in government (from World Values Survey Wave 6 [B111])	Sense there is respect is for individual human rights nowadays in one's country (from the World Values Survey Wave 6 [B111])
	Operations with local community engagement, impact assessments, and development programs (from the Global Reporting Initiative [B28])	Citizens having the legal right and practical ability to obtain information about government operations and the means to petition government agencies for it (from Freedom House [B24])	Laws, policies, and practices guarantee equal treatment of various segments of the population (from Freedom House [B24])

Table continues

Table B.4—Facial recognition indicator examples (continued)

Description of A/IS app	Facial recognition A/IS used by police departments in government to surveil people's faces to identify threats to public order in high-density cities		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Police	People	
Work			
	Sense of independence one has in performing tasks at work (from the World Values Survey Wave 6 [B111])		
	Satisfaction with job [from General Social Survey 2010 quality of work life module (Smith, et al. [B80])]		
	Sense that the conditions of one's job allows one to be about as productive as one could be (from The Department of Health and Human Services [B11])		

B.5 Gaming

Table B.5 contains indicators for gaming A/IS.

Table B.5—Gaming indicator examples

Description of A/IS app	A responsive video game that utilizes a built-in A/IS capability to respond to gamer input and changes outcomes as the game progresses		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Gamer	Spectators	
Life Satisfaction			
	Satisfaction with life as a whole (from the World Values Survey Wave 6 [B111])		
Affect			
	Sense of feeling content in a given time frame (adapted from the European Social Survey's Europeans' Personal and Social Well-being [B19])		
	Sense of feeling angry or stressed in a given time period (adapted from the European Social Survey's Europeans' Personal and Social Well-being [B19])		
Psychological Well-being			
	Sense one is capable and good at what they do (adapted from the European Social Survey's Europeans' Personal and Social Well-being [B19])		

Table continues

Table B.5—Gaming indicator examples (continued)

Description of A/IS app	A responsive video game that utilizes a built-in A/IS capability to respond to gamer input and changes outcomes as the game progresses		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Gamer	Spectators	
Community			
	Sense of belonging to a community (adapted from World Values Survey 6 [B111])		
	Social skills - a means to measure adapted from the question “Think of actual situations in which the motives of other people needed to be understood and responded to. How frequently did you show social intelligence or social skills in these situations?” (from Peterson and Seligman [B74])		
Culture			
	Engagement with/participated in arts or cultural activity at least 3 times in last year (from the UK ONS Measuring National Well-being: Domains and Measures [B87])		
Education			
	Access to opportunities to learn (from the UN SDG Indicators [B91])		
Economy			
	Employment status (from World Values Survey Wave 6 [B111])		Proportion of youth (aged 15–24 years) not in education, employment or training (for UN SDG Indicators [B91])
Health			
	Insufficient physical activity in adults (also: adolescents) (World Health Organization Global Reference List of 100 Core indicators [B110])		

B.6 Hiring

Table B.6 contains example indicators for a use of A/IS for hiring.

Table B.6—Hiring indicator examples

Description of A/IS app	Employee hiring A/IS for increased efficiency, long term success and candidate quality		
Level	Users	Stakeholder	Societal
Indicators measure the impact on:	HR departments	Job seekers	
Psychological Well-being			
	Feeling that the things one does are worthwhile (from UK ONS Measuring National Well-being: Domains and Measures [B87])		
	Sense one is capable and good at what they do (adapted from the European Social Survey’s Europeans’ Personal and Social Well-being [B19])		
Community			
		Sense of discrimination (adapted from the World Values Survey Wave 6 [B111])	
Economy			
Jobs	Degree to which one is worried about losing their job or not finding a job (World Values Survey Round 6 [B111])		Unemployment rate, by sex, age and persons with disabilities (from there UN SDG Indicators [B91])
Government			
			Equality of opportunity and the absence of economic exploitation (from Freedom House [B24])
Work			
	Sense of independence one has in performing tasks at work (from the World Values Survey Wave 6 [B111])		
	Satisfaction with job (from Smith et al. [B80])		
	Sense that the conditions of one’s job allows one to be about as productive as one could be (from The Department of Health and Human Services [B11])		
	Sense that current work life is interesting [from General Social Survey Round 3 module (Smith et al. [B80])]		

B.7 Genome banking

Table B.7 contains example indicators for genome banking and analysis.

Table B.7—Genome banking indicator examples

Description of A/IS app	Predictive medical interventions enabled by the sequencing of individual genetic information, with personal and public health impacts		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Individual	Government or insurance provider banking genomes	
Government			
	Laws, policies, and practices guarantee equal treatment of various segments of the population (from Freedom House [B24])		Laws, policies, and practices guarantee equal treatment of various segments of the population (from Freedom House [B24])
Health			
	Healthy Life Expectancy (UK ONS Measuring National Well-being: Domains and Measures [B87])		
	Satisfaction with quality of health care (from the World Values Survey Wave 6 [B111])	Satisfaction with quality of health care (from the World Values Survey Wave 6 [B111])	
	Sense that one's state of health is good (from the World Values Survey Wave 6 [B111])		

B.8 Healthcare app

Table B.8 contains example indicators for a healthcare app.

Table B.8—Healthcare app indicator examples

Description of A/IS app	An app that diagnoses the medical situation of its users through assessing and correlating the collected patient data (such as detection of pre-diabetic markers including the level of obesity, BMI, family history, blood sugar levels, waist line size, etc.); and alerts the patients by recommending treatment methods.		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Patients	Healthcare providers	
Life Satisfaction			
	Satisfaction with life as a whole (from the World Values Survey Wave 6 [B111])		
Affect			
	Sense of stress and sadness in a given time period. (adapted from the European Social Survey's Europeans' Personal and Social well-being [B19])		

Table continues

Table B.8—Healthcare app indicator examples (continued)

Description of A/IS app	An app that diagnoses the medical situation of its users through assessing and correlating the collected patient data (such as detection of pre-diabetic markers including the level of obesity, BMI, family history, blood sugar levels, waist line size, etc.); and alerts the patients by recommending treatment methods.		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Patients	Healthcare providers	
Psychological Well-being			
	Sense of control over one’s medical treatment (adapted from Sense of mastery is a form of perceived personal control. Personal control refers to a sense of control over the events in one’s life. European Commission’s Minimum data set of European mental health indicators [B16])		
	Sense of engagement in decision making about medical health care treatments and prevention (adapted from the OECD Better Life Index [B58])		
Community			
	Sense that if one were in trouble, they would have relatives or friends they can count on to help them whenever they need them, or not (from OECD Better Life Index [B58])		Sense of discrimination (adapted from the World Values Survey Wave 6 - Sense of frequency that racist behavior occurs in one’s neighborhood [B111])
Economy			
			Household net financial wealth (from the OECD Better Life Index [B58])
Environment			
			Amount of medication and other health care products that are wasted because they are not used (adapted from proportion of urban solid waste regularly collected and with adequate final discharge out of total urban solid waste generated, by cities from the SDGs [B91])

Table continues

Table B.8—Healthcare app indicator examples (continued)

Description of A/IS app	An app that diagnoses the medical situation of its users through assessing and correlating the collected patient data (such as detection of pre-diabetic markers including the level of obesity, BMI, family history, blood sugar levels, waist line size, etc.); and alerts the patients by recommending treatment methods.		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Patients	Healthcare providers	
Health			
	Healthy life expectancy: the forecast of years left of life that one will have a high quality of life (UK ONS Measuring National Well-being: Domains and Measures [B87])		Coverage of essential health services [defined as the average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases and service capacity and access, among the general and the most disadvantaged population (from the UN SDG Indicators [B91])]
	Sense that one’s state of health is good (from the World Values Survey Wave 6 [B111])		
	Amount a person pays for medical care in a given time period. (From Out-of-pocket payment for health from the World Health Organization Global Reference List of 100 Core indicators [B110])		
	Satisfaction with quality of health care (from the World Values Survey Wave 6 [B111])		
Work			
		Satisfaction with job (from Smith et al. [B80])	
		Sense that the conditions of one’s job allows one to be about as productive as one could be (from The Department of Health and Human Service [B11])	
		Sense of independence one has in performing tasks at work (from the World Values Survey Wave 6 [B111])	

B.9 Permitting, licensing, and ticketing

Table B.9 contains example indicators for police functions of permitting, licensing and ticketing.

Table B.9—Permitting, licensing, and ticketing indicator examples

Description of A/IS app	Robot officers for licensing, permitting and ticketing, such as car tabs, automated traffic tickets, permitting signage, etc.		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Citizens	Police	
Affect			
	Feeling stressed/anxious (adapted from the European Social Survey’s Europeans’ Personal and Social well-being [B19])		
Community			
			Sense of discrimination (adapted from the World Values Survey Wave 6 - Sense of frequency that racist behavior occurs in one’s neighborhood [B111])
Economy			
		Degree to which one is worried about losing their job or not finding a job (from the World Values Survey Wave 6 [B111])	
Government			
	Sense of confidence in government (national, local, civil service, judicial system, police, political parties, etc.) (from World Values Survey Wave 6 [B111])	Rule of law prevailing in civil and criminal matters (from Freedom House [B24])	Sense that government is free from pervasive corruption (from World Values Survey Wave 6 [B111])
			Laws, policies, and practices guarantee equal treatment of various segments of the population (from Freedom House [B24])
Work			
		Satisfaction with job (Smith et al. [B80])	
		Sense that the conditions of one’s job allows one to be about as productive as one could be (from The Department of Health and Human Services [B11])	

B.10 Personal assistant

Table B.10 contains example indicators for a personal assistant.

Table B.10—Personal assistant indicator examples

Description of A/IS app	Personal Assistant used by an individual to manage and guide daily tasks, calendar, and encourage chosen behavioral patterns, with behavioral patterns determined by the user		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Person using PA		
Life Satisfaction			
	Satisfaction with life as a whole (from the World Values Survey Wave 6 [B111])		
Affect			
Affect *	Positive affects: feeling happy, calm, peaceful, etc. (adapted from the European Social Survey’s Europeans’ Personal and Social well-being [B19])		
Affect	Negative affects: feeling sad, depressed, anxious, etc. (adapted from the European Social Survey’s Europeans’ Personal and Social well-being [B19])		
Psychological Well-being			
	Sense that one leads a purposeful and meaningful life (adapted from the OECD Better Life Index [B58])		
	Sense one is capable and good at what they do (adapted from the European Social Survey’s Europeans’ Personal and Social Well-being [B19])		
Community			
	Sense that if one were in trouble, they would have relatives or friends they can count on to help them whenever they need them, or not (from OECD Better Life Index [B58])		Sense that most people can be trusted or that one needs to be very careful in dealing with people (from the World Values Survey Wave 6 [B111])
	Sense of Belonging to community (adapted from the World Values Survey Wave 6 [B111])		
	For those living with or married to a partner, their sense happiness in their relationship on a scale from “extremely unhappy” to “perfect” (from UK ONS Measuring National Well-being: Domains and Measures [B87])		

Table continues

Table B.10—Personal assistant indicator examples (continued)

Description of A/IS app	Personal Assistant used by an individual to manage and guide daily tasks, calendar, and encourage chosen behavioral patterns, with behavioral patterns determined by the user		
Level	User	Stakeholder	Societal
Indicators measure the impact on:	Person using PA		
Education			
	Access to opportunities to learn (from the UN SDG Indicators [B91])		
Environment			
			How much (people) know about global warming or climate change (adapted from the UN SDG indicators [B91])
Health			
	Sense that one’s state of health is good from (the World Values Survey Wave 6 [B111])		Proportion of population living in households with access to basic services (from UN SDG Indicators [B91])
Work			
	Satisfaction with the balance between the time spent on the job and the time spent on other aspects of life (from the European Social Survey Round 5 [B18])		
	Average amount of time spent on leisure time out of doors, away from home in previous 12 months (from UK ONS Measuring National Well-being: Domains and Measures [B87])		

Annex C

(informative)

IEEE Std 7010 value statements

This annex is for those who do not necessarily directly use IEEE Std 7010 for A/IS development etc, but have some influence or control over its use.

A/IS technologies are relatively novel and their use and the understanding of intended and unintended impacts are hard to predict. A/IS impact human well-being in many complex ways, some known and some unknown. IEEE Std 7010 supports the use of a common framework to understand the well-being implications of A/IS. This clause sets forth some of the value of IEEE Std 7010 to the following:

- a) The public
- b) Business managers and shareholders
- c) Policy makers
- d) Researchers
- e) Educators and the media
- f) Philosophers

This annex does not attempt to include every aspect of the value of IEEE Std 7010; it is presented as a starting place.

Example: Scenario C.1

This hypothetical scenario suggests values derived from non-A/IS creators from the use of IEEE Std 7010 applied by A/IS creators of autonomous vehicles:

- Researchers use IEEE Std 7010 to develop adequate evaluation metrics for the algorithms they create.
- Developers use their skills to think of creative ways in which impacts on human well-being discovered through the WIA process can be improved.
- By using the WIA indicators, business managers find and leverage new business opportunities.
- Educators use the WIA to create training programs and educational resources to support the safe development and deployment of AVs. This could include safety-drivers training resources as well as translational work between technologists, policy makers, and other stakeholders.
- Philosophers use the WIA to study the moral implications of AVs (Awad, et al. [B2]).
- Policy makers use IEEE Std 7010 to inform their regulatory actions in relation to automated vehicles (Acousta [B1]).
- IEEE Std 7010 creates an opportunity for the public to be an active participant in the responsible development and deployment of AVs—to help make sure that they are safe and welcoming for the members of their community.
- The media uses IEEE Std 7010 to understand the well-being impacts of AVs and to educate the public about the risks and rewards.

End of Scenario C.1

C.1 Value of IEEE Std 7010 to the public

It is the intent of IEEE Std 7010 to benefit the public by providing a means by which A/IS are created for the well-being of human well-being and by contributing to reducing risks to current and future human well-being from A/IS. Because of its iterative process, IEEE Std 7010 provides a mode for continual learning and improvement to human well-being from A/IS.

IEEE Std 7010 conceivably provides the public a framework to understand how a particular A/IS potentially benefits or harms humans. It also provides the public a means to understand the short- and long-term implications of an A/IS on human well-being. It could potentially help the public to understand what A/IS are and are not and to understand the limits of A/IS. Thus, it is hoped that IEEE Std 7010 will contribute to aligning public perceptions with more realistic assessments.

It is conceivable that IEEE Std 7010 will contribute to avoiding situations ranging from over-trust to unnecessary fear. Another benefit of IEEE Std 7010 is in providing the public a basis on which to trust A/IS. It could be used to give the public more information about the impacts, benefits, and risks of A/IS on human well-being, thereby allowing the public to become more informed and more effective advocates of their own interests to companies and policy-makers.

Because it incorporates a systems approach through its definition of indicators, and because of its stakeholder engagement process, IEEE Std 7010 could potentially provide the public new forms of participation in an A/IS life, which allows the public to have a say in an A/IS concept and development, such as by contributing to the definition of the goals and direction of an A/IS project to help secure current and future well-being of people and the planet.

When A/IS users and stakeholders are engaged in the IEEE 7010 WIA process and have access to the well-being indicators dashboard, it is conceivable that there could be an additional beneficial impact on the well-being of humans because of their engagement. It is also conceivable that IEEE Std 7010 could be of value to funders, investors, buyers, or acquirers of A/IS by providing a framework and foundation for guiding and assessing well-being impacts from an A/IS.

C.2 Value of IEEE Std 7010 to business managers and shareholders

It is conceivable that business managers and shareholders of enterprises ranging from micro (less than 10 employees), small (less than 50 employees), medium (less than 250 employees), and large (250 or more employees) businesses could gain value from IEEE Std 7010 financially, as well as in terms of goodwill, market share, marketing, organizational learning, research and development, risk management, and other areas. IEEE Std 7010 provides a means for working with users and stakeholders, thereby enhancing an entity's capacity for organizational learning through establishing a process of awareness and accounting for impacts on human well-being. IEEE Std 7010 provides a means for risk management, ranging from establishing and helping protect social license to brand reputation and brand safety. It provides a process for assessing and forecasting impacts and for identification of unintended negative consequences or harnessing unintended positive impacts. Another use of IEEE Std 7010 is to aid in building trust with future regulators and as a foundation for working with regulators. Yet another use is to help legal personnel in assessing risk. It is conceivable that IEEE Std 7010 could be used to help business managers and shareholders in preparing for future regulations.

Another use of IEEE Std 7010 could be to provide a means to help establish, maintain, and protect the trust of the public by demonstrating that a company accounts for and cares about the well-being of humans. This recommended practice could also potentially be used to establish and demonstrate that A/IS provided by a company or entrepreneur are trustworthy, thereby contributing to an entity's competitive market advantage in terms of the greater likelihood of early product adoption, greater traction in establishing markets, increased sales, greater market share, customer loyalty, the building of entity goodwill, and overall greater market and

financial sustainability. Use of IEEE Std 7010 may provide accountants and financial managers information and data for producing annual reports, particularly for material risk disclosure, corporate social responsibility and sustainability reporting, and public relations management. Another use could be to increase trust among stakeholders when stakeholders are engaged in the process of identifying well-being indicators.

Example: Scenario C.2

A hypothetical startup is hoping to apply IEEE Std 7010 because their product uses A/IS to assess health patterns and psychological benefits from a meditation app they have developed. The startup does not have a formal management structure; they meet as a team and decide who is responsible for signing off on their IEEE 7010 plan, who is responsible for collecting data and evaluating impacts, and who is responsible for integrating lessons learned into the next design task of the product.

End of Scenario C.2

Example: Scenario C.3

In this scenario, a business manager is deciding whether to have use IEEE Std 7010 to monitor an A/IS home assistant service for elderly people. The A/IS helps with medication scheduling, ordering, management, biofeedback, movement monitoring, and communication with the health care team and family. The manager is using IEEE Std 7010 to generate information for a cost-benefit analysis, risk analysis, and for pricing strategies. Her goal is to decide whether or not to use IEEE Std 7010. She uses two domains to explore costs and benefits: satisfaction with life and health.

Impact on the user	Risks	Benefits
Satisfaction with life	User will be more isolated	User has increased access to health care
	User feels less in control	There is proper fulfillment of prescriptions and other aspects of care plan
	User will take less responsibility of their own health care	User has increased sense of efficacy and control over health care plan
Sense that one's state of health is good and coverage of essential health services	A/IS will make a mistake or be misused and result in ill-health	Users are healthier and happier
		Users have higher quality of life
	If data is mismanaged etc. (see 1.6) well-being is harmed	User has more options and opportunities to be healthier
		Health costs decrease

The manager decides to begin the process of the WIA.

End of Scenario C.3

C.3 Value of IEEE Std 7010 to policy makers

It is conceivable that policy makers or civil servants at all levels of government gain value from IEEE Std 7010 through greater awareness of the benefits and risks of A/IS. Many policymakers currently lack an understanding of current A/IS capabilities and applications, the opportunities and challenges associated with specific applications, and the impact of its use on humans. Harnessing the application of A/IS effectively is crucial for building public trust and confidence.

IEEE Std 7010 can be used as a means to assess, measure, monitor, and manage impacts on human well-being when creating, procuring and using A/IS in government administration. It is conceivable that the standard can provide alignment in measuring the impact on human well-being from A/IS when the well-being

metrics used for well-being indicators dashboard are comparable to other metrics used by government. Such alignment equips policy makers with the knowledge to effectively allocate funding, organize priorities, and manage trade-offs. Another potential use of IEEE Std 7010 is to help policy makers in the development of an area's approach to A/IS, providing policy makers opportunities to strategically invest in local initiatives that stimulate an area's economy.

In terms of promulgating rules and regulations for A/IS and other governmental activities, such as funding, incentives, public-private partnerships, monitoring, assessment, and other policy development for A/IS, policy makers have a large role to play. To keep pace with technology in government, policy making is crucial to gaining and maintaining public trust in A/IS, which in turn is important to the development of the A/IS field. The ability to anticipate the political implications of A/IS involves, in part, understanding the impacts on human well-being of A/IS. It is conceivable that IEEE Std 7010 can be used to inform policy development and to provide a framework for robust discussions about the potential risks and regulatory responses regarding the impact on human well-being of A/IS. Such dialog could provide policy makers with an opportunity to influence the design of A/IS technology for the benefit of human well-being. Another use of IEEE Std 7010 is to provide indicators and a process that can be adapted by policymakers for the development of rules and regulations.

The OECD report “Hello World: Artificial Intelligence and its use in the public sector” [B61] is a resource for understanding the value of IEEE Std 7010 as well.

Example: Scenario C.4

This scenario explains the ways policy makers could use IEEE Std 7010. This is a hypothetical scenario in which a government agency, the Office of Science and Technology Policy (OSTP), is considering the development of a new framework to evaluate government A/IS initiatives that prioritizes well-being. An analyst suggests the use of IEEE Std 7010 to understand the impacts of A/IS related policies and programs. To determine how to incorporate IEEE Std 7010 into the government's evaluation framework, OSTP consults their stakeholders: other agencies, the private sector, nonprofit sector, citizens and academics. The feedback is to use the well-being indicators already in use by the various stakeholders for developing a well-being indicators dashboard that can be used to evaluate A/IS initiatives. For example, the police force is planning to invest in A/IS to predict crime and traffic accidents, subject to OSTP approval. The OSTP will use indicators for crime rates and traffic accidents that the police force collects, as well as indicators for sense of safety, trust in government, and respect for human rights that academics and nonprofits use to evaluate the impact on well-being of the police forces' planned A/IS investment. If the investment is made, the OSTP will use these and potentially other indicators to monitor its impact. They will populate a well-being dashboard with the indicators, A/IS initiatives, and data.

End of Scenario C.4

Example: Scenario C.5

This scenario explains how nongovernmental organizations use IEEE Std 7010. A hypothetical nonprofit that advocates for wildlife is evaluating a new A/IS tool that monitors wildlife diversity. However, the team selecting indicators is concerned that many possible environmental and economic indicators are relevant, and is unsure of how to decide. One approach the nonprofit takes is to determine an initial list of indicators and then, through user and stakeholder interviews and additional research, expand the list gradually as the most important and relevant indicators emerge over time.

End of Scenario C.5

C.4 Value of IEEE Std 7010 to researchers

It is conceivable that the IEEE 7050 WIA process could be used for an understanding of how A/IS impact human well-being issues from a multidisciplinary perspective. For example, economic researchers might use certain indicators to measure specific topics, whereas positive psychology researchers or environmental researchers might use other indicators for other topics. Using IEEE Std 7010, researchers from multiple fields might form an amalgamation of indicators measuring economic, psychological, and environmental impacts.

When data is shared among researchers or A/IS creators using IEEE Std 7010, they have increased access to data. Increased availability of well-being data offers the possibility of improving the understanding of A/IS impacts on human well-being. It is hoped that researchers using the IEEE Std 7010 framework to gather data further the development and use of indicators by contributing to validating indicators, rendering greater precision and identifying better indicators to measure the impacts on human well-being from A/IS. Repeated iterations of research and data collection allow researchers to improve indicator frameworks. It is conceivable that use of IEEE Std 7010 will also contribute to researchers better understanding the determinants, causes, and other relationships among well-being factors in relation to A/IS.

It is also conceivable that researchers could use IEEE Std 7010 to identify fields of study for understanding how A/IS is of benefit or harm to human well-being and to conduct new research that is relevant to public and societal good.

Example: Scenario C.6

XYZ Research Institute has received a grant to develop an A/IS system that encompasses early detection of autism in young children. The grant requires evaluation indicators for various components of the project. Because the early autism detection A/IS system will be engineered for children as young as infants, the A/IS creators feel there is a heightened need to monitor and track the impacts on the well-being of the infants. Because autism occurs in families of every nature, it will also need to be highly adaptable to different family types, dynamics, and circumstances, so there is a need to monitor and track the impacts on the well-being of the families. XYZ Research Institute decides to use IEEE Std 7010 to guide the development of their A/IS system for early detection of autism. They realize there will be some complexity in gathering certain well-being data for infants but nevertheless determine that by using IEEE Std 7010, they will not only gather data that helps improve their A/IS, but also helps meet the grant requirements.

End of Scenario C.6

C.5 Value of IEEE Std 7010 to educators and media

With the growing number of classes offered in educational institutions related to A/IS issues, including ethics, with greater focus on A/IS impacts on human well-being by the media, it is conceivable that educators and the media could use IEEE Std 7010 to contribute to translating technical concepts into practical information for communication, comprehension, and use in multiple arenas and sectors.

Another use of IEEE Std 7010 could be to help educators and the media synthesize diverse perspectives through the use of indicators in a well-being dashboard. Educators and the media can use IEEE Std 7010 to build a holistic understanding of what A/IS impacts are, how to teach them, and how to communicate them to the public. Yet another use of IEEE Std 7010 could be to help educators and the media clarify issues of ethics, bias, and transparency that are related to well-being, and place these issues into a framework so they are approached, understood, and communicated.

With the growing number of universities and professional certification programs offering courses in information technology ethics and related issues, educators could also use IEEE Std 7010 as a resource for curricula.

It is conceivable that the media could use IEEE Std 7010 to help ensure news reporting accurately reflects impacts on human well-being and does not unnecessarily stoke anxiety or misrepresent technical research, risks and implications (for example, as in solutions journalism).

C.6 Value of IEEE Std 7010 to philosophers

It is conceivable that IEEE Std 7010 could be of value to philosophers by providing a framework to understand how humans interact with and are impacted by A/IS. Philosophers would study the ethical framework with which A/IS creators use this standard and explore the relationship between ethical and well-being implications of A/IS. It is conceivable that through philosophical study of the implementation of IEEE Std 7010 by A/IS creators, philosophers will uncover decision-making factors and socio-technical factors (e.g., relationship of human to A/IS in labor, appropriate roles in society, human-robot relationships). With the use of IEEE Std 7010, philosophers would also explore aspects of well-being across cultures and over time.

Annex D

(informative)

Integration of IEEE Std 7010 into existing processes

IEEE Std 7010 should be used as part of existing processes or on its own. Table D.1 and Figure D.1, Figure D.2, and Figure D.3 present abstract sketches for this with the intent of generating ideas.

Table D.1—Ideal for integration of IEEE Std 7010 into existing processes

Standard, Framework, Guidance Document	Conceptual orientation for integration of IEEE Std 7010 (how IEEE Std 7010 would be used in tandem)
Plan-Do-Check-Act Cycle	IEEE Std 7010 used as part of the Plan-Do-Check-Act cycle, such as ISO 9001:2015 [B39], with Step One of the WIA part of the Plan step and well-being indicators dashboard part of the Check step.
Triple Bottom Line Framework—People, Planet, Profit	The WIA used to understand the impacts on the environment, economy, and society.
Computational Sustainability	Indicators from the well-being indicators dashboard used to assess and manage a system.
Life Cycle Analysis (LCA)	The WIA as part of assessment of the impacts throughout the LCA. The well-being indicators dashboard part tracking impacts along the life cycle.
Value Sensitive Design	Use of IEEE Std 7010 includes an approach based on Value Sensitive Design: An iterative, participatory approach to take into account human values in the design of technology, involving three types of investigations: conceptual, empirical, and technical.

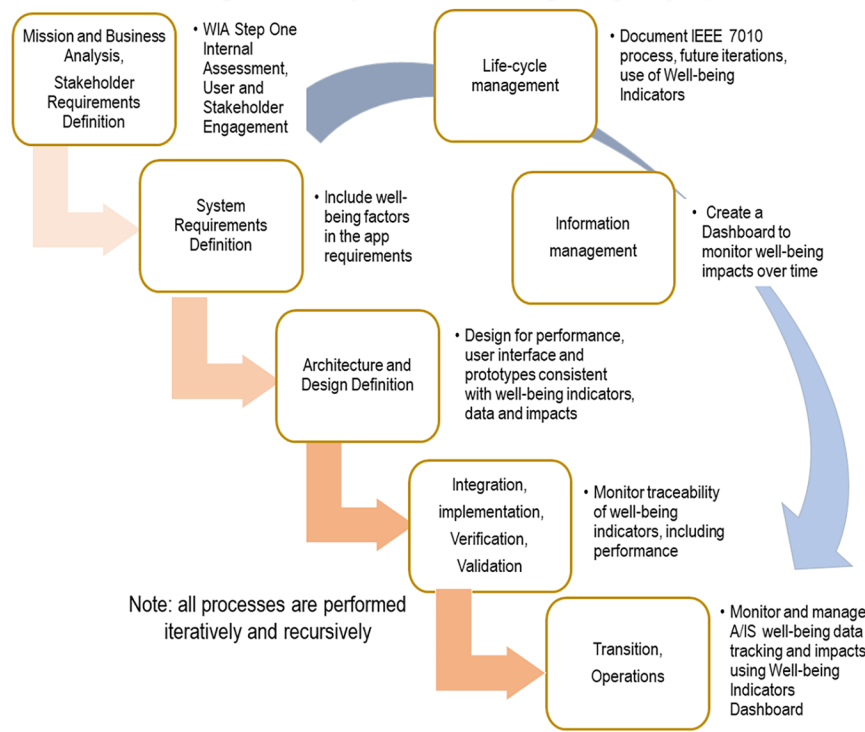


Figure D.1—Use of well-being indicators in the software engineering life cycle processes

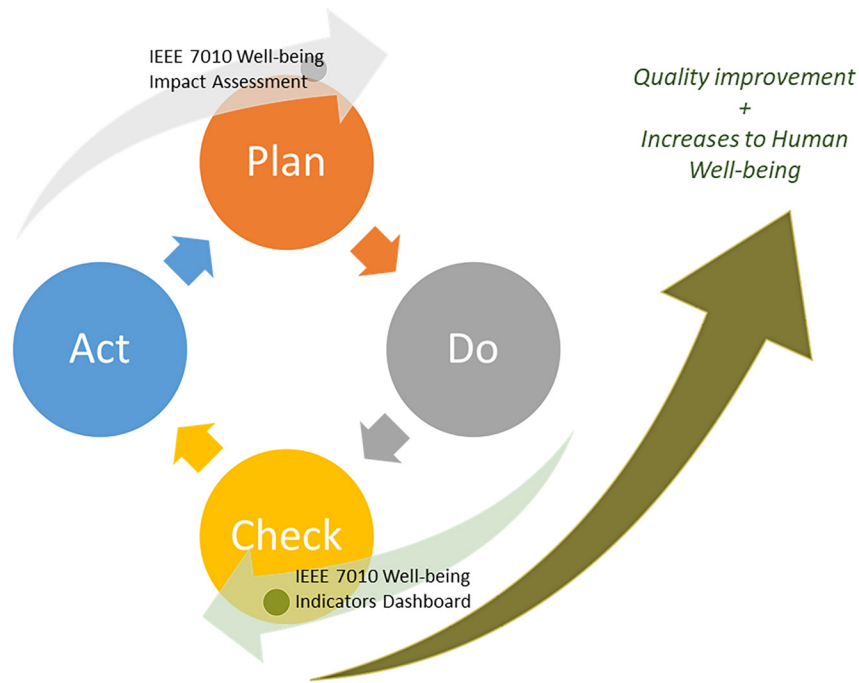
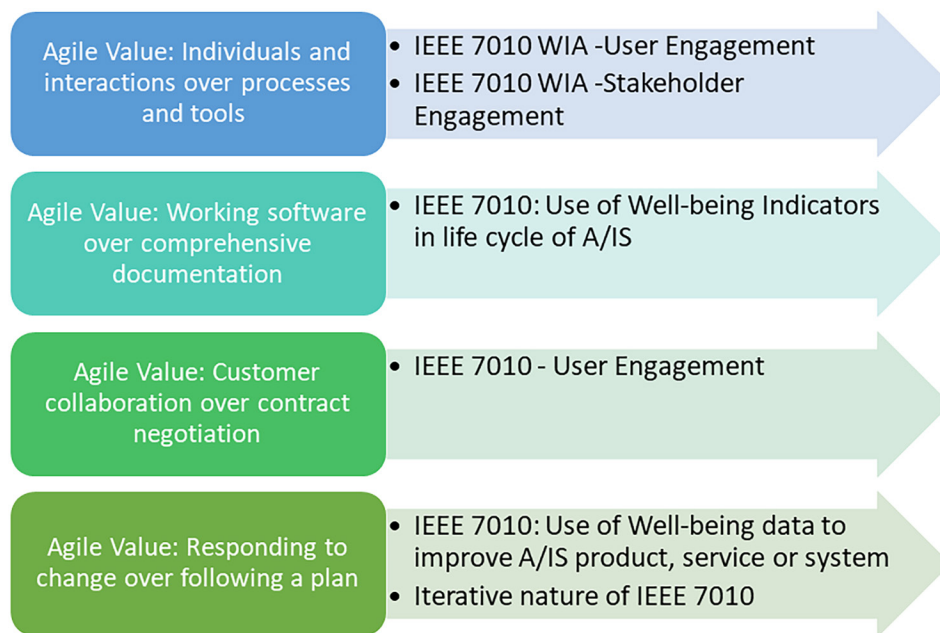


Figure D.2—Basic conceptualization for integration of IEEE 7010 into plan-do-check-act quality management type systems



NOTE—The integration of IEEE 7010 into an Agile environment should take a start small, grow-out approach, using only a few indicators at the onset, as fits the needs and circumstances of A/IS creators.

Figure D.3—Explanation for integration of IEEE 7010 into Agile values

Annex E

(informative)

Notional Examples for [Clause 5](#)

E.1 Notional example for WIA Activity 1 ([5.1](#))

This is one of many hypothetical scenarios intended to understand the application of IEEE Std 7010. The entity and names in this scenario and the others in this document are hypothetical. This scenario is to illustrate Activity 1 only.

An AI startup has just launched a self-help app, PastLove, for pet owners who have recently lost a beloved pet. The owners of the start-up are seeking to more effectively market products to grieving individuals and improve the A/IS. The site lets people upload and discuss images and stories about their pets. The site goes viral when the company hires a marketing firm to promote therapy services using AI algorithms trained to detect depression. These algorithms are trained on voluntarily shared user data. The A/IS creators of PastLove consult IEEE Std 7010 in order to identify the best indicators for the identification of emotional affect. While consulting [Clause 6](#) of IEEE Std 7010-2020, they find indicators for feeling happy, sad, a sense of community, loneliness and feeling loved. They decide to use these but are also seeking more specific indicators to measure progress in the grief process. They look for this in the Additional Resources, but it is not clear whether any of the indicators are appropriate for measuring the grief process. In this case, the A/IS creators identify experts who are competent in assessments for grief processing and consult with them to identify indicators that measure positive progress through the grief process as part of their internal analysis for use in their well-being indicators dashboard. Their well-being indicators dashboard includes indicators sourced from [Clause 6](#) and the specific indicators identified by experts to measure the grief process. The data for the indicators is used to improve the A/IS functions and the user well-being through detection of depression and delivery of grief processing services.

E.2 Notional example for WIA Activity 1 Task 1 ([5.1.1](#))

This scenario is based on hypotheticals and two facts: Helsinki has adopted a goal to end personal car ownership. In 2020, Helliwell, Layard, and Sachs' World Happiness Report [[B31](#)] rated Finland as the happiest country for the third time in a row. Everything else is in this scenario hypothetical to the IEEE Std 7010-2020 Working Group members' knowledge.

In this scenario, AI developers are working for a government-owned corporation in Finland. They are tasked with creating a transportation system that realizes the goal of no personal ownership of vehicles by 2040. Because Finland was deemed the happiest country in the world by the World Happiness Report in 2018, 2019, and 2020, the city has asked the AI developers to be sure to include satisfaction with life, an indicator used by the WHR.

NOTE 1—In this scenario and other scenarios in this recommended practice the popular term “autonomous vehicles” or AV is used in lieu of the term “automation system” that SAE International recommends.

The AI developers are planning a pilot study on an island community that approved the plan via a vote. Almost 80% of the population of the island already relies completely on public transportation within and outside of the island. Thus, only about 5000 people are changing their habit for the study. For the duration of one month, the 5000 car owners will not use their personal cars for any transportation on the island. (They will use their personal vehicles for transportation off the island.)

The AI developers decide to use IEEE Std 7010 to test the success of their pilot study, as they want to employ a comprehensive approach to managing impacts.

They start with WIA Activity 1 Task 1: Internal Analysis

What is the A/IS? The A/IS service is the transportation system designed to provide the people of Finland with an integrated transportation network that uses a variety of AI (AVs) and non-AI (e.g., bike-share) systems in order to eliminate the need for private car ownership. This system should be able to compete with private vehicle ownership in terms of both cost and convenience.

Some of the factors the A/IS creators considered during the initial analysis task:

- The fleet of vehicles will emit zero greenhouse gas emissions.
- The vehicles will be designed in a way that they are accessible to people with disabilities.
- The vehicles will utilize sensor systems that allow for increased safety. The technology incorporated inside the vehicle will protect user privacy.
- The interaction between people and the vehicles need to incorporate explainable and interpretable communication interfaces.

Some of the discussed product features included:

- Traffic minimization and optimizing of vehicle use, to reduce traffic and optimize efficiency.
- Choice by users to share a ride with another user who is needing one, or to use the vehicle alone. Riders get credits for sharing, which allows them to ride for lesser cost.
- Social interactions between the AV and people including vehicles with faces whereby the lights represent eyes and the bumper represents the mouth. The lights will both pick up expressions from pedestrian faces and display the intent of the vehicles. Riders in the vehicles will have the option to choose the nature of the ride (e.g., is it a leisurely ride to the grocery or is there a need to get somewhere on time, such as to pick up a small child from daycare, or is it a medical emergency?) which will be displayed on the vehicle's face for pedestrians and other drivers to decide how to interact. When riders who are not in an emergency situation choose the polite version, stopping for all pedestrians, they get extra credits.
- Riders can also choose to log personal preferences for music, talk shows, or other entertainment, and when sharing rides, music, etc. they both like will be played if they choose.
- Riders can choose to spend their AV commute time in learning new skills, relaxing, or engaging in other activities. The AV encourages them to learn new skills.

What is the need it meets/problem it solves? The AI system is designed to fulfill the goal of the city, and to give people transportation in an urban environment than they currently have with personal vehicles.

Who are the users and stakeholders? The users and stakeholders are as follows:

- Intended users
 - General residents
 - Workers who commute to the island
 - Elderly residents
 - Disabled residents

- Unintended users
 - Children of residents (and other family members who do not have a license to drive)
 - Tourists and guests of residents
 - People with suspended licenses
 - Non-residents who are curious to try out the AI vehicles
- Stakeholders
 - Taxi, bus, and for-hire rideshare drivers
 - Delivery service providers (grocery store deliveries, etc.)
 - AI algorithm data labelers
 - Developers of the AI system
 - Insurance industry
 - Pedestrians
 - Public transit users
 - Police
 - Car dealerships
 - Road maintenance agency

In this scenario, the A/IS creators decide to limit their scope of user engagement to just intended users for the first iteration. They intend to consider unintended users and stakeholders in the second iteration as this is their first iteration and they do not want the WIA to become unwieldy.

NOTE 2—This is a scenario, and should not be taken as recommended practice. In practice, A/IS creators should engage with all stakeholders who are meaningfully or potentially meaningfully impacted.

They decide that in future iterations, they will label indicators for intended user, unintended user, or stakeholders, or have different well-being indicators dashboards for unintended users or stakeholders.

What are the possible impacts on human well-being? To assess what the possible impacts on human well-being are, the AI developers brainstorm based on their own knowledge and research on the subject. Using IEEE Std 7010, they want to have at least one indicator for each domain. Once they have decided on the indicators they will employ for their WIA, they use a sunburst to display the domains as displayed in [Figure E.1](#), including the following:

- Satisfaction with Life
 - Satisfaction with life at the present moment
 - Psychological well-being
 - Sense of autonomy (source other than [Clause 6](#))
- Affect
 - Feeling content
 - Feeling angry (i.e., road rage)
- Community
 - Sense of safety
 - Sense that one sees oneself as part of a community
 - Sense of discrimination in terms of access to transportation

- Culture
 - Value of sharing (source other than [Clause 6](#))
- Education: users learn about AI (source other than [Clause 6](#))
- Economy
 - Standard of living
 - Industry value add
 - Jobs (i.e., taxi, rides share workers, delivery)
- Environment
 - GHG emissions
 - Renewable energy use
- Health
 - Presence of health problems preventing one from doing things one normally does related to air quality
 - Exercise—frequency people take a walk in their neighborhood (source other than [Clause 6](#))
 - Bicycle usage (source other than [Clause 6](#))
- Human Settlements
 - Area of public and green spaces
 - Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities
 - Satisfaction with transportation system in the city or area one lives
 - Death rate and injury rate due to road traffic injuries (adapted to include injuries)
- Government
 - Equality of opportunity in using the service (adapted)
 - Regulatory frameworks helping to ensure equal treatment of everyone in the population (adapted)
 - Citizens having the legal right and practical ability to obtain information about government (data access and right over personal data)
- Work: average amount of time spent on leisure time out of doors, away from home in previous 12 months

In the WIA indicator dashboard example, the colored blocks in the outer circle represent individual indicators, belonging to their corresponding domains represented by a block of the same color in the inner circle. The user is able to click and select a block from the outer circle in order to reveal more details about that specific indicator. The purple block selected in the figure corresponds to the GHG emissions indicator within the environment domain. The inner graph is a visualization of greenhouse gas emissions (Umwelt Bundesamt [B83]). The A/IS creators used the indicators to identify the impacts, and added indicators when they were unable to find any to reflect an impact that came to mind. As they identified indicators, they went back to the design. For example, when they added the indicators of GHG emissions and renewable fuel use, they added the design element of electric cars.

They begin to plan for Activity 1 Task 2, whereby they will engage with 20 residents who live and work on the island. They will present their concept and ask for input on how the residents imagine it will impact their lives before presenting the domains.

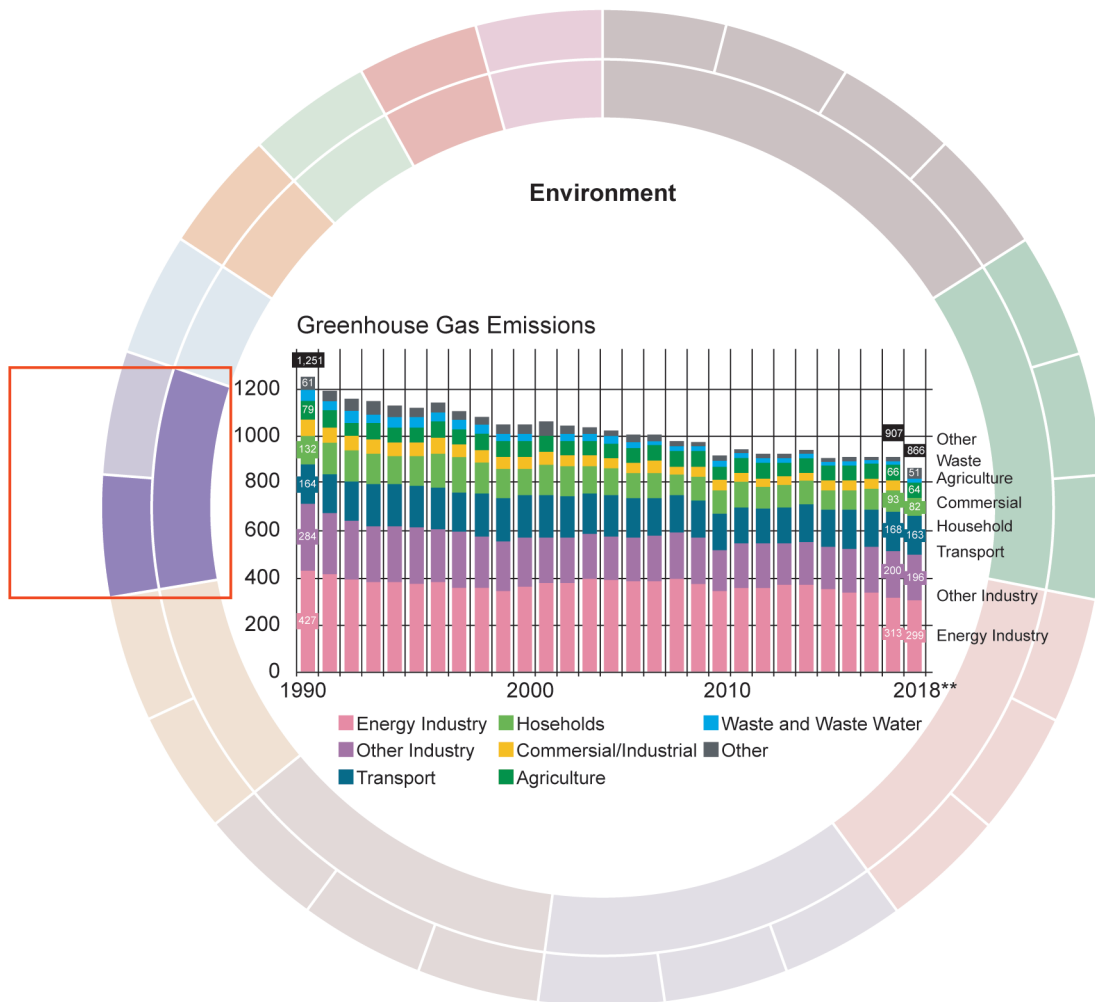


Figure E.1—Well-being indicators dashboard example for WIA Activity 1 Task 1

E.3 Notional example for WIA Activity 1 Task 3 (5.1.3)

This scenario is a continuation of Scenario Two. The A/IS creators decide to categorize users and stakeholders into three tiers follows:

- First Tier: users and stakeholders that are directly impacted
 - Intended users: residents and workers who commute to the island
 - Unintended users: pedestrians
- Second Tier: special consideration (children, vulnerable populations, and populations needing assistive technologies)
 - Intended users: elderly, disabled
 - Unintended users: children of island residents
- Third Tier: the indirect and future users and stakeholders
 - Unintended users: tourists and guests of island residents
 - Unintended users: people with suspended licenses

- Unintended users: non-residents of the island who are curious to try out the AI vehicles
- Unintended stakeholders: taxi, bus and for-hire rideshare drivers
- Unintended stakeholders: delivery service providers (grocery store deliveries, etc.)
- Unintended stakeholders: AI algorithm data labelers
- Unintended stakeholders: developers of the AI system
- Unintended stakeholders: the insurance industry

The A/IS creators decide to engage the first-tier users and special consideration users in separate processes to develop four different tiers of well-being dashboards, but in their first iteration, they decide to limit their scope to use the intended users in an effort to understand how to use the data. They intend to continue to the other users and stakeholders as soon as is practicable.

E.4 Notional Example for WIA Activity 2 (5.2)

The IEEE 7010 Indicator Exploration Tool allows for a simplified user interface when evaluating which of the IEEE 7010 indicators are relevant to a specific A/IS. In this notional example, in [Figure E.2](#), the user of the Well-being Indicators Dashboard Tool has selected the work domain, followed by the workplace life balance indicator that measures satisfaction with the balance between the time spent on the job and the time spent on other aspects of life (from the European Social Survey Round 5 [\[B20\]](#)). In the case of the well-being indicators dashboard, other information will also be available. At a minimum, the actual data related to the selected indicator should be displayed. By itself, the Well-being Indicators Exploration Tool is not a dashboard but it could be utilized to become one.

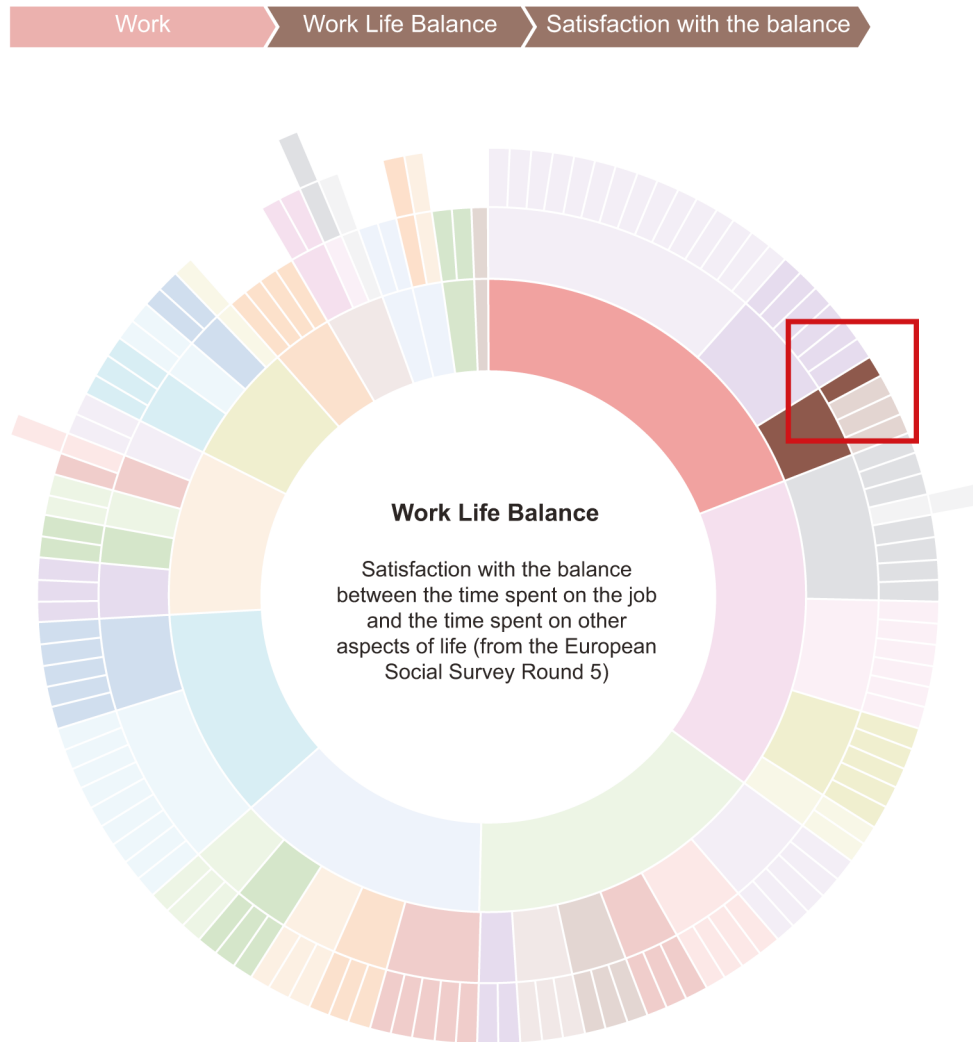


Figure E.2—Well-being Indicators Exploration Tool

E.5 Notional example for WIA Activity 5 (5.5)

An AI startup has just launched an autonomous vehicle (AV) user app, DriverHealth, that monitors the driver's fatigue and alertness via integrated state-of-the-art biosensing systems. The data is used to alert drivers and prevent accidents. A product utilization analysis as part of the data collection plan has produced some evidence that some users feel increased discomfort and anxiety as a result of being reminded of their lack of sleep and potentially dangerous behavior behind the wheel. As a result, the A/IS creators work with a group of concerned users and redesign how alert messages are sent to reduce unintended negative impacts. They add indicators for anxiety, sleep, and sense of comfort while driving to their well-being indicators dashboard.

Annex F

(informative)

Managerial adoption guidance

This annex provides suggestions for managerial adoption of IEEE Std 7010. It outlines roles and responsibilities for functions within organizations. It is optimal when using IEEE Std 7010 that there is support from all levels of an organization (e.g., executive, managers, and employees).

Regardless of their size and organizational structure, an organization should strive to create an environment where all departments are collaboratively involved in the WIA process and intergroup cooperation is supported and rewarded. In small organizations, such as start-ups, small entrepreneurial enterprises, or research projects, the use of IEEE Std 7010 is conceivable as organic, and responsibilities to implement IEEE Std 7010 are met without designating roles. In larger organizations, it is likely be helpful to assign roles and responsibilities.

This annex is intended to support the achievement of such collaboration and cooperation within businesses (Table F.1) and government (Table F.2).

Table F.1—Managerial adoption guidance for businesses

Managerial roles and responsibilities for business	
Role/Function	Key Responsibilities
Administrative Department	
Top Management/C-Suite (Chief Executive Officer, President, etc.)	Gives approval and provides support
	Appoints a senior level role (i.e., A/IS ombudsperson, Corporate Responsibility Officer, Chief Social Responsibility Officer, Chief Values Officer, Brand Safety Manager, CMO/legal/risk management)
	Determines responsibilities for roles appointed
	Approves allocation of resources for implementation of IEEE Std 7010 (money, time, personnel, etc.)
Senior Responsible Person (or other senior level role such as VP, etc.)	Takes responsibility internally for implementation
	Develops training program
	Determines who takes the training program
	Trains staff
	Aids in developing role and responsibility descriptions
	Allocates resources for implementation
	Facilitates the process of implementing IEEE Std 7010 within a project
	Facilitates collaboration and cooperation between projects and among departments
	Resolves disputes and helps ensure consistency
	Acts as communication channel within the company
Strategist; Business Case Developer; Commercial Assessor	Speaks publicly about matters related to IEEE Std 7010
	Formulates company’s marketing and financial well-being strategy
	Identifies marketing and financial well-being benefits to the company
	Sets marketing and financial well-being goals, targets and key performance indicators
	Works with project/product managers and other departments for cooperation in well-being data collection and use

Table continues

Table F.1—Managerial adoption guidance for businesses (continued)

Managerial roles and responsibilities for business	
Role/Function	Key Responsibilities
Legal Department	Analyzes legal risks
	Works with Strategist to formulate risk management strategies and policies
	Advises all staff on risk strategies for legal risks
	Oversees sharing of well-being data within and externally to company
Human Resources	Formulates well-being benefits-based review, evaluation, compensation and reward system based on positive contributions to human well-being in addition to, or parallel to, monetary compensation based on profitability
	Compensation ideas: <ul style="list-style-type: none"> • Wellness days - paid leave for self-care • Allocation of time and resources for pursuing a project, market or concept of personal interest • Well-being credit in the form of gift coupons or other benefits • Recognition awards such as <i>Well-being Employee of the Week</i>
IT	Works with A/IS creators to implement well-being indicators dashboard
	Helps with indicator adaption and data collection
Finance Department	
Accounting	Reports on matters relevant to IEEE Std 7010 in shareholder reports and annual financial reports (similar to CSR reports)
	Accounts for resources allocated for implementation of IEEE Std 7010 (money, time, personnel, etc.)
Risk Managers	Analyzes financial, brand and other business-related risks
	Works with Legal and Strategist to formulate risk management strategies and policies
	Advises all staff on risk strategies for risks
Marketing Department	
PR	Communicates to the public about IEEE Std 7010
	Supports staff for communication within and externally
Advertising and Sales	Develops A/IS use instruction
	Collaborates in well-being data collection
Distribution	Works with A/IS creators to collect well-being data
Corporate Social Responsibility	Assists in stakeholder engagement for IEEE Std 7010 implementation
	Supports in writing WIA statement
	Reports to external stakeholders in cooperation with Accounting
Operations Department	
Chief Operations Officer (COO)	Issues internal letter of approval and support
	Allocates resources for implementation of IEEE Std 7010 (money, time, personnel, etc.)
	Reviews well-being impact statement

Table continues

Table F.1—Managerial adoption guidance for businesses (continued)

Managerial roles and responsibilities for business	
Role/Function	Key Responsibilities
Project managers, Product managers, High level designers	Oversees implementation of IEEE Std 7010
	Receives training for implementing IEEE Std 7010
	Trains team or helps ensure team is trained
	Devises goals, targets, KPIs for implementation of IEEE Std 7010 for the product or project
	Analyzes well-being data
	Writes up Well-being Impact Statement.
	Works with researchers who use data for research purpose (overseen by legal department)
Engineers, Programmers, Data miners and data scientist, Machine learning trainer, Hardware developers, Integrator, Software testers, Usability testers	Implements IEEE Std 7010
	Receives training for implementing IEEE Std 7010

Table F.2—Managerial adoption guidance for governmental agencies

Managerial roles and responsibilities for agencies	
Role/Function	Key Responsibilities
Departments	
Body of Authority such as a President, Minister, Governor, Mayor, Congress, etc.	Appoints or allocate responsibility to a designated administrative body, committee or lead person such as a minister, administrative head, as fits the government structure
	Appropriates funding for implementation and management of IEEE Std 7010
Designated administrative body, committee or lead person	Develops a communication strategy to educate governmental staff on the declaration of intent to adopt IEEE Std 7010
	Utilizes IEEE Std 7010 for A/IS related into policies, programs and projects
	Oversees operationalization of the policy changes, including funding and resource allocation for operationalization
	Creates and empowers committees to facilitate collaboration among various internal corporate areas as well as inter-agency collaboration, as needed and appropriate
	Works with Bodies with decision rights and Bodies with operational/ implementation rights and responsibilities

Table continues

Table F.2—Managerial adoption guidance for governmental agencies (continued)

Managerial roles and responsibilities for agencies	
Role/Function	Key Responsibilities
Bodies with decision rights (legal, procurement, financier, HR, etc.) and Bodies with Operational/ Implementation rights and responsibilities, (Analytics/Data/IT)	Develops training program
	Communicates about matters related to IEEE Std 7010
	Reviews compatibility of IEEE Std 7010 with the legislative framework
	Facilitates the process of implementing IEEE Std 7010 within a project
	Facilitates cohesive implementation of IEEE Std 7010 between bodies
	Creates job descriptions, expectations and reward systems
	Allocates resources for implementation of IEEE Std 7010, including access to expertise within, across, and outside the organization
	Reports and helps ensure transparency of information
A/IS creators	
Project managers, Product Managers High level designers Engineers, Programmers, Data miners and data scientist, Machine learning trainer, Hardware developers, Integrator, Software testers, Usability testers	Implements IEEE Std 7010

Annex G

(informative)

Bibliography

Bibliographical references are resources that provide additional or helpful material but do not need to be understood or used to implement this standard. Reference to these resources is made for informational use only.

[B1] Acosta, A.J. “What Governments Across The Globe Are Doing To Seize The Benefits Of Autonomous Vehicles.” Berkman Klein Center for Internet & Society at Harvard University July 2018.⁶⁶

[B2] Awad, E., S. Dsouza, R. Kim, J. Schulz, J. Henrich, A. Shariff, J.-F. Bonnefon, and I. Rahwan, “The Moral Machine experiment,” *Nature*, vol. 563, pp. 59–64, 24 October 2018.⁶⁷

[B3] Beck, K., et al. “Manifesto For Agile Software Development.”⁶⁸

[B4] Bobi-Rakova, “bobi-rakova/indicators-sunburst.” GitHub, March 14, 2019.⁶⁹

[B5] Bruce, P. and A. Bruce, *Practical Statistics for Data Scientists: 50 Essential Concepts*. Boston: O'Reilly Media, 2017.

[B6] BusinessDictionary.com. WebFinance.⁷⁰

[B7] Central Intelligence Agency, “Country Comparison: Distribution of Family Income—Gini Index” from *The World Fact Book*⁷¹

[B8] Centre for Bhutan Studies. *Gross National Happiness Indicators*.⁷²

[B9] Certified B-Corporations. B Lab.⁷³

[B10] Collins Dictionary.⁷⁴

[B11] Department of Health and Human Services, Centers for Disease Control and Prevention & National Institute for Occupational Health and Safety. “Fundamentals of Total Worker Health Approaches.”⁷⁵

[B12] Diener, E., *Assessing Well-Being: The Collected Works of Ed Diener*. Dordrecht: Springer, 2009.

[B13] Diener, E., “Subjective Well-Being,” *Psychological Bulletin*, vol. 95, no. 3, May 1984,⁷⁶

[B14] Dijkstra, L. and H. Poelman, *A harmonised definition of cities and rural areas: the new degree of urbanisation*. European Commission.⁷⁷

⁶⁶ Available at: <https://cyber.harvard.edu/publication/2018/what-governments-across-globe-are-doing-seize-benefits-autonomous-vehicles>

⁶⁷ Available at: <https://www.nature.com/articles/s41586-018-0637-6>

⁶⁸ Available at: <https://agilemanifesto.org/>

⁶⁹ Available at: <https://github.com/bobi-rakova/indicators-sunburst>

⁷⁰ Available at: <http://www.businessdictionary.com/>

⁷¹ Available at: <https://www.cia.gov/library/publications/the-world-factbook/rankorder/2172rank.html>

⁷² Available at: <http://www.grossnationalhappiness.com/>

⁷³ Available at: <https://bcorporation.net>

⁷⁴ Available at: <https://www.collinsdictionary.com/us/>

⁷⁵ Available at: https://www.cdc.gov/niosh/docs/2017-112/pdfs/2017_112.pdf

⁷⁶ Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2162125

⁷⁷ Available at: https://ec.europa.eu/regional_policy/en/information/publications/working-papers/2014/a-harmonised-definition-of-cities-and-rural-areas-the-new-degree-of-urbanisation

- [B15] Ericson, W., *Performance Dashboards: Measuring, Monitoring and Managaing Your Business*. Hoboken, NJ: John Wiley and Sons, 2011.
- [B16] European Commission's minimum data set of European mental health indicators, 1998.⁷⁸
- [B17] European Parliament. *European Parliament Regulation (EU) 2016/679 General Data Protection Regulation (GDPR)*.⁷⁹
- [B18] *European Social Survey*.⁸⁰
- [B19] *European Social Survey. Personal and Social Well-Being (ESS3 2006, ESS6 2012)*.⁸¹
- [B20] *European Social Survey Round 5 Work Family Well-being Module*.⁸²
- [B21] Eurostat. *Income and living standards—Overview*.⁸³
- [B22] Eurostat. *Lifelong learning*.⁸⁴
- [B23] *Financial Times—Work-Life Balance*,⁸⁵
- [B24] *Freedom in the World 2016: The Annual Survey of Political Rights and Civil Liberties*. New York: Freedom House, 2016.⁸⁶
- [B25] Frey, B. and S. Luechinger, *Concepts of Happiness and Their Measurement*. Marburg: Metropolis-Verlag, 2007.
- [B26] *Food and Agriculture Organization of the United Nations*.⁸⁷
- [B27] Glanz, K., B. K. Rimer, and K. Viswanath, eds. *Health Behavior: Theory, Research, and Practice*. San Francisco: Jossey-Bass, 2015.
- [B28] *The Global Reporting Initiative*.⁸⁸
- [B29] Graham, C., *Happiness Around the World: The Paradox of Happy Peasants and Miserable Millionaires*. Oxford, UK: Oxford University Press, 2009.
- [B30] Hasso Plattner Institute of Design at Stanford, *An Introduction to Design Thinking Process Guide*.
- [B31] Helliwell, J., R. Layard, and J. Sacks, eds. *World Happiness Report 2020*. New York: Sustainable Development Solutions Network, 2020.⁸⁹
- [B32] Hoekema, D. A. and T. Ehrlich, “Civic Responsibility and Higher Education,” *Academe*, vol. 86, no. 5, September–October 2000.

⁷⁸ Available at: https://ec.europa.eu/health/ph_projects/1998/monitoring/fp_monitoring_1998_annexe2_09_en.pdf

⁷⁹ Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02016R0679-20160504>

⁸⁰ Available at: <https://www.europeansocialsurvey.org/>

⁸¹ Available at: <http://www.europeansocialsurvey.org/data/themes.html?t=personal/>

⁸² Available at: https://www.europeansocialsurvey.org/docs/round5/questionnaire/ESS5_final_work_family_wellbeing_module_template.pdf

⁸³ Available at: <https://ec.europa.eu/eurostat/web/income-and-living-conditions/>

⁸⁴ Available at: https://www.un.org/esa/sustdev/natlinfo/indicators/methodology_sheets/education/life_long_learning.pdf

⁸⁵ Available at: <https://www.ft.com/stream/e60f876f-efa4-45fc-9880-2c783aa4ad08>

⁸⁶ Available at: https://freedomhouse.org/sites/default/files/2020-02/Freedom_in_the_World_2016_complete_book.pdf

⁸⁷ Available at: <http://www.fao.org/home/en/>

⁸⁸ Available at: <https://www.globalreporting.org/>

⁸⁹ Available at: <https://worldhappiness.report/>

- [B33] Hoffman, R.R., S.T. Mueller, G. Klein, and J. Litman, “Metrics for Explainable AI: Challenges and Prospects.” arXiv.org. Cornell University, February 1, 2019.⁹⁰
- [B34] Huppert, F.A. “Psychological Well-Being: Evidence Regarding Its Causes and Consequences.” Wiley Online Library. John Wiley & Sons, Ltd (10.1111), March 9, 2009.⁹¹
- [B35] Huppert, F. A. and T. C. So, “Flourishing Across Europe: Application of a New Conceptual Framework for Defining Well-Being,” *Social Indicators Research*, vol. 100, no. 3, pp. 837–861, 2013.⁹²
- [B36] IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, *Ethically Aligned Design*, 1st Ed. Piscataway, NJ: IEEE Standards Association, 2019.^{93,94}
- [B37] IEEE Std 1517-2010, IEEE Standard for Information Technology—System and Software Life Cycle Processes—Reuse Processes.
- [B38] “IPCC, 2012: Glossary of Terms.” In *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*, edited by Field, Christopher B., Barros, Vicente, Stocker, Thomas F., Dahe, Qin, Jon Dokken, David, Ebi, Kristie L., Mastrandrea, Michael D., Mach, Katharine, J., Plattner, Gian-Kasper, Allen, Simon K., Tignor, Melinda, Midgley, Pauline, M., 555–564, Cambridge: Cambridge University Press, 2012, pp. 555–564.⁹⁵
- [B39] ISO 9001:2015, Family: Quality Management Standards.⁹⁶
- [B40] ISO/IEC/IEEE 2475: Systems and software engineering—Vocabulary.⁹⁷
- [B41] ISO/IEC/IEEE 12207:2017, Systems and software engineering—Software life cycle processes.
- [B42] ISO/IEC/IEEE 15288, Systems and software engineering—System life cycle processes.
- [B43] Johnson, K.. “Redefinition of the BEA Economic Areas.” *Survey of Current Business*, February 1995, pp. 75–81..⁹⁸
- [B44] Kailas, A., C.-C. Chong, and F. Watanabe, “From Mobile Phones to Personal Wellness Dashboards,” *IEEE Pulse*, vol. 1, no. 1, pp. 57–63, July–August 2010.
- [B45] Keyes, C.L.M. “Flourishing.” *The Corsini Encyclopedia of Psychology*, January 30, 2010. Wiley Online. Library.⁹⁹
- [B46] Kim, J. and J. Canny, “Interpretable Learning for Self-Driving Cars by Visualizing Causal Attention.” arXiv.org. Cornell University, March 30, 2017.¹⁰⁰
- [B47] Lehmann, E. L. and J. P. Romano, *Testing Statistical Hypotheses*, 3rd Ed. New York: Springer, 2005.¹⁰¹

⁹⁰Available at: <https://arxiv.org/abs/1812.04608>

⁹¹Available at: <https://onlinelibrary.wiley.com/doi/full/10.1111/j.1758-0854.2009.01008.x>

⁹²Available at: <http://dx.doi.org/10.1007/s11205-011-9966-7>

⁹³The IEEE standards or products referred to in this clause are trademarks of The Institute of Electrical and Electronics Engineers, Inc.

⁹⁴IEEE publications are available from The Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (<http://standards.ieee.org/>).

⁹⁵Available at: https://archive.ipcc.ch/pdf/special-reports/srex/SREX-Annex_Glossary.pdf

⁹⁶Available at: <https://www.iso.org/iso-9001-quality-management.html>

⁹⁷ISO/IEC publications are available from the ISO Central Secretariat (<http://www.iso.org/>). ISO/IEC publications are available in the United States from the American National Standards Institute (<http://www.ansi.org/>)

⁹⁸Available at: <https://apps.bea.gov/scb/pdf/regional/PROJ/1995/0295rea.pdf>

⁹⁹Available at: <https://onlinelibrary.wiley.com/doi/abs/10.1002/9780470479216.corpsy0363>

¹⁰⁰Available at: <https://arxiv.org/abs/1703.10631>

¹⁰¹Available at: <https://www.springer.com/gp/book/9780387988641>

- [B48] Lexico.com. Dictionary.com and Oxford University Press.
- [B49] Malik, S., *Enterprise Dashboards: Design and Best Practices for IT*. Hoboken, NJ: John Wiley and Sons, 2005.
- [B50] Manning, N. and D. L. Wetzel, “Tales of the Unexpected: Rebuilding Trust,” in *The Day After Tomorrow: A Handbook on the Future of Economic Policy in the Developing World*, Canuto, O. and M. Giugale, eds. Washington, D.C.: World Bank, 2010, pp. 163–179.¹⁰²
- [B51] Mantei, M. M. and T. J. Teorey, “Cost/benefit analysis for incorporating human factors in the software lifecycle,” *Communications of the ACM*, vol. 31, no. 4, pp. 428–439, January 1988.¹⁰³
- [B52] McMillan, D. W. and D. M. Chavis, “Sense of community: A definition and theory,” *Journal of Community Psychology*, vol. 14, no. 1, pp. 6–23, January 1986.¹⁰⁴
- [B53] Mental Health Commission New South Wales, *Physical health and mental wellbeing: evidence guide*. Sydney: Mental Health Commission of NSW, 2016.¹⁰⁵
- [B54] MITRE Corporation & University of Vermont Complex Systems Center. “The Hedonometer.”¹⁰⁶
- [B55] MoneyZine.com, “work environment.”¹⁰⁷
- [B56] Ofstad, S., L. Westly, and T. Bratelli, *Symposium: sustainable consumption: 19–20 January 1994: Oslo, Norway*. Oslo: Norwegian Ministry of Environment, 1994.
- [B57] Olszewska, J. I., M. Houghtaling, P. Gonçalves, T. Haidegger, N. Fabiano, J. L. Carbonera, S. R. Fiorini, and E. Prestes, “Robotic Ontological Standard Development Life Cycle” *IEEE International Conference on Robotics and Automation 2018: Workshop on Elderly Care Robotics, Technology and Ethics*. 2018.¹⁰⁸
- [B58] Organisation for Economic Co-Operation and Development (OECD). “Better Life Index.”¹⁰⁹
- [B59] Organization of Economic Cooperation and Development (OECD), *Glossary of Statistical Terms*.¹¹⁰
- [B60] Organisation for Economic Co-Operation and Development (OECD). “Going Digital.”¹¹¹
- [B61] Organisation for Economic Co-Operation and Development (OECD). “Hello World: Artificial Intelligence and its use in the public sector.”¹¹²
- [B62] Organisation for Economic Co-operation and Development (OECD). *How's Life in the Digital Age?: Opportunities and Risks of the Digital Transformation for People's Well-being*.¹¹³
- [B63] Organisation for Economic Co-operation and Development (OECD). “Measuring the Digital Transformation: A Roadmap for the Future.”¹¹⁴

¹⁰²Available at: http://siteresources.worldbank.org/EXTPREMNET/Resources/C9TDAT_161-180.pdf

¹⁰³Available at: <https://doi.org/10.1145/42404.42408>

¹⁰⁴Available at: <https://onlinelibrary.wiley.com/doi/abs/10.1002/1520-6629%28198601%2914%3A1%3C6%3A%3AAID-JCOP2290140103%3E3.0.CO%3B2-I>

¹⁰⁵Available at: <https://nswmentalhealthcommission.com.au/resources/physical-health-and-mental-wellbeing-an-evidence-guide>

¹⁰⁶Available at: <http://hedonometer.org/>

¹⁰⁷Available at: <https://www.money-zine.com/definitions/career-dictionary/work-environment>

¹⁰⁸Available at: http://real.mtak.hu/86419/1/WELCARO-2018_paper_17.pdf

¹⁰⁹Available at: <http://www.oecdbetterlifeindex.org/>

¹¹⁰Available at: <https://stats.oecd.org/glossary/index.htm>

¹¹¹Available at: <http://www.oecd.org/going-digital>

¹¹²Available at: <https://oecd-opsi.org/wp-content/uploads/2019/11/AI-Report-Online.pdf>

¹¹³Available at: <https://doi.org/10.1787/9789264311800-en>

¹¹⁴Available at: <https://www.oecd.org/going-digital/measuring-the-digital-transformation-9789264311992-en.htm/>

[B64] Organisation for Economic Co-Operation and Development (OECD). “Measuring Well-being and Progress: Well-being Research.”¹¹⁵

[B65] Organisation for Economic Co-Operation and Development (OECD). OECD Guidelines On Measuring Subjective Well-Being.¹¹⁶

[B66] Orr, M. G., C. Lebiere, A. Stocco, P. Pirolli, B. Pires and W.G. Kennedy. “Multi-scale Resolution of Cognitive Architectures: A Paradigm for Simulating Minds and Society.” *Social, Cultural, and Behavioral Modeling Lecture Notes in Computer Science*, vol. 10899, 14 June 2018. Pp. 3–15.¹¹⁷

[B67] Ovaska, T. and R. Takashima, “Economic policy and the level of self-perceived well-being: An international comparison,” *Journal of Socio-Economics*, vol. 35, no. 2, pp. 308–325, April 2006.¹¹⁸

[B68] Oxford English Dictionary, Oxford University Press.¹¹⁹

[B69] Pavot, W. and E. Diener, “The affective and cognitive context of self-reported measures of subjective well-being,” *Social Indicators Research*, vol. 28, no. 1, pp. 1–20, January 1993.¹²⁰

[B70] Pavot, W. and E. Diener, “Review of the Satisfaction With Life Scale,” *Psychological Assessment*, vol. 5, no. 2, pp. 164–172, 1993.¹²¹

[B71] Pavot, W., E. Diener, C. R. Colvin, and E. Sandvik, “Further Validation of the Satisfaction With Life Scale: Evidence for the Cross-Method Convergence of Well-Being Measures,” *Journal of Personality Assessment*, vol. 57, no. 1, pp. 149–161, 1991.¹²²

[B72] Pearl, J. and D. Mackenzie, *The Book of Why: The New Science of Cause and Effect*. New York: Basic Books.

[B73] Penn Positive Psychology Center. “World Well-Being Project.”¹²³

[B74] Peterson, C. and M.E.P. Seligman, *Character Strengths and Virtues: A Handbook and Classification*. Washington, D.C.: APA Press and Oxford University Press, 2004.

[B75] Picard, R. W., “Affective Computing,” M.I.T Media Laboratory Perceptual Computing Section Technical Report 321, 1997.¹²⁴

[B76] Rodriguez, F. and E. J. Wilson III, “Are Poor Countries Losing the Information Revolution?” *mfoDev Working Paper*. Washington D.C: World Bank, May 2000.¹²⁵

[B77] Ryff, C. D. and B. Singer, “The Contours of Positive Human Health,” *Psychological Inquiry*, vol. 9, no. 1, pp. 1–28, 1998.¹²⁶

[B78] Safe Communities Foundation NZ. “What Is a Safe Community.”¹²⁷

¹¹⁵Available at: <https://www.oecd.org/statistics/measuring-well-being-and-progress.htm/>

¹¹⁶Available at: <https://doi.org/10.1787/9789264191655-en>

¹¹⁷Available at: https://doi.org/10.1007/978-3-319-93372-6_1

¹¹⁸Available at: <https://doi.org/10.1016/j.socec.2005.11.054>

¹¹⁹Available at: <https://www.oed.com>

¹²⁰Available at: <https://doi.org/10.1007/bf01086714>

¹²¹Available at: <https://doi.org/10.1037/1040-3590.5.2.164>

¹²²Available at: https://doi.org/10.1207/s15327752jpa5701_17

¹²³Available at: <http://wwbp.org/>

¹²⁴Available at: <https://affect.media.mit.edu/pdfs/95.picard.pdf>

¹²⁵Available at: <http://documents.worldbank.org/curated/en/600361468762019045/Are-poor-countries-losing-the-information-revolution>

¹²⁶Available at: https://doi.org/10.1207/s15327965pli0901_1

¹²⁷Available at: <https://www.safecommunities.org.nz/about-us/about-us>

- [B79] Seeman, T., Support & Social Conflict: Section One—Social Support. MacArthur Foundation, 2008.¹²⁸
- [B80] Smith, T., P. Marsden, M. Hout, and J. Kim, General social surveys, 1972–2012 [cumulative file] Ann Arbor, MI: Inter-University Consortium for Political and Social Research, 2013.¹²⁹
- [B81] Stanford Encyclopedia of Philosophy. “Social Institutions.”¹³⁰
- [B82] The Social Progress Imperative. “Social Progress Index.”¹³¹
- [B83] Umwelt Bundesamt. “Indicator: Greenhouse Gas Emissions.”¹³²
- [B84] UNESCO Convention against Discrimination in Education (1960) and Articles 13 and 14 (Right to Education) of the International Covenant on Economic, Social and Cultural Rights: a comparative analysis.¹³³
- [B85] UNESCO, “Universal Declaration on Cultural Diversity.”¹³⁴
- [B86] UNESCO. “TVETipedia Glossary.”¹³⁵
- [B87] United Kingdom Office for National Statistics. “Measures of National Well-being Dashboard.”¹³⁶
- [B88] United Nations, Mobilizing Sustainable Transport for Development. New York: United Nations, 2016.¹³⁷
- [B89] United Nations. “Sustainable Development Goals: Goal 12: Ensure Sustainable Development and Consumption Patterns.”¹³⁸
- [B90] United Nations. “Sustainable Development Goals Knowledge Platform.”¹³⁹
- [B91] United Nations. “Sustainable Development Goals Indicators.”¹⁴⁰
- [B92] United Nations. “World Soil Day 5 December.”¹⁴¹
- [B93] United Nations Conference on Trade and Development. “Information and Communication Technology Development Indices.” 2003.¹⁴²
- [B94] United Nations Convention on Biological Diversity, 1992.¹⁴³
- [B95] United Nations Development Programme. “Human Development Index (HDI)”¹⁴⁴
- [B96] United Nations Human Rights Office of the High Commissioner. “The Right to Adequate Housing Toolkit.”¹⁴⁵

¹²⁸ Available at: <https://macses.ucsf.edu/research/psychosocial/socsupp.php>

¹²⁹ Available at: http://people.wku.edu/douglas.smith/GSS%201972_2012%20Codebook.pdf

¹³⁰ Available at: <https://plato.stanford.edu/entries/social-institutions/>

¹³¹ Available at: <https://www.socialprogress.org>

¹³² Available at: <https://www.umweltbundesamt.de/en/indicator-greenhouse-gas-emissions#textpart-1>

¹³³ Available at: <https://unesdoc.unesco.org/ark:/48223/pf0000145922>

¹³⁴ Available at: http://portal.unesco.org/en/ev.php-URL_ID=13179&URL_DO=DO_TOPIC&URL_SECTION=201.html

¹³⁵ Available at: <https://unevoc.unesco.org/go.php?q=TVETipedia+Glossary>

¹³⁶ Available at: <https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/articles/measuresofnationalwellbeingdashboard/2018-09-26>

¹³⁷ Available at: <https://sustainabledevelopment.un.org/content/documents/2375Mobilizing%20Sustainable%20Transport.pdf>

¹³⁸ Available at: <http://www.un.org/sustainabledevelopment/sustainable-consumption-production>.

¹³⁹ Available at: <https://sustainabledevelopment.un.org/sdgs>

¹⁴⁰ Available at: <https://unstats.un.org/sdgs/indicators/indicators-list>

¹⁴¹ Available at: <http://www.un.org/en/events/soilday>

¹⁴² Available at: http://unctad.org/en/docs/iteipc20031_en.pdf

¹⁴³ Available at: <https://www.cbd.int/doc/legal/cbd-en.pdf>

¹⁴⁴ Available at: <http://hdr.undp.org/en/content/human-development-index-hdi>

¹⁴⁵ Available at: <http://www.ohchr.org/EN/Issues/Housing/toolkit/Pages/RighttoAdequateHousingToolkit.aspx>

- [B97] United Nations Human Rights Office of the High Commissioner. “What Are Human Rights?”¹⁴⁶
- [B98] United States Department of Transportation. “Automated Driving Systems 2.0: A Vision For Safety.”¹⁴⁷
- [B99] US Aid Food and Nutrition Technical Assistance (Fanta) Project, “Household Food Insecurity Access Scale (HFAS) for Measurement of Food Access: Indicator Guide.”¹⁴⁸
- [B100] Verbert, K., E. Duval, J. Klerkx, S. Govaerts, and J. Santos, “Learning Analytics Dashboard Applications,” *American Behavioral Scientist*, vol. 57, no. 10, pp. 1500–1509, 28 February 2013.¹⁴⁹
- [B101] Visual-Question-Answering.¹⁵⁰
- [B102] von Schirnding, Y., “Construction of Indicators,” in *Health in Sustainable Development Planning: The role of indicators*. Geneva, Switzerland: World Health Organization; Chapter 4.¹⁵¹
- [B103] Wikipedia, “Governmental agency.”¹⁵²
- [B104] Willard, B., *The Sustainability Advantage: Seven Business Case Benefits of a Triple Bottom Line*. Duncan, Canada: New Society Publishers.
- [B105] World Commission on Environment and Development, *Our Common Future*. Suffolk, EN: Oxford University Press, 1987.
- [B106] *World Happiness Report*.¹⁵³
- [B107] World Health Organization, “Constitution of the World Health Organization,” in *Basic Documents*, 45th Ed., Supplement, October 2006.¹⁵⁴
- [B108] World Health Organization. “Mental Health.”¹⁵⁵
- [B109] World Health Organization, WHOQOL-HIV instrument. Geneva, Switzerland; 2002.¹⁵⁶
- [B110] World Health Organization. *World health organization global reference list of 100 core indicators*, 2015.¹⁵⁷
- [B111] World Values Survey. WVS Wave 6 (2010–2014).¹⁵⁸
- [B112] World Well-Being Project.¹⁵⁹
- [B113] Yigitbasioglu, O. and O. Velcu, “A review of dashboards in performance management: Implications for design and research,” *International Journal of Accounting Information Systems*, vol. 13, no. 1, pp. 41–59, March 2012.¹⁶⁰

¹⁴⁶Available at: <http://www.ohchr.org/EN/Issues/Pages/WhatareHumanRights.aspx>

¹⁴⁷Available at: https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf

¹⁴⁸Available at: <https://www.fantaproject.org/monitoring-and-evaluation/household-food-insecurity-access-scale-hfias>

¹⁴⁹Available at: <https://journals.sagepub.com/doi/abs/10.1177/0002764213479363>

¹⁵⁰Available at: <https://visualqa.org/index.html>

¹⁵¹Available at: <https://www.who.int/mediacentre/events/IndicatorsChapter4.pdf>

¹⁵²Available at: https://en.wikipedia.org/wiki/Government_agency

¹⁵³Available at: <http://worldhappiness.report>

¹⁵⁴Available at: https://www.who.int/governance/eb/who_constitution_en.pdf

¹⁵⁵Available at: https://www.who.int/features/factfiles/mental_health/en

¹⁵⁶Available at: https://apps.who.int/iris/bitstream/handle/10665/77774/WHO_MSD_MER_Rev.2012.01_eng.pdf;jsessionid=6EC1B95B984C8169292527D154BE2C83?sequence=1

¹⁵⁷Available at: <https://www.who.int/healthinfo/indicators/2015/en/>

¹⁵⁸Available at: <http://www.worldvaluessurvey.org/WVSDocumentationWV6.jsp>






¹⁵⁹Available at: <http://wwbp.org/about.html>

¹⁶⁰Available at: <http://doi.org/10.1016/j.accinf.2011.08.002>



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