



International
Institute of Information
Technology Bangalore

Ethical Assessment Framework for IoT/AI Solutions in Health

July 2025



Centre for Internet of
Ethical Things (CIET)
IIIT-Bangalore

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Preface

This policy brief is an outcome of a research study that was carried out for a period of one year, funded by the Government of Karnataka. This research was part of a project that is the result of a tripartite agreement entered between IIIT-Bangalore, the Government of Karnataka, and the World Economic Forum. The objectives of this project are multi-fold and call for both technical and policy research at the intersection of Ethics and Internet of Things (IoT/AI) in the following application domains – Smart cities, Healthcare and Agriculture. The project is planned with different teams at IIIT-B working on various technical and policy aspects.

The following work is based on the policy strand of this project which in the second year focused on building an ethical assessment framework for IoT/AI interventions in one of the said application domains: digital health. Through the policy strand we also, for the long term, plan to contextualize research output from other technical teams working on the project.

For feedback and more information on the effort, please write to ciet-admin@iiitb.ac.in

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Acknowledgements

We thank our interview respondents from academia and industry who provided valuable inputs for developing the ethical assessment framework to be used for evaluating automated and autonomous technologies in healthcare service delivery. We are also grateful for the reviews and inputs that we received from the participants of the stakeholders' meet held in December 2024. We thank the Secretary, Managing Director, General Manager, and other representatives of the Department of Electronics, Information Technology and Biotechnology, Government of Karnataka and officials from the World Economic Forum for their continued support to CIET. We acknowledge the valuable contributions of the advisory committee members and other governing committee members of CIET. We also thank the Director and departmental officials at the Karnataka Digital Health Society (KDHS). KDHS offered their insights into ongoing strategies for digital health interventions and allowed us to carry out collaborative capacity-building sessions. We hope that the findings of this research and the collaborative efforts that were undertaken enrich the landscape of digital health within Karnataka in the near future.

Overview

Objective

In this report, we have arrived at a contextually adaptable ethical assessment framework that can be used by decision makers to evaluate the technologies within the domain of healthcare.

Our objective here was to examine the contextual realities around digital health interventions from an ethical point of view. This framework is expected to offer guidelines for the ethical governance of digital health.

We do so by looking at four main ethical dimensions: **Justice & Equity, Fairness, Trust & Consent and Dignity of life and work.**

Methodology

To arrive at this framework, we relied on an extensive literature review, semi-structured interviews with important stakeholders from the industry, academia, and the government. We also spoke to frontline workers and target beneficiaries (patients) and visited Primary Health Centres (PHCs) and Sub Centres to understand existing practices around digital health interventions.

We also looked at policy guidelines offered by international agencies, reports, tenders, project proposals, and policies around the evaluation of health technologies and other such interventions.

Against this backdrop, the role of the ethical framework developed is twofold:



To equip decision-makers with the capacity to evaluate any IoT/AI-intervention in a way that does not require extensive technical understanding of the IoT/AI-intervention's inner workings.



To ensure that all relevant agents who are participating in the delivery of a particular service are acknowledged. Through this, authorities will also be able to gauge the potential impact the IoT/AI-intervention might have on such agents within the digital health ecosystem.

The Case of Digital Health

Health systems witness an intricate interaction between heterogeneous actors, both human and non-human actors, demanding feedback pathways for their responsive action. Collaborative teamwork in itself is a complex process allowing for a set of diversified actors to share their capabilities in achieving a common goal (Textor et al., 2022). Additionally, they function in the social context with intricate connections of multiple systems. Such systemic interactions are essentially influenced and shaped by the culture, tradition, socioeconomic context, environmental factors and legal and regulatory contexts (WEF, 2024). When faced with such dynamic circumstances, systems exhibit capabilities to self-organise and evolve to adapt to the changing local context and global requirements, showing unpredictable emergent behaviours (Braithwaite et al., 2018). Given this background, it is important to understand that digital health is a continuously changing landscape. It is context-specific and needs a clear vision to move from pilot interventions to scaled implementation. For this, we mapped existing principles of bioethics to four derived ethical values.

Ethical Dimensions in Digital Health

Principles of Bioethics

Justice



Equity

Explicability



Fairness

Beneficence



Trust

Non-maleficence

Autonomy



Dignity of Life and Work

Equity	Equity as a derived value of the principles of justice 1) to understand the opportunities and challenges for end users from accessing and availing the rightful and intended services 2) to understand the opportunities and challenges for the actors in multi-sectoral services
Fairness	Fairness as a derived value of the principle of explicability given by Floridi et al., (2018)* in terms of three primary constructs: system explainability, transparency, and reviewability, essential to ethically ensure equity and just outcomes.
Dignity	Dignity as a derived value of autonomy in along two prongs – self dignity and social dignity, both of which become essential to see how the system is experienced by those that it is meant for.
Trust	Trust as a value that bestows a degree of assurance to users and providers based on security, privacy, and accountability, as well as a degree of confidence arising from dependability and reliability on entities that need to work coherently to complete a certain task or service.

*Floridi, L., Cows, J., Beltrametti, M., Chatila, R., Chazerand, P., Dignum, V., ... & Vayena, E. (2018). AI4People—An ethical framework for a good AI society: Opportunities, risks, principles, and recommendations. *Minds and machines*, 28(4), 689-707.

Consolidated Ethical Assessment: For Evaluators and Decision Makers

Who should use it?

The ethical elicitation made by the technology developer/entrepreneur (applicant) needs to be evaluated by the High-level Committee members (HLC) from a legislative and executive point of view and by the Technical Assessment Committee members (TAC) from a technical standards and compliance point of view. This can also be used by the Health Technology Assessment (HTA) centres.

How should it be used?

The following tables provide an in-depth view of how responses elicited should be evaluated by the decision makers. Here, each question presented to the technology developers/entrepreneurs who are applicants is mapped against the respective ethical values of equity (E), fairness (F), dignity (D) and trust (T). For the purposes of this report, this has been indicated at the end of each question with vertical bars | |.

Note: The questions presented in the framework below are the outcome of an extensive **ethical elicitation process** that has been carried out by CIET. While the agencies engage in the activities recommended above, they may use the suggested questions from the framework and come up with more concrete technical and procedural requirements that may need to be adopted to mitigate any potential ethical concerns from IoT/AI interventions related to Justice, Trust, Fairness, and Dignity for their specific use-case.

Operationalising Ethics in Digital Health

Who is this meant for?

The tables in this section are presented to those who are enlisting their technological product/services in response to a tender/expression of interest prompt. Each table evaluates the level of preparedness on the technology developer's/entrepreneur's part (the applicant). This would in turn indicate the ethical considerations that foreground the technology being proposed.

Project Description and Scope

We propose that the evaluation begin with a set of scoping questions (those which were also arrived at from our findings and marked as G1, G2 and so on, which reflects attributes along all four ethical dimensions) that are to be answered in the early stages of any intervention. These questions broadly help understand:

- the purpose behind an intervention
- the existing gaps that it is meant to address
- the technological means to address such gaps
- the potential impact of the intervention

Questions on Overview of the Project

- What is the intent behind your intervention? (Describe your problem statement here) philosophy, positionality and how this intervention reflects your worldview) |G1|
- How did you arrive at the objectives of your proposed technological intervention (Mention the gaps that you are addressing and the primary driving factors for doing so) |G2|
- How does your organisational vision, mission, and value systems align with the proposed/deployed intervention? |G3|

Assessing Functional Overview

Specify where does your intervention fit in in terms of levels of automation/autonomy.

(Drawn from Parasuraman et, al. (2000)*)

- Level 10: Computer Decides everything, human out of the loop
- Level 9: Computer informs human, only if it decides to
- Level 8: Informs the human only if asked
- Level 7: Executes automatically, then necessarily informs the human
- Level 6: Allows human a restricted time to veto before execution
- Level 5: Executes that suggestion if human asks
- Level 4: Suggests one alternative
- Level 3: Narrows the selection to a few
- Level 2: Machine offers a complete set of alternatives
- Level 1: Machine offers no assistance, human takes all decisions

Specify which stage is your intervention in? (Select multiple if applicable).

- Stage 1: Conceptualisation
- Stage 2: Knowledge Translation and Development
- Stage 3: Service Delivery Environment
- Stage 4: Sustainability and Scalability

Specify the level of interdependencies

- Restricted to individual clinical settings
- Interdepartmental
- Interorganisational
- Multi-sectoral, specify the sectors involved

Specify the target population

- Paediatric (Upto 13 years of age)
- Geriatric (Above 65 years of age)
- Adolescent (Between 13 and 18 years of age)
- Pregnant and lactating mothers
- Terminally ill
- Other underrepresented groups (Justify)

The following sections outline a framework to evaluate the IoT/AI intervention stage-wise.

*Parasuraman, R., Sheridan, T. B., & Wickens, C. D. (2000). A model for types and levels of human interaction with automation. IEEE Transactions on systems, man, and cybernetics-Part A: Systems and Humans, 30(3), 286-297.

CONCEPTUALISATION

Leading to the initiation of the digital health solution, four major areas deserve attention- the guiding purpose behind the technology, primary driving factors, the nature of partnership or collaboration and the targeted population or the site of action are key. An in-depth understanding of the need for a technology, choices of services, site of action, target population are useful in contextually tracing the origin points of processes within the life cycle of a digital health intervention.

Purpose - Unpacking what guides the technological intervention

Aim & objectives	What is the intent behind your intervention? G1
Understanding of Technology	Explain your understanding of the software/model that your technological intervention is built on. (Here, please elaborate on the working principles that guide your technology design and development.) F1
Motivations	How did you arrive at the objectives of your proposed technological intervention (Mention the gaps that you are addressing and the primary driving factors for doing so) G2
Organisational characteristics	How does your organisational vision, mission, and value systems align with the proposed/deployed intervention? G3

Driving factors defining the technological intervention

Mapping Stakeholders	Who are your envisioned stakeholders? How was the stakeholder mapping carried out? E1
Prior experience	How do you see your prior experience (if any, either in engaging with relevant stakeholders or in relevant contexts) invoking the degree of confidence and assurance amongst stakeholders? (Share your organisational strengths, reflect on the primary driving factors you have detailed for, both digital and non-digital settings) T1

Collaborating to Understand

Creating a collaboration eco system of shared goals	How do you define the roles and responsibilities of the collaborating stakeholders to arrive at consensus in achieving the shared goal? E2 What mechanisms are envisioned to listen to the voices of the identified stakeholders /offer alternate channels to respond before committing to collaborate of the collaborating stakeholders? E3
Know-how of the embedded context	What measures are in place to capture the functional and local context understandings amongst the collaborating stakeholders? F2
Capability Mapping	What are your stakeholders' existing capabilities? D1 What are the new capabilities expected with the introduction of your intervention? D2 How are they rewarded for the additional tasks or compensated for any laid off opportunities? D3

Collaborating to Understand (Contd.)

Channels of feedback	What are the existing dependability and accountability mechanisms within the collaborating ecosystem? (Detail out the vertical and horizontal hierarchies involved and the existing reporting channels.) T2
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End Beneficiaries

Direct and indirect beneficiaries	<p>How did you identify the direct and indirect beneficiaries? E4 </p> <p>How do you plan to maximise the reach to your target beneficiaries? E5 </p> <p>How are the affordability factors taken into consideration to include maximum reach of the targeted beneficiaries? E6 </p>
Interim beneficiaries	What mechanisms are in place to include any interim beneficiaries? Here you may have to detail out your plans to include any new beneficiary or prospective beneficiaries that you may identify/emerge along the life-cycle of your intervention E7
Benefits and risks	<p>What are potential benefits that you foresee with the introduction of your technology? T3 </p> <p>What are the anticipated risks/adverse effects for the target beneficiaries that you anticipate? T4 </p> <p>How are potential risks to stakeholders on the ground taken into consideration? T5 </p>

KNOWLEDGE TRANSLATION AND DEVELOPMENT

Any choice to deploy technological solutions in healthcare would have to come with a) an accurate translation of domain-specific knowledge (both medical and technical) b) a mapping of the human actors and their existing work practices c) an outlining of new anticipated tasks for existing actors d) mapping of the new actors and the respective skills required (if any). Owing to these attributes, this stage of the IoT/AI intervention focuses on standard settings by evaluating technical specifications, globally accepted standards and the universally expected compliances of a system from an ethical point of view.

Arriving at Technical Specifications

Information from domain experts	<p>What methods were employed to capture the views of domain experts? E8 </p> <p>How are the views of domain experts incorporated into the planning of the design, development and deployment phases? F3 </p>
User research	<p>What methods were employed to gather perspectives of target beneficiaries (including those at the last-mile) E9 </p> <p>How are the views of target beneficiaries incorporated into the planning of the design, development and deployment phases? F4 </p>
Clinical Immersion	<p>What mechanisms were employed to capture the contextual dynamics of the stakeholder interactions? E10 </p> <p>How are the dynamic contextual requirements translated and incorporated through the design, development and deployment phases? F5 </p>
Organisational characteristics	<p>How does your organisational vision, mission, and value systems align with the proposed/deployed intervention? G3 </p>

Solution Design

Changing landscape and requirements of collaborators	What mechanisms have been thought of to make your technological intervention flexible and adaptable to changing requirements of collaborators? (Briefly describe the system configurability, compatibility and modularity) F6
Software philosophies	What software philosophies are considered best fit to accommodate such changes? Justify? (Philosophies like waterfall, agile, privacy by design) F7
Getting appropriate representativeness in data	What methods of data selection are used to ensure data representativeness? (Elaborate on sampling techniques, data weightages, augmentation, synthetic data generation (if any). Explain if bias and fairness audits were carried out to ensure transparent inclusion criteria and explainability of your code/model) F8
Managing Modularity	Elaborate on the new and existing modules (if any) of your technology stack. How easy or difficult is it to decouple and respond to the changing requirements without impacting other parts? F9

Development Process

Acknowledging the of real-time deployment challenges	What measures have been taken to ensure that your intervention is inclusive and accessible for target beneficiaries irrespective of their language, gender, disability, age, religion, class, caste, literacy (including digital literacy) and cultural values)? E11
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Development Process (Contd.)

<p>Acknowledging the of real-time deployment challenges</p>	<p>What kind of feedback mechanisms are you incorporating to account for differential use by target beneficiaries along the lines of gender, age, caste, class, disability, literacy level (including digital)? E12 </p> <p>What kind of feedback channels exist for the service providers including the last mile user group to effectively deliver the expected outcome? E13 </p> <p>What kind of accountability mapping and redressal mechanisms are being designed to take the stakeholders' voices into consideration in an inclusive manner? (Here, map who is accountable for what set of actions. Also provide details of any expected structural and functional deviations, particularly in the reporting process) T6 </p>
<p>Capturing the use error/user induced error</p>	<p>What are the known use errors and user induced error? What proactive measures are taken to rectify these? F10 </p>
<p>Regulation and Licensing</p>	<p>What are the regulatory bodies that you have sought/aim to seek approval from? F11 </p>
<p>Envisioned automation/ autonomy and its effects on roles and responsibilities</p>	<p>What processes do you aim to automate? How did you arrive at that? F12 </p> <p>What tasks are added or deleted from the existing work practices through your automation decisions? F13 </p>

Development Process (Contd.)

<p>Envisioned automation/autonomy and its effects on roles and responsibilities</p>	<p>What are the anticipated benefits and unintended harms with the proposed automation/ autonomy? T7 </p> <p>How does it affect the existing roles and responsibilities of the actors involved? D4 </p> <p>What measures are being taken to mitigate these effects of automation/autonomy? D5 </p> <p>How are the tensions on the specific requirements on the responsibilities of the stakeholders addressed? D6 </p>
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Testing and Validation

<p>Primary users/ local partners</p>	<p>How was the product/ project tested and validated with the users it is meant for? F14 </p>
<p>Expert in the loop</p>	<p>How is the reliability testing being carried out? Who are authorised to do testing and validation? T8 </p>
<p>Controlled and real-time settings</p>	<p>Explain how was the pilot testing conducted? (controlled and real time settings) F15 </p> <p>What were the major changes discovered during the pilot testing? F16 </p>
<p>Reliability testing/ Addressing the confounding factors</p>	<p>How were/will newly arising findings be factored in, especially adding to the reliability concerns? F17 </p>

Testing and Validation (Contd.)

<p>Auditability/ Reviewability</p>	<p>Is the envisioned intervention auditable? Enlist the mechanisms identified for data auditability? F18 What measures are taken to allow the technological intervention for reviewing and incorporating changes with newer findings/arising needs? (Detail out the FAIR principles (findable, accessible, interoperable & reviewable that are followed) F19 </p>
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SERVICE DELIVERY ENVIRONMENT

In this section, we have captured the contextual realities of the service delivery environment. The perspectives shared by the service providers and the end users add to the granular analysis of the ethical essentials in building technologies. It becomes imperative to decision-making authorities especially at the legislative and executive levels in assessing the guiding factors listed under this section to ensure that effective and efficient service delivery mechanisms are in place.

Infrastructural Mapping

<p>Infrastructure availability and allocation</p>	<p>How is the infrastructural mapping and allocation currently done? (Elaborate on available resources and their distribution) E14 What are the mechanisms in place to transition to/add new infrastructure? (Elaborate on both digital and non-digital infrastructure) E15 </p>
<p>Humans in the Loop</p>	<p>Elaborate on the methodologies followed to map the human resources (existing and those expected) in service delivery in the context of your intervention? E16 </p>

Infrastructural Mapping

Humans in the loop	<p>What are the changed roles and responsibilities of the existing service providers in the functional context? What are the key roles and responsibilities of new service providers? D7 </p> <p>What safety protocols are in place to preserve the dignity of the human-in-loop (includes providers and end beneficiaries) D8 </p>
Decisions on Sourcing	<p>What are the criteria identified for sourcing the necessary hardware and/or software resources? (Elaborate on funding sources, timeline and the procurement policies) F22 </p> <p>What policies are in place to ensure that the procured goods adhere to safety protocols? (you may talk about the biocompatibility factors and other relevant certifications obtained for the raw materials) T9 </p>

Data Management

Differing access and Permissions	<p>How are the interfaces designed to allow differential access to the identified user groups? F (Elaborate on how different user groups were created and how data access was distributed amongst them) F23 </p> <p>What security measures are in place to safeguard the data use/misuse amongst the identified user groups (elaborate on different logins, web interfaces and data handling permissions) T10 </p>
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Data Management (Contd.)

Data Ownership	What factors are being considered to acknowledge appropriate data ownership and attribution? (Who owns what kind of data) F24 What service delivery strategies are in place to manage data ownership and distribution? (Explain the interoperability protocols, management of data breaches, etc) T11
Privacy, Security and Consent Mechanisms	What mechanisms are used to uphold the values of privacy, security and confidentiality of all the collaborating stakeholders? (Elaborate on consent-seeking mechanisms, consent-revoking mechanisms, surveillance mechanisms, and security measures to uphold data confidentiality and prevent data misuse) T12

Operations Management

Data Creation and Management	<p>Elaborate on the data capture and exchange mechanisms in place. How do they allow/disallow for interoperability with the existing platforms? (Provide details of ABDM compliance, particularly in terms of interoperability) F25 </p> <p>Elaborate on the mechanisms in place to ensure that data capture and usage are systemically organised according to the globally and/or regionally accepted standards of clinical documentation and reporting. (Here, comment on adherence to ICD classification, SNOWMED, ABDM and NDHM protocols) F26 </p> <p>What accountability mechanisms are in place to ensure global data compliances are adherence to? T13 </p>
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Operations Management (Contd.)

Emerging Choices by Partners	Who are the other potential partners useful in completing the service delivery who were not accounted for in the conceptualisation phase? D9
Beneficiary Usage	Describe the evaluation criteria to assess whether the intervention fulfils the stated objectives? T14 How are unaccounted, adverse effects documented? Describe the evaluation criteria to assess any unaccounted adverse effects caused by the intervention T15

Evaluating Usability

Ease of use	How was the usability evaluation carried out? D10
Long-term monitoring	In the long run, do you see your technological intervention enabling actions beyond its primary objectives? If so, what mechanisms are in place to ensure that these actions are appropriately governed and managed? T16

SACALABILITY AND SUSTAINABILITY

In this section, we focus exclusively on arising ethical dilemmas around expanding both scope and scale. When we speak of sustainability here, we are not only alluding to ecological sustainability but also to economic and social sustainability. Within this phase, it becomes imperative for decision-making authorities at the legislative, executive and standard setting levels to assess the direct and indirect impacts of any technological intervention in the long run. Towards this end, the following factors serve as guidelines.

Scalability Decisions and Outcomes

<p>Recognising possibilities of change</p>	<p>What mechanisms are in place to recognise opportunities and understand future possibilities of change with respect to scaling up? F27 Describe the strategies in place to scale your technological intervention in an inclusive manner. E17 </p>
<p>Flexibility and adaptability</p>	<p>What additional safety and security factors are considered important in the technology design to accommodate flexibility of use and contextual adaptability while scaling up? T17 </p>

Scalability Decisions and Outcomes

<p>Scalability decision making</p>	<p>Elaborate on your scaling policies and the frequency of its updation. T18 How is the scaled-up intervention affecting the work practices of the existing and new stakeholders? D11 What measure are in place to ensure that such stakeholders' voices are heard? D12 What capacity building activities are undertaken to equip them for the scaled-up operations? D13 What strategies are in place to address their grievances in the scaled-up environment? T19 </p>
<p>Evaluating scalability outcomes</p>	<p>Elaborate on the governance measures identified to evaluate scalability outcomes (at regional, state or national level, as applicable) T20 </p>

Sustainability Choices

Sustainable usage	What are the mechanisms instituted for ensuring sustained and reviewable usage of your intervention? (Here, comment on how long-term use of the intervention can be made possible. Elaborate on possibilities to repair/upgrade/recycle) F28 What measures are in place to check your accountability to the ecological environment? T21
Handover and Transfer Strategies	If the technology is being used by a third-party, what are the handover and transfer strategies in place to ensure effective use and compliance by said party? F29
Integrative solutions for sustainable outcomes	How does the technology allow for horizontal integration with the existing channels for sustained usage? (Comment on the modularity of your designs) F30
Sustainability and social good	What social goods do you envision as your contribution meant for use in other similar service delivery contexts? E18

End of Framework

EXPECTED OUTCOME

The four tables attempt to elicit responses along four distinct stages within the life-cycle of a technological intervention. Each phase has questions mapped to specific ethical dimensions (i.e., equity, fairness, dignity and trust, within | |). Using these mappings, the evaluator will then be able to see how the technological intervention fares along each of the four dimensions.

The technology developer/entrepreneur will not be privy to the mapping of the questions to the ethical dimensions. This is in the interest of ensuring that the framework is not reverse-engineered/tampered with to provide desirable outcomes.

RESEARCH OUTPUTS AND WAY FORWARD

- a. Collaborative exchanges are underway with the Karnataka Digital Health Society (KDHS). The ethical assessment framework developed is currently being used to assess Request for Proposal (RfP) documents of two interventions. The assessment is also meant to inform KDHS about the potential ethical dilemmas within the interventions that are being proposed to ensure informed and ethical public service delivery.

- b. Methods of classification of health technologies that are currently operational are being examined. Doing so allows us to identify questions that are relevant to a particular category of technology and accordingly administer the ethical assessment framework.

- c. Work in progress to develop a web tool automating the evaluation framework by mapping of applicant questionnaire to relevant ethical tables. This web tool is envisioned as a plug-and-play tool, to be used with existing channels of technology evaluation. This will allow for ease of use on the decision-makers' end and spontaneous feedback for the applicants.

Glossary of Terms

- **ABDM:** Ayushman Bharat Digital Mission
- **Accountability:** The requirement for representatives to answer to the represented on the disposal of their powers and duties, act upon criticisms or requirements made of them, and accept (some) responsibility for failure, incompetence, or deceit.
- **Adverse Effect:** Any unfavourable or detrimental event associated with the usage of a digital health intervention, regardless of whether intervention is the direct cause.
- **Anticipated Risk:** A potential threat that can be recognized, anticipated, fairly ahead of time, enabling preparation and preventive actions.
- **Auditability:** The ability of a system to retain an independent, documented process for obtaining records, statements of fact, or other relevant information and assessing them objectively, to determine the extent to which specified requirements are fulfilled.
- **Beneficiaries:** People, organizations, or entities that gain advantages, benefits, or services from a project, program, or intervention related to digital health.
- **Biocompatibility:** The ability of a medical device or material to perform with an appropriate host response in a specific application.
- **Configurability:** The ability of a system to allow for rearrangement of its components according to newer standards to meet emerging needs.
- **Dependability:** Ability of a system to perform reliably, safely and securely over time under specified conditions as and when required.
- **Direct Beneficiaries:** Those beneficiaries who directly receive the intended /envisioned benefits.
- **Horizontal Integration:** Horizontal integration connects components at the same hierarchical level to enable interoperability and coordination.
- **ICD Classification:** International Classification of Diseases is a globally used system developed by the WHO, for classifying diseases, health conditions, and related health problem.

Glossary of Terms

- **Indirect Beneficiaries:** Those beneficiaries who benefit from a project, program, or intervention without getting direct assistance or services (eg. family members, caregivers).
- **Interim Beneficiaries:** Those beneficiaries receiving benefits in the transitional phase
- **Intervention:** Any technology enabled intentional action, or series of actions carried out to accomplish specific goals or health outcomes for a desired change.
- **Last-mile Beneficiaries:** These are the final recipients of services, goods, or benefits, typically those who are hardest to reach- the remote, underserved, or marginalized area
- **Modularity:** Defined as the design approach where complex assemblies are constructed from a limited number of simple elements or modules that are independent, self-contained and interchangeable, allowing for customisation and efficient production of related products.
- **NDHM:** National Digital Health Mission, India
- **Reliability:** The ability of a system to perform its required functions for a given period of time.
- **Representativeness:** It concerns the ability of one thing to stand for another. In this case, it refers to the ability of the data used in IoT/AI systems to accurately represent the population the system is meant to serve.
- **Reviewability:** Reviewability involves systematically implementing comprehensive technical and organisational transparency mechanisms that allow the design, deployment, and functioning of socio-technical systems and processes to be reviewed as a whole.
- **Safety:** It refers to the avoidance of unwanted harms (safety risks) throughout the entire life cycle of an AI system
- **Security:** Addressing vulnerabilities to attack and other threats that could compromise an AI system, which in turn could lead to harmful outcome .

Glossary of Terms

- **SNOWMED:** A comprehensive clinical terminology system used to record, store, and share detailed medical information in a standardized, machine-readable way.
- **Stakeholder:** Any individual, group, or organization that has an interest in, influence over, or believes they will be impacted/is impacted by a digital health intervention.
- **Target Beneficiaries:** Specific people, groups, or communities that a program, project, or intervention is intended for.
- **Technology Stack:** Refers to a set of technologies and tools used in the development of a project, each with its own features, capabilities and limitations.
- **Usability -** The extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.
- **Use error:** Use error refers to an act or omission of an act that results in a different outcome than intended, potentially due to design deficiencies.
- **User-induced error:** An error or unintended outcome that occurs directly as a result of the actions or decisions of the user, rather than because of a system or design flaw.
- **Vertical Integration:** Vertical integration connects systems at different hierarchical levels, enabling information, control, or value to flow upward and downward within the hierarchy.

Note: The glossary of terms presented here includes working definitions that are both our own and adapted from terminology defined by various relevant international agencies. Below are some useful links that we drew from:

- <https://aistandardshub.org/ai-standards/information-technology-artificial-intelligence-artificial-intelligence-concepts-and-terminology/>
- <https://webstore.iec.ch/en/publication/77839>
- <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9536679>
- <https://csrc.nist.gov/glossary>

The Center for Internet of Ethical Things (CIET) was set up to foster research and innovation in the area of Internet of Things (IoT/AI) technologies. The Center explicitly engages with ethical and moral aspects of technologies to ensure better progress towards the 2030 Sustainable Development Goals (SDGs) and to nurture a thriving innovation ecosystem in the area of IoT/AIs within the State of Karnataka.



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