HOCHSCHULE NEUBRANDENBURG
University of Applied Sciences

Defining 'Value' in Digital Health Interventions: A Triangulated Approach to Model Development

Axel Mühlbacher[1,2], Ann-Kathrin Fischer[1,2]

1 Hochschule Neubrandenburg | University of Applied Sciences Neubrandenburg, Germany

2 Gesellschaft für empirische Beratung mbH | Affiliated Institute of the University of Applied Sciences Neubrandenburg) Germany

ISPOR Europe 2023
Glasgow, Scotland, UK

12 November 2025
10 – 11 am

Podium Session: Measuring the Social and Environmental Impacts of Innovative Treatments

P57

HOCHSCHULE NEUBRANDENBURG
University of Applied Sciences

Statements, Declarations & Ethical Approval

Funding and Conflict of Interest: This study is part of the NADI research consortium, which is funded by the Innovation Fund of the Federal Joint Committee (G-BA), Germany (01VSF23031). The funding body had no role in the design of the study, data collection, analysis, interpretation, or manuscript preparation. The authors declare that they have no competing interests.

Acknowledgments: The authors would like to express their sincere gratitude to the colleagues at TU Berlin (Reinhard Busse, Cornelia Henschke, Hendrikje Rödiger, Laura Wittich) and MHH Hannover (Volker Amelung, Lena Kraft, Anna-Lena Brecher, Sophia Sgraja) for their valuable collaboration and methodological input throughout the development of the study. We also thank the members of the scientific advisory board within the NADI research consortium for their critical reflections and guidance throughout the conceptualization process. Special thanks go to Lisa Töbel, former project staff member, whose expertise and continued engagement in discussions provided important guidance and conceptual clarity during the development of the research.

Ethical Approval and Patient Consent: This study was reviewed and approved by the ethics committee of Hochschule Neubrandenburg (HSNB/218/24).

Gemeinsamer Bundesausschuss Innovationsausschuss

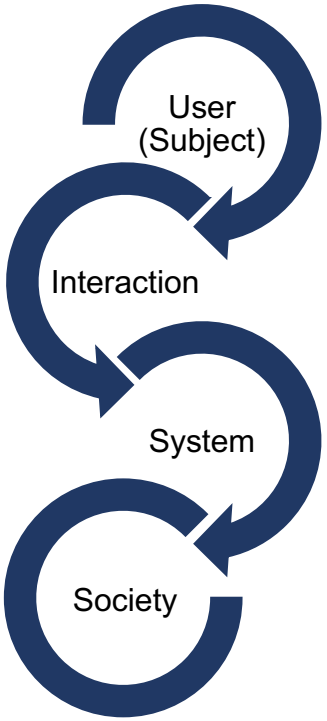
© Hochschule Neubrandenburg

Introduction: What are Digital Health Interventions (DHIs)?

- Address individual and systemic challenges in healthcare
- Four main groups (WHO, 2023):
  - For patients & caregivers – support self-management and lifestyle change.
  - For healthcare providers – assist in diagnosis, treatment, coordination.
  - For health system management – improve organization, efficiency, planning.
  - For data services – enable secure and effective data use.

→ DHIs create value on multiple levels, e.g.:

- Clinical benefit for users
- Improved interaction between patients and professionals
- System efficiency through better management and data integration
- Societal impact via accessibility, equity, and sustainability



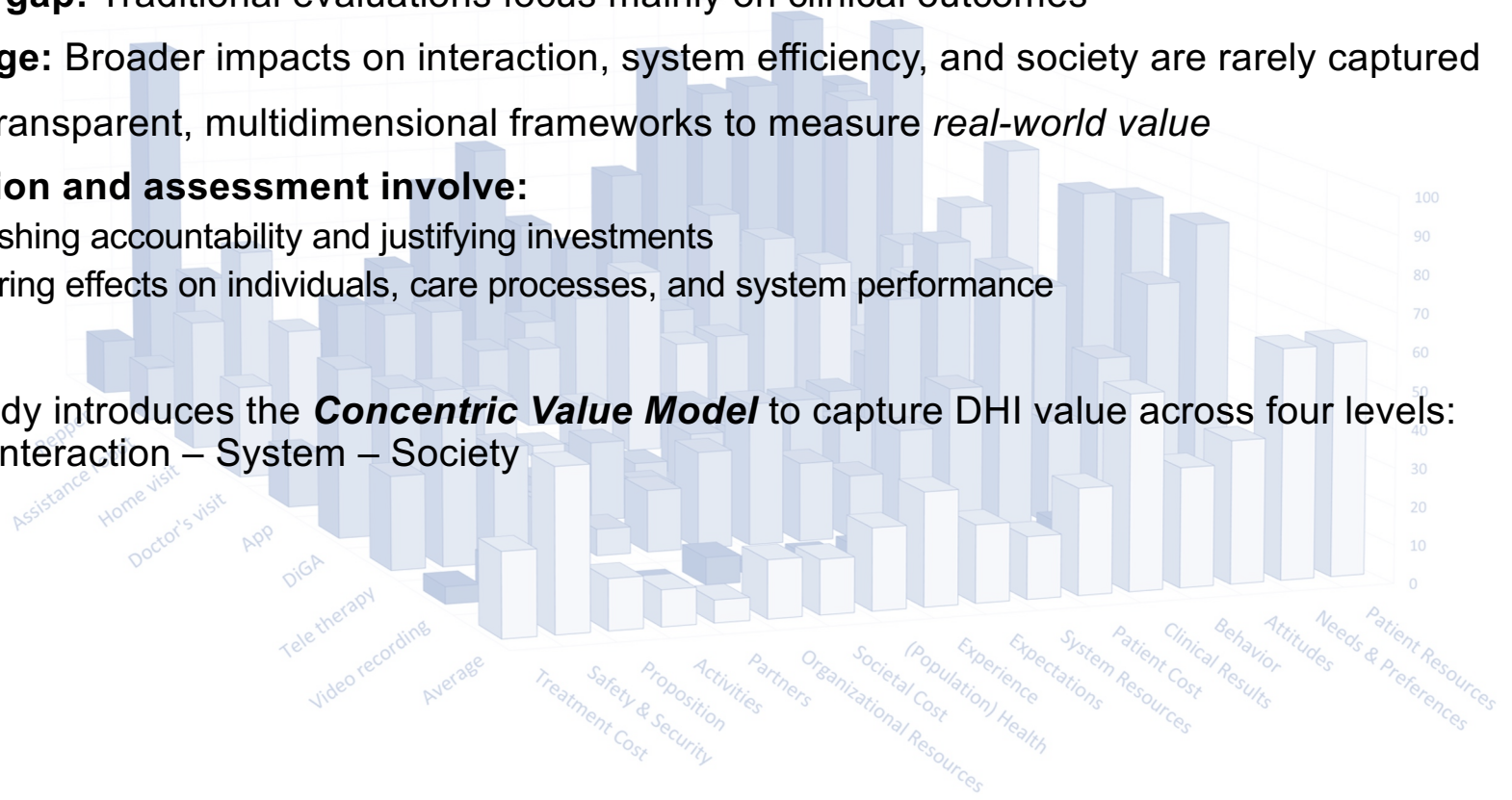
© Hochschule Neubrandenburg

World Health Organization, *Classification of digital interventions, services and applications in health: a shared language to describe the uses of digital technology for health, 2nd ed. 2023. 66.*

Problem Statement: Valuing Innovations in Digital Health

- **Current gap:** Traditional evaluations focus mainly on clinical outcomes
- **Challenge:** Broader impacts on interaction, system efficiency, and society are rarely captured
- **Need:** Transparent, multidimensional frameworks to measure *real-world value*
- **Evaluation and assessment involve:**
  - Establishing accountability and justifying investments
  - Monitoring effects on individuals, care processes, and system performance

→ This study introduces the ***Concentric Value Model*** to capture DHI value across four levels:
Subject – Interaction – System – Society



© Hochschule Neubrandenburg

Method: Triangulation

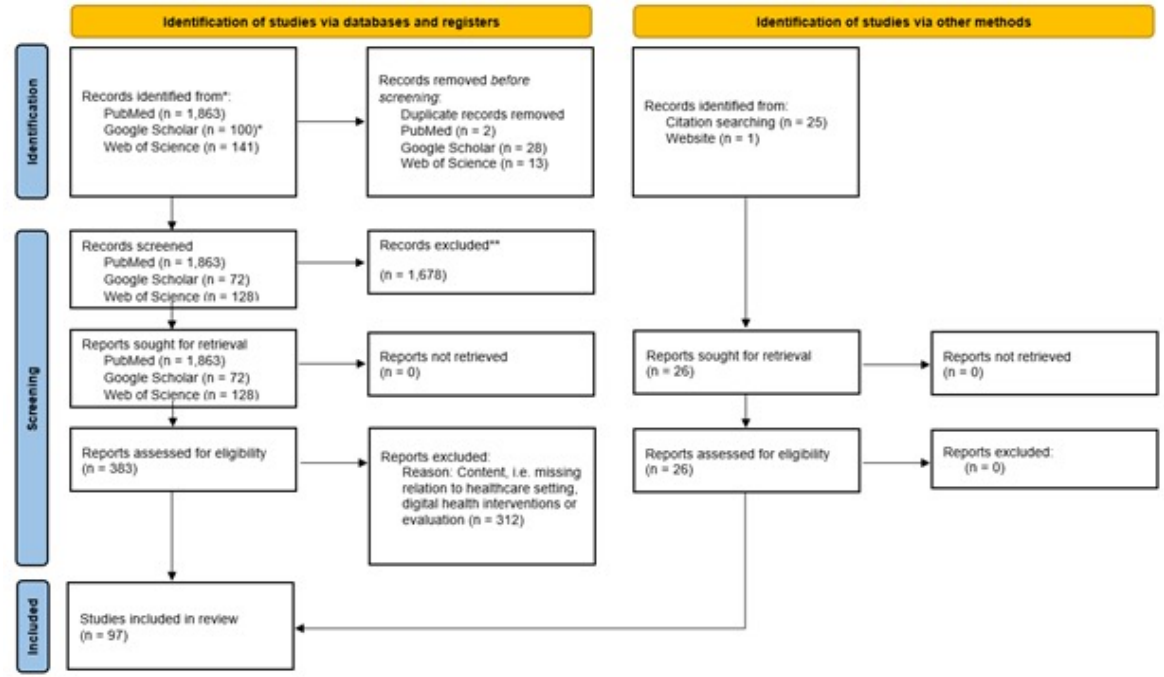
Systematic Review	Review of Reviews	Qualitative Interviews
Theoretical evidence – conceptual foundation for multidimensional value assessment	Empirical evidence – real-world application of value criteria	Stakeholder evidence – practical validation and refinement of dimensions

© Hochschule Neubrandenburg

Method: Triangulation

Systematic Review

- **Aim:** Identify conceptual dimensions and criteria in existing value assessment frameworks (VAFs) for DHIs
- **Method:** PRISMA-based search (PubMed, Web of Science, Google Scholar); thematic synthesis
- **Results:** 97 frameworks included; four core dimensions identified
- **Outcome:** Theoretical evidence – conceptual foundation for multidimensional value assessment



© Hochschule Neubrandenburg

Method: Triangulation

Systematic Review

- **Aim:** Identify conceptual dimensions and criteria in existing value assessment frameworks (VAFs) for DHIs
- **Method:** PRISMA-based search (PubMed, Web of Science, Google Scholar); thematic synthesis
- **Results:** 97 frameworks included; four core dimensions identified
- **Outcome:** Theoretical evidence – conceptual foundation for multidimensional value assessment

Table 3: Descriptive characteristics of included publications and approaches

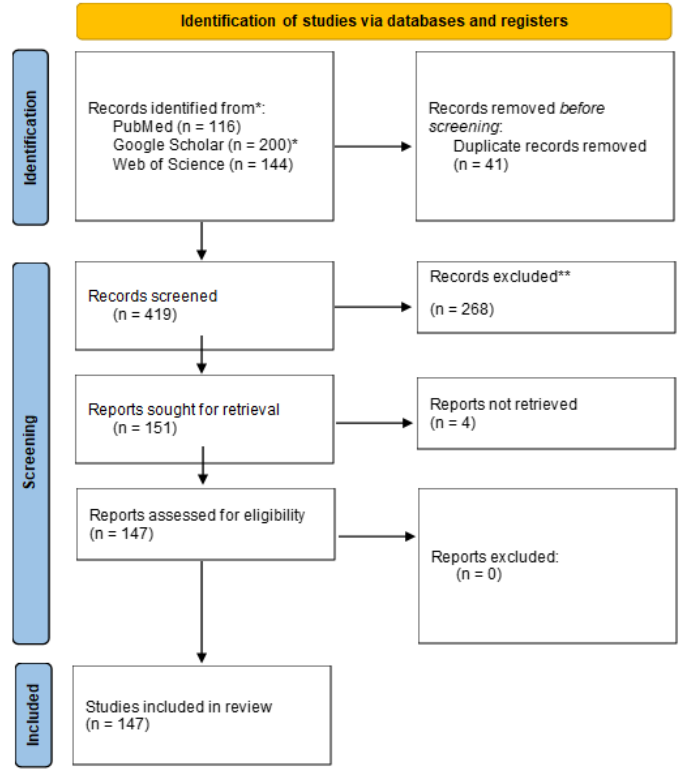
Characteristic / Dimension	Category / Criterion	n (%)
Publication year (N = 97)	≤1999	2 (2)
	2000–2009	6 (6)
	2010-2019	33 (34)
	≥2020	56 (58)
Approach type (N = 92)	Checklists & Scorecards	15 (16)
	Frameworks & Models	40 (44)
	Specific Component	12 (13)
	Definition & Requirements	25 (27)
DHI type (N = 92)	mHealth / apps	33 (36)
	Telemedicine / telehealth	8 (9)
	Health IT / information systems	12 (13)
	Artificial intelligence	7 (8)
	Other	7 (8)
	Not specified	25 (27)
Health problem (N = 92)	Infection diseases	8 (9)
	Chronic diseases	5 (5)
	Mental health	4 (4)
	Oncology	3 (3)
	Other health contexts	10 (11)
	Not specified	62 (67)

© Hochschule Neubrandenburg

Method: Triangulation

Review of Reviews

- **Aim:** Examine how value is operationalized in empirical DHI evaluations
- **Method:** Review of 147 systematic reviews (2010–2024); PRISMA-guided synthesis of applied metrics
- **Results:** Focus on clinical and behavioral outcomes; system & societal aspects underrepresented
- **Outcome:** Empirical evidence – real-world application of value criteria



*Sorted by relevance, first 100 records were screened **No automation tools were used. *From:* Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: http://www.prisma-statement.org/

© Hochschule Neubrandenburg

Method: Triangulation

Qualitative Interviews

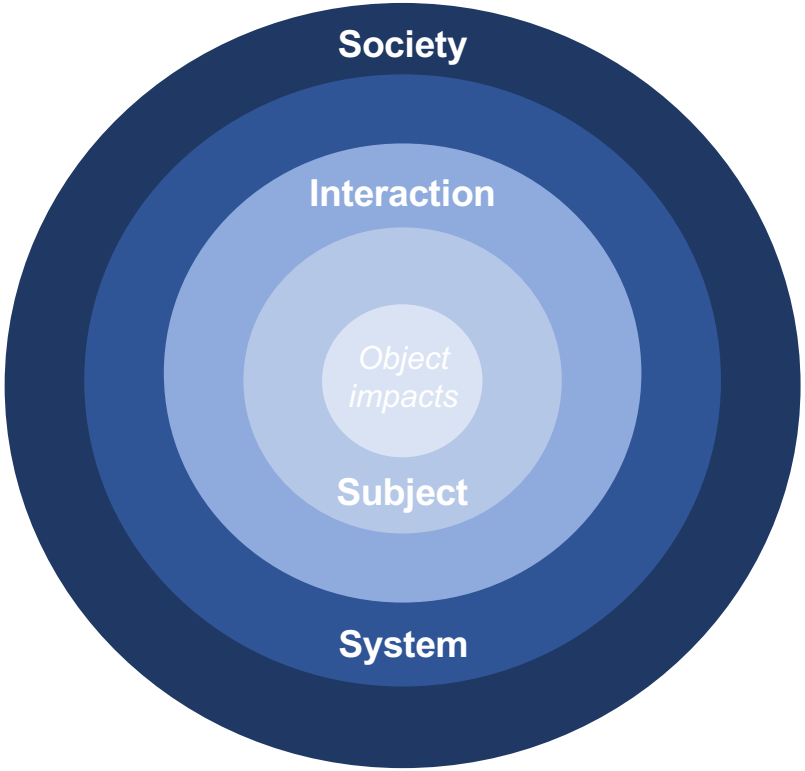
- **Aim:** Validate and contextualize the value dimensions from stakeholder perspectives
- **Method:** Semi-structured interviews (n = 10); diverse participants; content analysis
- **Results:** All four dimensions confirmed; strong focus on usability, autonomy, and system efficiency
- **Outcome:** Stakeholder evidence – practical validation and refinement of dimensions

- **N = 5 interviews, recruited via study network** (students, young professionals, healthcare managers, seniors)
- **N = 5, recruited via third-party provider** (unbiased recruitment from the general population)
- **Semi-structured approach:** Participants' experiences, perspectives on concentric circles, and a card game including criteria from concentric circles.

© Hochschule Neubrandenburg

Results: The Concentric Value Model

- Value is created across multiple levels that are nested and build upon each other:
  - **Impact on the Subject:** Effects of an object on the individual user, e.g., **clinical benefit**.
  - **Impact on the Interaction:** Quality and efficiency of interactions between the subject and the object, e.g., **user-friendliness**.
  - **Impact on the System:** Infrastructure and mechanisms that enable access to and use of an object, e.g., **interoperability, cost-efficiency**.
  - **Impact on Society:** Societal and regulatory context as well as the long-term social and environmental effects of an object, e.g., **sustainability, social acceptance**.



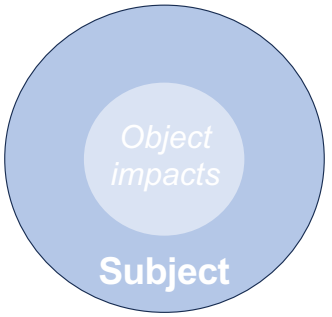
© Hochschule Neubrandenburg

Results: Model Components

Impact on Subject:

- Focuses on the effects of an object (e.g., people, products, services, systems, or policies) on the individual or end-user.

Dimension	Dimension / Criterion	Description	Within-dimension proportion	Across-dimension proportion	References
Subject	Clinical Benefit	Refers to measurable health improvements, including morbidity, mortality, and patient-reported outcomes; may be assessed via clinical and surrogate parameters, with emphasis on effectiveness compared to alternatives.	22%	8%	[3-5, 8, 16, 26-28, 30, 36, 38, 42-44, 46, 59, 67, 92, 96, 100]
Subject	Clinical Risk	Refers to prevention of adverse events and patient safety; includes risk classification, monitoring, and mitigation, e.g. for vulnerable users or AI-driven interventions.	12%	4%	[3, 10, 26, 28, 36, 38, 43, 50, 94, 97]
Subject	Behavioral Change	Describes how DHIs promote healthy behaviors through structured activities, cognitive strategies, and persuasive elements; effectiveness depends on integration into daily routines.	7%	3%	[9, 12, 16, 25, 55, 65, 96]
Subject	Knowledge Development	Refers to the DHI's role in conveying and assessing health knowledge; promotes digital health literacy and supports individualized understanding of health conditions.	5%	2%	[9, 12, 58, 65]
Subject	Individual Resources	Describes how DHIs conserve time, money, and energy through efficient delivery and affordability; includes reimbursement and personal resource activation.	12%	4%	[25, 29, 31, 43, 65, 66, 78]
Subject	Transparency and Technical Security	Involves clear communication of key information and robust data protection; ensures user trust through transparency, data control, and secure system design.	42%	15%	[11, 13, 20, 21, 29, 31, 34, 40-43, 45-48, 50, 72, 96, 100, 102]



© Hochschule Neubrandenburg

Results: Model Components

Impact on Subject

Dimension	Dimension / Criterion	Description	Within-dimension proportion	Across-dimension proportion	References
Subject	Clinical Benefit	Refers to measurable health improvements, including morbidity, mortality, and patient-reported outcomes; may be assessed via clinical and surrogate parameters, with emphasis on effectiveness compared to alternatives.	22%	8%	[3-5, 8, 16, 26-28, 30, 36, 38, 42-44, 46, 59, 67, 92, 96, 100]
Subject	Clinical Risk	Refers to prevention of adverse events and patient safety; includes risk classification, monitoring, and mitigation, e.g. for vulnerable users or AI-driven interventions.	12%	4%	[3, 10, 26, 28, 36, 38, 43, 50, 94, 97]
Subject	Behavioral Change	Describes how DHIs promote healthy behaviors through structured activities, cognitive strategies, and persuasive elements; effectiveness depends on integration into daily routines.	7%	3%	[9, 12, 16, 25, 55, 65, 96]
Subject	Knowledge Development	Refers to the DHI's role in conveying and assessing health knowledge; promotes digital health literacy and supports individualized understanding of health conditions.	5%	2%	[9, 12, 58, 65]
Subject	Individual Resources	Describes how DHIs conserve time, money, and energy through efficient delivery and affordability; includes reimbursement and personal resource activation.	12%	4%	[25, 29, 31, 43, 65, 66, 78]
Subject	Transparency and Technical Security	Involves clear communication of key information and robust data protection; ensures user trust through transparency, data control, and secure system design.	42%	15%	[11, 13, 20, 21, 29, 31, 34, 40-43, 45-48, 50, 72, 96, 100, 102]

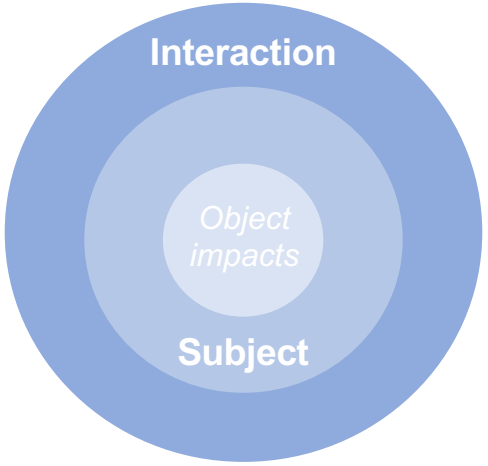
© Hochschule Neubrandenburg

Results: Model Components

Impact on Interaction:

- Analyzes the quality and efficiency of interactions between the subject and the object.

Dimension	Dimension / Criterion	Description	Within-dimension proportion	Across-dimension proportion	References
Interaction	Task Support	Refers to how DHIs facilitate efficient, goal-oriented task completion by emphasizing essential content and minimizing complexity.	2%	0%	[76]
Interaction	Expectation Conformity	Describes how DHIs align with user expectations through consistent design and functionality, reducing cognitive effort and supporting intuitive interaction.	2%	0%	[76]
Interaction	Comprehensibility	Refers to how clearly a DHI communicates current steps and options; supports intuitive use through self-descriptive interfaces and clear navigation.	2%	0%	[76]
Interaction	Learnability	Describes how easily users can understand and operate a DHI; supported by guidance, feedback, and interaction that promote digital health literacy.	3%	1%	[58, 76]
Interaction	Controllability	Refers to user autonomy over timing, flow, and feature access; supports self-determination and ensures voluntary, preference-based use of DHIs.	8%	2%	[45, 47, 58, 64, 76]
Interaction	Reliability and Error Prevention	Describes system stability, fault tolerance, and input accuracy; supported by preventive measures, user control, technical performance, and continuous optimization.	34%	7%	[4, 5, 25, 26, 31, 35, 50, 52, 55, 57, 64, 66, 76, 94, 100]
Interaction	User Engagement	Refers to how DHIs motivate continued use through appealing design, gamification, and visual elements that enhance user experience and acceptance.	5%	1%	[9, 12, 76]
Interaction	Inclusion and Accessibility	Describes how DHIs ensure equitable, barrier-free use across diverse user groups through contextual adaptability, affordability, and inclusive design.	15%	3%	[11, 27, 40, 41, 43, 46, 100]
Interaction	Customizability and Personalization	Refers to how DHIs adapt to individual needs through configurable settings, personal goals, and user-centered design to support tailored experiences.	8%	2%	[21, 65, 75, 99]
Interaction	Information Exchange and Communication	Describes how DHIs support interaction through multiple communication channels, personalized content, and transparent health information to aid decision-making.	18%	4%	[12, 46, 48, 55-57, 63, 64, 92, 97, 102]
Interaction	Support and Service	Refers to the provision of technical and professional assistance; includes service quality, user training, and structured implementation to enhance acceptance.	5%	1%	[1, 25, 86]



© Hochschule Neubrandenburg

Dimension	Dimension / Criterion	Description	Within-dimension proportion	Across-dimension proportion	References
Interaction	Task Support	Refers to how DHIs facilitate efficient, goal-oriented task completion by emphasizing essential content and minimizing complexity.	2%	0%	[76]
Interaction	Expectation Conformity	Describes how DHIs align with user expectations through consistent design and functionality, reducing cognitive effort and supporting intuitive interaction.	2%	0%	[76]
Interaction	Comprehensibility	Refers to how clearly a DHI communicates current steps and options; supports intuitive use through self-descriptive interfaces and clear navigation.	2%	0%	[76]
Interaction	Learnability	Describes how easily users can understand and operate a DHI; supported by guidance, feedback, and interaction that promote digital health literacy.	3%	1%	[58, 76]
Interaction	Controllability	Refers to user autonomy over timing, flow, and feature access; supports self-determination and ensures voluntary, preference-based use of DHIs.	8%	2%	[45, 47, 58, 64, 76]
Interaction	Reliability and Error Prevention	Describes system stability, fault tolerance, and input accuracy; supported by preventive measures, user control, technical performance, and continuous optimization.	34%	7%	[4, 5, 25, 26, 31, 35, 50, 52, 55, 57, 64, 66, 76, 94, 100]
Interaction	User Engagement	Refers to how DHIs motivate continued use through appealing design, gamification, and visual elements that enhance user experience and acceptance.	5%	1%	[9, 12, 76]
Interaction	Inclusion and Accessibility	Describes how DHIs ensure equitable, barrier-free use across diverse user groups through contextual adaptability, affordability, and inclusive design.	15%	3%	[11, 27, 40, 41, 43, 46, 100]
Interaction	Customizability and Personalization	Refers to how DHIs adapt to individual needs through configurable settings, personal goals, and user-centered design to support tailored experiences.	8%	2%	[21, 65, 75, 99]
Interaction	Information Exchange and Communication	Describes how DHIs support interaction through multiple communication channels, personalized content, and transparent health information to aid decision-making.	18%	4%	[12, 46, 48, 55-57, 63, 64, 92, 97, 102]
Interaction	Support and Service	Refers to the provision of technical and professional assistance; includes service quality, user training, and structured implementation to enhance acceptance.	5%	1%	[1, 25, 86]

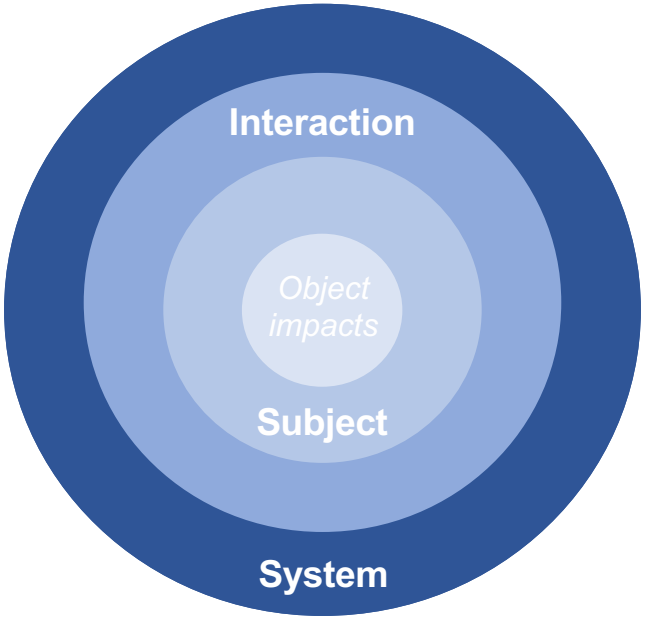
© Hochsc

Results: Model Components

Impact on the System:

- Examines the infrastructure and mechanisms that enable the use and access to an object.

Dimension	Dimension / Criterion	Description	Within-dimension proportion	Across-dimension proportion	References
System	Scalability and Expandability	Refers to the ability of DHIs to grow and evolve through modular design, technical flexibility, and lifecycle adaptation to support broader use and integration.	16%	4%	[11, 15, 20, 29, 32, 37, 49, 50, 55, 56, 66, 68, 70, 74]
System	Interoperability	Describes how DHIs enable seamless, secure data exchange with other systems; requires standardized integration, user flexibility, and cross-platform compatibility.	15%	4%	[10, 11, 20, 21, 29, 31, 32, 43, 44, 50, 56, 84, 100]
System	Organizational Compatibility	Refers to how DHIs align with organizational workflows, culture, and structures; supports efficient implementation through integration, resource allocation, and staff readiness.	31%	9%	[2, 3, 6, 7, 10, 20, 24-29, 31, 38, 48, 53, 56, 63, 68, 70, 77, 100]
System	System Efficiency	Describes how DHIs generate long-term resource and cost savings; includes implementation and operational costs, and supports economic evaluations from multiple perspectives.	21%	6%	[3, 11, 16, 19, 20, 24, 26-30, 38, 40, 41, 50, 59, 68, 78, 97, 100]
System	Maintainability	Refers to the ease of maintaining DHIs through stable infrastructure, automatic updates, and efficient error resolution to ensure long-term system stability.	2%	1%	[26, 94, 100]
System	Availability	Describes how DHIs ensure continuous access through sufficient infrastructure, timely service provision, and minimal wait times to support system integration.	10%	3%	[5, 11, 30, 51, 54, 57, 64, 80]
System	Management	Refers to how DHIs support planning, control, and optimization through data-driven processes; includes strategic alignment, funding, and stakeholder coordination.	4%	1%	[4, 5, 55, 69]



© Hochschule Neubrandenburg

Dimension	Dimension / Criterion	Description	Within-dimension proportion	Across-dimension proportion	References
System	Scalability and Expandability	Refers to the ability of DHIs to grow and evolve through modular design, technical flexibility, and lifecycle adaptation to support broader use and integration.	16%	4%	[11, 15, 20, 29, 32, 37, 49, 50, 55, 56, 66, 68, 70, 74]
System	Interoperability	Describes how DHIs enable seamless, secure data exchange with other systems; requires standardized integration, user flexibility, and cross-platform compatibility.	15%	4%	[10, 11, 20, 21, 29, 31, 32, 43, 44, 50, 56, 84, 100]
System	Organizational Compatibility	Refers to how DHIs align with organizational workflows, culture, and structures; supports efficient implementation through integration, resource allocation, and staff readiness.	31%	9%	[2, 3, 6, 7, 10, 20, 24-29, 31, 38, 48, 53, 56, 63, 68, 70, 77, 100]
System	System Efficiency	Describes how DHIs generate long-term resource and cost savings; includes implementation and operational costs, and supports economic evaluations from multiple perspectives.	21%	6%	[3, 11, 16, 19, 20, 24, 26-30, 38, 40, 41, 50, 59, 68, 78, 97, 100]
System	Maintainability	Refers to the ease of maintaining DHIs through stable infrastructure, automatic updates, and efficient error resolution to ensure long-term system stability.	2%	1%	[26, 94, 100]
System	Availability	Describes how DHIs ensure continuous access through sufficient infrastructure, timely service provision, and minimal wait times to support system integration.	10%	3%	[5, 11, 30, 51, 54, 57, 64, 80]
System	Management	Refers to how DHIs support planning, control, and optimization through data-driven processes; includes strategic alignment, funding, and stakeholder coordination.	4%	1%	[4, 5, 55, 69]

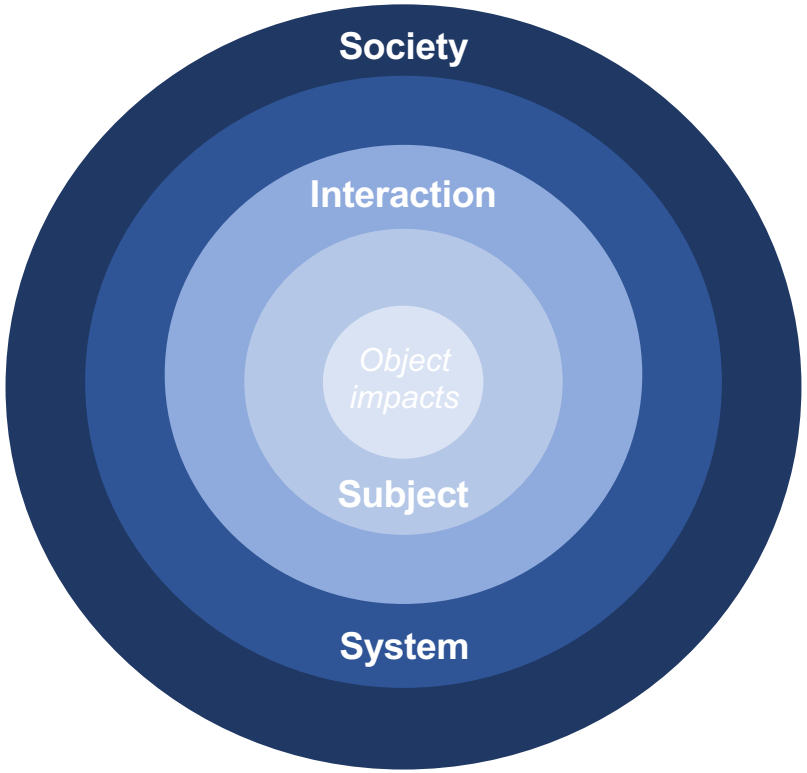
© Hochschule Neubrandenburg

Results: Model Components

Impact on the Society:

- Considers societal and regulatory frameworks, as well as long-term social and environmental impacts of an object.

Dimension	Dimension / Criterion	Description	Within-dimension proportion	Across-dimension proportion	References
Society	Environmental Protection and Sustainability	Describes how DHIs promote ecological responsibility by conserving resources and minimizing environmental impact through sustainable design and implementation.	6%	1%	[34, 45, 78]
Society	Social and Public Perception	Refers to public acceptance of DHIs based on societal expectations, human-centered design, and social readiness for adoption.	6%	1%	[32, 54, 77]
Society	Social Equity and Justice	Describes how DHIs promote equal opportunities and reduce disparities by supporting disadvantaged groups and evaluating social impacts.	32%	5%	[20, 24, 28, 30, 34, 38, 43, 45, 63, 65, 68, 78, 94, 100]
Society	Innovation and Progress	Refers to how DHIs introduce new solutions through technological advancements; supports adoption, evaluation, and improved healthcare delivery.	11%	2%	[10, 20, 54, 78, 99]
Society	Economic Growth	Describes how DHIs support economic development and job creation by improving processes and enabling cost-effective, scalable solutions.	9%	1%	[28, 38, 45, 59]
Society	Regulatory Responsibility	Describes how DHIs ensure compliance with legal and policy frameworks; promotes transparency, accountability, and user trust.	26%	4%	[11, 20, 25, 30, 34, 38, 45, 51, 63, 78, 94, 100]
Society	Public Health	Describes how DHIs improve population health through prevention, expanded access, and measurable health outcomes at the societal level.	11%	2%	[45, 46, 51, 67, 78]



© Hochschule Neubrandenburg

Results: Model Components

Impact on the Society:

Dimension	Dimension / Criterion	Description	Within-dimension proportion	Across-dimension proportion	References
Society	Environmental Protection and Sustainability	Describes how DHIs promote ecological responsibility by conserving resources and minimizing environmental impact through sustainable design and implementation.	6%	1%	[34, 45, 78]
Society	Social and Public Perception	Refers to public acceptance of DHIs based on societal expectations, human-centered design, and social readiness for adoption.	6%	1%	[32, 54, 77]
Society	Social Equity and Justice	Describes how DHIs promote equal opportunities and reduce disparities by supporting disadvantaged groups and evaluating social impacts.	32%	5%	[20, 24, 28, 30, 34, 38, 43, 45, 63, 65, 68, 78, 94, 100]
Society	Innovation and Progress	Refers to how DHIs introduce new solutions through technological advancements; supports adoption, evaluation, and improved healthcare delivery.	11%	2%	[10, 20, 54, 78, 99]
Society	Economic Growth	Describes how DHIs support economic development and job creation by improving processes and enabling cost-effective, scalable solutions.	9%	1%	[28, 38, 45, 59]
Society	Regulatory Responsibility	Describes how DHIs ensure compliance with legal and policy frameworks; promotes transparency, accountability, and user trust.	26%	4%	[11, 20, 25, 30, 34, 38, 45, 51, 63, 78, 94, 100]
Society	Public Health	Describes how DHIs improve population health through prevention, expanded access, and measurable health outcomes at the societal level.	11%	2%	[45, 46, 51, 67, 78]

© Hochschule Neubrandenburg

Discussion: Reframing Value Assessment

Problem:

- Current DHI evaluations focus on isolated indicators (e.g. cost-effectiveness, clinical outcomes).
- Broader, stakeholder-informed dimensions often neglected.

Rationale:

- Existing frameworks lack integration of societal and systemic aspects.
- DHIs require dynamic, context-sensitive assessment.

Solution:

- The Concentric Value Model structures value creation across four dimensions:
  Subject – Interaction – System – Society.
- Reflects co-produced value across levels of the health ecosystem.

© Hochschule Neubrandenburg

Discussion: Positioning the CVM within Existing Paradigms

Recent Frameworks:

- e.g., Whole Health Paradigm, ISPOR Value Flower, EUnetHTA Core Model, INAHTA HTA Principles

Comparison:

- CVM includes established domains (clinical benefit, efficiency, equity)
- Expands by adding digital-specific and user-centered dimensions:
  - Behavioral support
  - Usability
  - Technical transparency
  - Inclusion

Added Value:

- Bridges HTA and real-world experience.
- Enables cross-level integration and longitudinal assessment.

© Hochschule Neubrandenburg

HOCHSCHULE
NEUBRANDENBURG
University of Applied Sciences

Thank you for your attention!

Contact

Axel Mühlbacher
E-Mail: muehlbacher@hs-nb.de
Tel: +49 395 5693 3108

Ann-Kathrin Fischer
E-Mail: akfischer@hs-nb.de
Tel.: +49 395 5963 3305