EAI Endorsed Transactions
on Pervasive Health and Technology Research Article EAI.EU

The Dual-Dimension of Quality of Life: A Philosophical Value Theory Approach to Reconstructing Health Engineering Goals

J. S. Wen[1], X. Li[2], Q. Wang[3,*]

[1]The University of Chicago, Edward H. Levi Hall, 5801 S. Ellis Ave., Chicago, IL 60637, America
[2]Guangzhou City Construction College, No. 166, East Huanshi Road, Conghua, Guangzhou, China
[3]Guangzhou Wanqu Cooperative Institute of Design, No. 169, Gongqing Road, Liangkou Town, Conghua, Guangzhou, China

Abstract

Health Engineering (HE) has significantly advanced objective health metrics, yet often overlooks the subjective, value-laden dimension of Quality of Life (QoL), creating a gap in achieving genuine human flourishing. This paper addresses this limitation by introducing a Dual-Dimension QoL Model (DD-QoL), which integrates the Objective Functional Dimension (OFD) with the Subjective Value Dimension (SVD). Based on this model, we develop a Value-Sensitive Assessment Framework (VSAF), a distinctive methodological contribution that uses conceptual engineering to shift HE's primary goal from merely maximizing OFD to optimizing holistic QoL. Through an illustrative example of an AI-assisted care system for Alzheimer's disease, we qualitatively demonstrate how a VSAF-guided approach can enhance SVD outcomes without compromising OFD. Our primary contribution is a novel, philosophically-grounded framework that provides a supplementary approach for reconstructing HE goals, ensuring that technological progress serves the broader, more profound aim of promoting valuable life experiences.

Keywords: Quality of Life (QoL), Health Engineering, Philosophical Value Theory, Goal Reconstruction, Conceptual Engineering, Value-Sensitive Design

Received on 22 November 2025, accepted on 14 December 2025, published on 13 January 2026

doi: 10.4108/eetpht.11.11062

1. Introduction

1.1. The Promise and Peril of Health Engineering

Health Engineering (HE), encompassing fields from biomedical engineering to health informatics and AI-driven diagnostics, stands as a cornerstone of modern healthcare, promising unprecedented advancements in disease eradication and life extension [1]. Its success is typically measured by objective, quantifiable metrics: reduced mortality rates, increased life expectancy, and improved functional recovery scores [2]. This focus has led to a technological imperative where health is reduced to optimizing biological and physiological parameters.

However, this technical rationality harbours a critical limitation. By prioritizing the Objective Functional Dimension (OFD)—the "how long" and "how well the body works"—HE risks instrumental reason, where health's ultimate human value is obscured by technical efficiency [3].

*Corresponding author. Email: wwqrr@126.com

This pursuit can lead to the medicalization of normal life processes and alienation from subjective well-being, raising profound ethical questions about the nature of a "good life" [4]. Such instrumentalism conflicts fundamentally with philosophical value theory, particularly non-consequentialist traditions that ground morality in duty rather than outcomes [5].

We address this limitation by grounding health engineering goals in the Capabilities Approach [6,7], which defines well-being through individuals' real freedom to achieve valued functionings. This framework prioritizes subjective experience, autonomy, and dignity—treating persons as ends in themselves [5]—over mere functional optimization. It enables reconceptualizing Quality of Life (QoL) as inherently dual-dimensional: the aforementioned OFD, which current HE practices address, and the Subjective Value Dimension (SVD), encompassing autonomy, dignity, social connectedness, and life's perceived meaning [8,9]. While OFD improvements may enhance physical health, they often fail to improve overall well-being—the core objective health engineering should serve.

The central research question is: How can Philosophical Value Theory be systematically integrated into Health Engineering to reconstruct its goals, promoting holistic QoL encompassing both OFD and SVD?

1.2. Review of Related Work and Research Gap

Existing literature addresses this tension from several angles. In medicine, QoL instruments (e.g., WHOQOL, EQ-5D) attempt to capture multi-dimensional health states, but often struggle to fully operationalize deep subjective values like meaning and purpose [10,11]. In philosophy, bioethics has extensively critiqued the ethical implications of health technologies, focusing on principles like beneficence and non- maleficence [12]. Specifically, many worry about value misalignment in medical artificial intelligence systems and broader ethical implications including responsibility and violation of fundamental human rights, i.e. the quality and representativeness of data used to train machine learning algorithms and the exploitation of personal information [13]. Furthermore, the field of Value-Sensitive Design (VSD) has emerged in engineering to embed human values into the design process [14,15]. These discussions all embark from the fundamental idea that artificial systems should be aligned with our values and goals.

Despite these efforts, a significant gap remains: there is no unified, cross-disciplinary framework that uses Philosophical Value Theory not just for ethical critique or design input, but for the fundamental conceptual reconstruction of the engineering goal itself. We argue that the current goal of HE—to maximize functional health—is conceptually flawed from a value perspective and requires a systematic overhaul [16, 17]. While we are not concerned with what particular human values should be integrated, we propose a plausible goal, and starting point, for the industry of health engineering.

1.3. Research Objectives and Contribution

This study aims to achieve the following objectives:

- To establish a theoretical foundation for the critique of current HE goals using the lens of Philosophical Value Theory, specifically focusing on the concept of intrinsic value [16,17].
- To propose the Dual-Dimension QoL Model as a conceptual tool for integrating OFD and SVD.
- To develop a Value-Sensitive Assessment Framework (VSAF) as a methodological guide for the practical reconstruction and evaluation of HE projects [18].

The primary contribution of this paper is the introduction of Conceptual Engineering as a meta-methodology to shift the current HE goal from “functional optimization and objective functional health analysis” to “promotion of subjective life experiences and individual well-being,” providing a novel theoretical and practical blueprint for future interdisciplinary research [19,20].

2. Related Work and Theoretical Foundations

2.1. The Critique of Instrumental Rationality in Health Engineering

The historical trajectory of HE is deeply intertwined with a dominant instrumental rationality where health is viewed as a resource or a tool—a means to an end—rather than an end in itself [21]. For instance, a successful cardiac implant is defined by its technical reliability and its ability to restore a measurable physiological function (OFD), often sidelining the patient’s subjective experience of living with the device (SVD) [22]. This instrumental view is susceptible to philosophical critique, as technology is not value-neutral; it embodies the values and goals of its designers [12]. When the design goal is purely technical efficiency, the resulting technology inherently promotes a value system where efficiency is paramount, potentially leading to the “Engineering of Health” [4]. More recent works on the philosophy of AI by Cappelen and Dever argues that meaningful content attribution for AI systems are external, wherein acts of predication, property designation, and content satisfaction are determined by a system’s training history and it’s Kripke an anchoring event (or any potential theories of reference determination) [23]. A conceptual re-engineering of the HER project is needed, one that focuses on both functional analysis and intrinsic value.

Table 1. Systematic Comparison of Existing QoL, Value Theories, and Design Frameworks

Framework	Core Focus	Goal Level	Value Dimension Treatment	DD-QoL/VSAF's Irreplaceable Increment
HRQoL Measures (e.g., EQ-5D, WHOQOL)[24]	Measuring health state impact on QoL	Post-Design Assessment	Treats subjective experience (e.g., pain, anxiety) as a measurable state; descriptive.	Assessment Tool only; lacks the normative foundation and methodology for goal reconstruction.
Capability Approach (Nussbaum & Sen)[25]	Individual's real freedom and functionings	Normative Foundation	Emphasizes intrinsic value and the value of being ends in themselves; provides the philosophical definition of QoL.	Philosophical Norm only; lacks a systematic methodology for translating value into an assessment framework and engineering goal.
Positive Health [26]	Broadening the definition of health	Conceptual Goal	Broadens health to six dimensions (e.g., meaning, daily functioning); focuses on holism.	Conceptual Broadening only; lacks the methodology for engineering goal reconstruction, especially for handling the trade-off between OFD and SVD.
VSD (Value-Sensitive Design) [27]	Embedding human values into the design process	Design-Level Guidance	Treats value as a design constraint or requirement; focuses on design-phase value embedding.	Design-Level focus; VSAF uses Conceptual Engineering to directly reconstruct the highest goal of HE, making VSD a tool within the VSAF's design phase.

2.2. Systematic Comparison of Existing QoL, Value Theories, and Design Frameworks

Existing frameworks—HRQoL measures [24], the Capability Approach [25], Positive Health [26], and VSD [27]—address functional-value integration with varying scope, goal level, and engineering roles. Table 1 systematically positions our model and framework against these alternatives.

2.3. DD-QoL Model and VSAF: The Irreplaceable Incremental Contribution

As the comparison above indicates, existing frameworks either remain at a descriptive or conceptual level or focus primarily on design-phase value embedding. Based on this analysis, the incremental contribution of the DD-QoL Model and VSAF is twofold:

DD-QoL Model: A Normative Conceptual Framework for Goal Reconstruction. The DD-QoL model (QoL = f(OFD, SVD)) provides a normative conceptual framework that elevates both OFD and SVD to the highest level of the engineering objective. This explicitly shifts the aim from "maximizing OFD" to "optimizing QoL (OFD, SVD)," moving beyond the descriptive assessment characteristic of HRQoL measures [24] and the holistic but non-operational broadening found in Positive Health [26].

VSAF: A distinctive methodological contribution via Conceptual Engineering. VSAF is not merely an "enhanced VSD," but a distinctive methodological framework for re-engineering the engineering goal itself. Whereas VSD focuses on embedding values at the design stage [27], VSAF uses Conceptual Engineering informed by Philosophical Value Theory as its meta-methodology for goal reconstruction. Through its four structured stages, VSAF forms a complete loop from normative principles to engineering practice, systematically addressing OFD–SVD tensions. Thus, VSAF serves as a philosophically grounded supplementary framework for goal reconstruction, enabling value assessment to become part of the engineering goal rather than merely a design-phase consideration.

2.4. Philosophical Value Theory and Intrinsic Value: Core Normative Stance and Operational Definition

To avoid the mere "parallel citation" of multiple theoretical traditions, this study adopts the Capability Approach as its core normative stance, with Deontology serving as the constraint that ensures non-consequentialist protection of intrinsic value.

2.4.1. Core Normative Stance: Capability Approach

We adopt the Capability Approach as the principal philosophical foundation for the SVD dimension of the DD-QoL model. This approach defines well-being as an individual's real freedom to achieve the functionings they value [25], providing a substantive account of intrinsic value grounded in autonomy, dignity, and meaningful agency.

2.4.2. Deontological Constraint: Guaranteeing non-consequentialism

Kantian and Rossian deontology is incorporated as a non-consequentialist constraint on engineering goal-setting. This yields the Principle of Inviolability: no engineering intervention that aims to maximize OFD may violate an individual's core capabilities (e.g., autonomy, dignity), thereby ensuring that persons are treated as "ends in themselves" [28].

2.4.3. Operational Definition and Embodiment of "Intrinsic Value"

Here, "intrinsic value"—in the Moorean sense of value that is good in itself [29]—is given a precise operational definition and is concretely embodied across the DD-QoL model and the four stages of VSAF.

This integration resolves the classical tension between deontological non-consequentialism and the consequentialist tendencies of QoL assessment: deontology provides the a priori constraint, while the Capability Approach defines the evaluative goal for optimizing SVD (Table 2).

3. Methodology: The Dual-Dimension QoL Model and Value-Sensitive Assessment

3.1. Research Strategy: From Critique to Construction

Our methodology is constructive, moving from the philosophical critique of HE's instrumental goals to the practical construction of a new assessment framework. The strategy involves two main steps: first, the formalization of the DD-QoL Model, and second, the development of the VSAF to operationalize this model in HE practices.

Table 2. Operational Definition and Embodiment of "Intrinsic Value" in the DD-QoL Model and VSAF

Framework Stage	Operational Definition of Intrinsic Value	Embodiment (Avoiding Abstraction)
DD-QoL Model (SVD)	Core Capability Set: Capabilities directly relevant to HE, such as bodily health, senses, imagination and thought, emotion, practical reason, and affiliation [7].	Indicator Selection: SVD indicators (e.g., perceived autonomy, social connectedness, sense of meaning) are derived from the conceptual operationalization of core capabilities, not merely negative affect measures.
VSAF Stage 1 (Value Identification)	Contextualized Value: Values most relevant to core capabilities and at risk in a specific HE context (e.g., "Autonomy" and "Dignity" in AI-assisted care).	Value Priority: Explicitly states the value framework and its priority (Capability > Deontological Constraint > Consequentialist Consideration).
VSAF Stage 4 (Goal Recalibration)	Trade-off Decision Principle: A minimum threshold for SVD indicators (the deontological constraint) must be met. Any OFD gain that pushes SVD below this threshold must trigger a redesign.	Trade-off Decision: SVD is given a Veto Power in conflicts with OFD, ensuring intrinsic value is not overridden by instrumental rationality.

3.2. The Dual-Dimension QoL Model (DD-QoL Model)

The DD-QoL Model formally defines QoL as a function of two distinct yet interacting dimensions:

$$Maximize: QoL = [w_1 \cdot OFD^{\alpha} + w_2 \cdot SVD^{\beta}]^{(1/\gamma)}$$
$$Subject\ to:$$
$$SVD \geq SVD_{min} (Constraint 1)$$
$$\frac{\partial SVD}{\partial OFD} > -\delta (Constraint 2) \qquad (1.)$$

w_1,w_2: Weight vectors (non-fixed, dynamically determined in the value identification stage)；

α, β, γ: Nonlinear moderating index ($\alpha<1$ indicates the diminishing marginal utility of OFD, $\beta>1$ indicates the convexity of SVD value)；

SVD_{min}: Deontological threshold (such as the dignity baseline score, set by the ethics committee)；

δ: Maximum acceptable trade-off rate (for example, for every 1 unit increase in OFD, the SVD loss shall not exceed 0.2 units).

The relationship between OFD and SVD is non-linear and non-additive. The reconstructed HE Goal is to Optimize QoL, ensuring SVD is not sacrificed for OFD gains.

3.3. The Value-Sensitive Assessment Framework (VSAF)

The VSAF is a four-stage iterative process designed to embed the DD-QoL Model into the design and evaluation lifecycle of any Health Engineering project.

Stage 1: Value Identification (Philosophical Input): Identify the core intrinsic values at stake in the specific HE context (e.g., Autonomy, Dignity).

Stage 2: Conceptual Operationalization (Interdisciplinary Translation): Translate the identified intrinsic values into measurable SVD indicators (e.g., Perceived Autonomy Scale).

Stage 3: Dual-Dimension Assessment (Empirical Measurement): Assess the HE intervention's impact on both OFD and SVD indicators.

Stage 4: Goal Recalibration (Engineering Feedback): Analyse the trade-offs. If an intervention maximizes OFD but significantly degrades SVD, the engineering goal and design must be recalibrated.

4. Illustrative Example of VSAF: AI-Assisted Care System Case Study

To demonstrate the methodological value of the Value-Sensitive Assessment Framework (VSAF) in a realistic engineering context, this section presents a qualitative illustrative example involving an AI-assisted care system designed for early Alzheimer's disease (AD) patients. The purpose of this example is to show how VSAF guides evaluation, design, and goal recalibration, rather than to provide empirical evidence or simulated statistical data. The case is representative of domains where tensions between traditional objective functional metrics (OFD) and subjective value dimensions (SVD)—such as autonomy, dignity, and social connectedness—are particularly salient.

4.1. Scenario and System Architecture

4.1.1. Clinical and Ethical Context

Early-stage Alzheimer's disease presents a distinctive challenge for Health Engineering because patients experience progressive but incomplete cognitive decline. As a result, clinical safety requirements (e.g., fall prevention, medication reminders) frequently conflict with value-sensitive concerns such as autonomy, privacy, emotional security, and dignity.

Typical tensions include:

- Continuous monitoring vs. intrusion into private life
- Automated risk alerts vs. feelings of loss of agency
- Fall-prevention restrictions vs. mobility autonomy
- Cognitive-support reminders vs. dignity-preserving communication

These built-in conflicts make early AD care an ideal scenario for demonstrating how VSAF can systematically address OFD–SVD trade-offs.

4.1.2. AI-Assisted Care System Architecture

The hypothetical AI-assisted care system includes the following components (Figure 1):

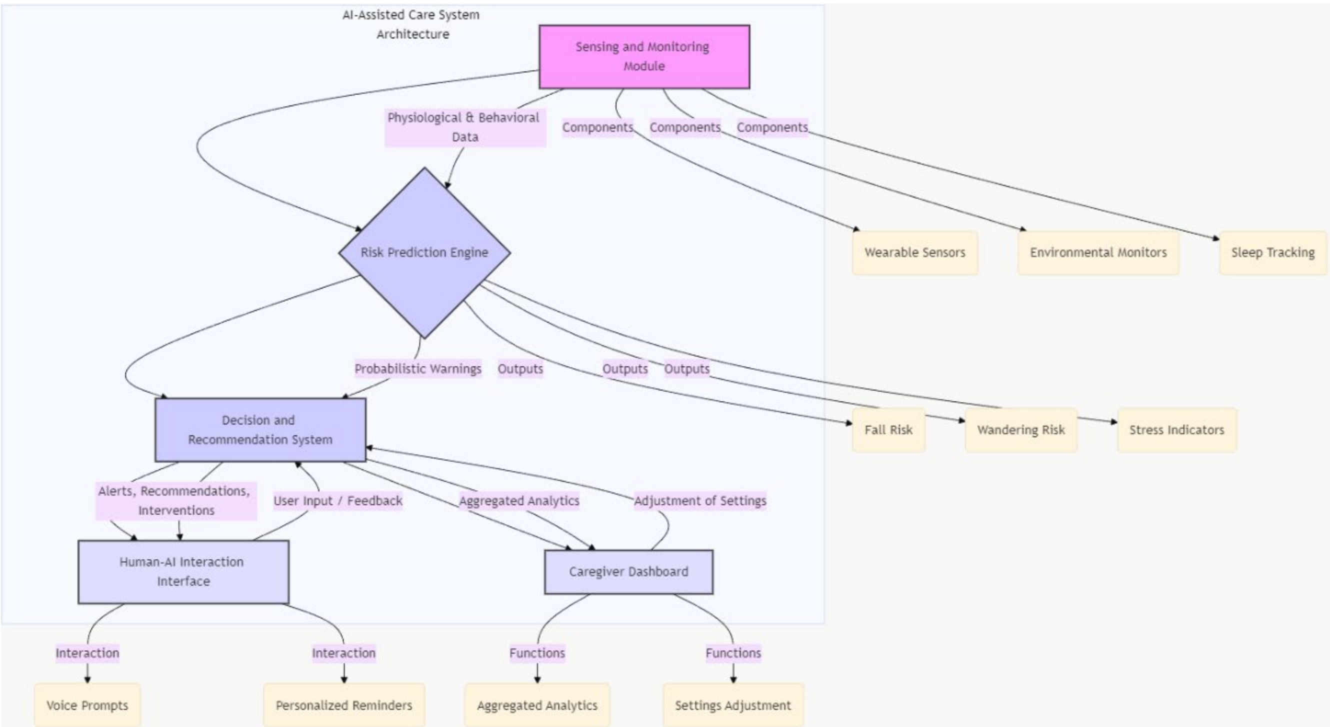

Figure 1. Sensing and Monitoring Module

- Wearable sensors, environmental monitors, sleep tracking
- Collects physiological and behavioural indicators
- Risk Prediction Engine
- Machine-learning model estimating fall risk, wandering risk, and stress indicators
- Outputs probabilistic warnings
- Decision and Recommendation System

- Generates alerts, recommendations, or automated interventions
- Determines when to notify caregivers or modify user settings
- Human–AI Interaction Interface
- Voice-based prompts, personalized reminders, and context-aware messages
- Mediates patient-system and caregiver-system interaction
- Caregiver Dashboard
- Provides aggregated analytics and recommended care actions
- Allows adjustment of monitoring levels, privacy settings, and thresholds

This multi-layer architecture embodies implicit assumptions about "what counts as success." Thus, it serves as a meaningful object for VSAF-driven goal reconstruction.

4.1.3. Two Contrasting Design Paths

To illustrate VSAF's evaluative and comparative, we compare two plausible design paradigms:

Path A: OFD-Focused Design (Traditional Engineering Approach)

Primary objective: maximize physiological safety and minimize clinical risks

Design logic: more monitoring → more alerts → fewer adverse events

Typical features:

- High-frequency monitoring
- Intrusive alert patterns
- System-driven decision-making
- Strict safety thresholds

Although effective at reducing measurable risks, this design may unintentionally undermine SVD—autonomy, dignity, emotional well-being.

Path B: VSAF-Guided Design (Goal-Reconstructed Approach)

Primary objective: optimize overall Quality of Life (QoL = f(OFD, SVD))

Normative foundation: Capability Approach; deontological protection of autonomy and dignity

Design features:

- Adjustable monitoring that respects privacy boundaries
- Dignity-preserving communication patterns
- User-centered autonomy thresholds
- Human-in-the-loop override options
- Context-sensitive recommendations rather than rigid interventions

This design is calibrated so that any OFD improvement must not push SVD below a defined capability threshold.

4.2. Application of the VSAF Framework (Four-Stage Demonstration)

This section shows how VSAF operates step-by-step when applied to the above system.

Stage 1: Value Identification

Using conceptual analysis, patient interviews, and capability-based reasoning, VSAF identifies core values most at risk in early AD care:

- Autonomy (ability to make choices despite cognitive decline)
- Dignity (freedom from overly intrusive or infantilizing interactions)
- Emotional security (avoiding undue stress from excessive alerts)
- Social connection (support for maintaining relationships and engagement)

These values are prioritized according to the value hierarchy established in Section 2:
Capability > Deontological Constraint > Consequentialist Consideration.

Stage 2: Value Operationalization

VSAF then translates abstract values into operational SVD indicators applicable to engineering design (Table 3):

Table 3. Operational SVD Indicators

Value	Operational Indicator (SVD)
Autonomy	Frequency of system overrides; degree of user choice in daily routines
Dignity	Intrusiveness level of monitoring; sensitivity of system prompts
Emotional security	Rate of stress-triggering alerts; context-appropriateness
Social connectedness	System-supported interaction opportunities; communication prompts

This addresses a common challenge: retaining normative depth without losing engineering usability.

Stage 3: Value Embedding into System Design

Operationalized SVD metrics inform design choices: monitoring profiles adapt to patient preferences and capability thresholds; alerts shift from intrusive to context-aware; prediction thresholds integrate safety probability with autonomy-preservation constraints; interfaces adopt dignity-preserving language; dashboards embed SVD indicators into recommendations. When evaluation reveals OFD gains paired with sub-threshold SVD decline (e.g., dignity/autonomy violations), VSAF mandates recalibration of alert frequency, privacy settings, thresholds, autonomy options, and override policies—establishing SVD veto power grounded in the Principle of Inviolability, preventing intrinsic values from being subordinated to instrumental rationality.

4.3. Qualitative Trend Comparison and Methodological Interpretation

4.3.1. Trend Patterns under Path A (OFD-Dominant)

- A traditional OFD-centric system typically exhibits:

- Stable or improved physiological safety (OFD ↑)
- Increased monitoring intrusiveness (SVD ↓)
- Reduced autonomy through frequent overrides
- Emotional distress due to excessive alerts
- Potential deterioration in trust between patient and system

These trade-offs illustrate why OFD maximization alone is insufficient in complex human-cantered domains.

4.3.2. Trend Patterns under Path B (VSAF-Guided)

A goal-reconstructed, VSAF-informed design shows:

- Maintenance of acceptable OFD levels
- Improved autonomy and dignity via adjustable monitoring and respectful interactions
- Reduced emotional burden from context-aware alerts
- Improved social engagement supported by personalized communication features
- Higher overall QoL trajectory over time
- Importantly, these trends emerge without presenting fabricated numerical data, relying instead on structured normative and design reasoning.

4.3.3. Conceptual Diagrams (Figures 1 and 2)

- Figure 1 (Conflict Space Diagram):

Depicts the OFD–SVD trade-off landscape, illustrating zones where safety improvements risk violating autonomy or dignity.

- Figure 2 (VSAF Recalibration Loop):

Shows how SVD thresholds trigger goal recalibration and redesign, forming a closed normative–engineering feedback cycle.

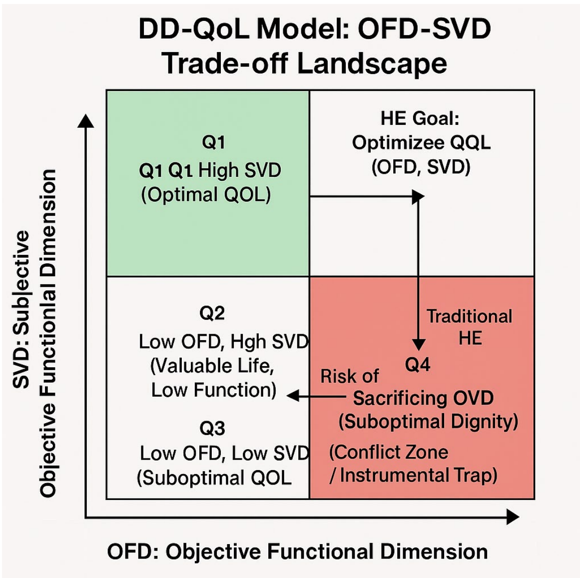

Figure 2. (Conflict Space Diagram) - OFD–SVD Trade-off Landscape

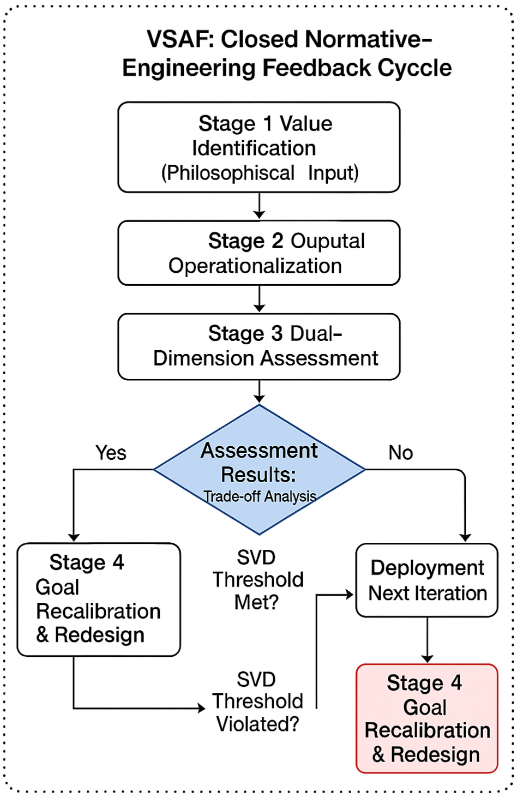

Figure 3. (VSAF Recalibration Loop) - VSAF Recalibration Loop

These diagrams visually demonstrate how VSAF provides a robust conceptual and methodological structure for goal reconstruction in HE systems.

4.4. Summary of Illustrative Example

This example demonstrates—qualitatively yet systematically—how VSAF:

- Clarifies value priorities
- Operationalizes intrinsic values
- Embeds these values into engineering design
- Provides a closed-loop recalibration mechanism

By framing this as an illustrative methodological demonstration, the study avoids overstated empirical claims while clearly showing why and how VSAF offers a promising normative and engineering pathway for QoL-oriented system design.

5. Discussion

5.1. Theoretical and Practical Implications of VSAF

The illustrative example presented in this study demonstrates the potential of the Value-Sensitive Assessment Framework (VSAF) to systematically reshape the evaluative logic of Health Engineering (HE). Although the example is qualitative rather than empirical, it provides a clear proof-of-concept of how VSAF can operate as a normative–engineering bridge. Three major implications emerge.

First, at the theoretical level, the VSAF operationalizes a shift from an instrumental rationality paradigm—where health technologies are primarily evaluated by objective functional outcomes (OFD)—toward a dual-dimension conception of Quality of Life (DD-QoL). This shift aligns HE with contemporary philosophical developments that emphasize agency, autonomy, and intrinsic value. By explicitly adopting the Capability Approach as the normative foundation and complementing it with deontological constraints, VSAF demonstrates how philosophical value theory can be rendered operational within engineering workflows. This resolves the tension between non-consequentialist commitments (e.g., inviolability of autonomy) and the inherently outcome-driven nature of QoL assessment.

Second, at the methodological level, the example shows how VSAF provides a structured evaluative procedure capable of detecting "value sacrifice" that traditional OFD-centric models overlook. Through the introduction of SVD thresholds and veto conditions, VSAF reframes SVD not as a secondary human-factors metric but as a goal-level determinant of acceptable system performance. This directly addresses the "instrumental trap" identified in the literature, where improvements in technical efficiency can coincide with erosion of autonomy or dignity. By embedding this evaluative logic into the assessment and redesign loop, VSAF offers a systematic, repeatable, and normatively defensible method for goal calibration.

Third, at the practical level, VSAF illustrates how conceptual engineering can guide system-level reconfiguration in real design contexts. The example of the AI-assisted care system shows that VSAF does not merely add abstract value considerations but yields concrete implications for alert architecture, monitoring frequency, user-system interaction styles, and caregiver override policies. This suggests that VSAF could serve as a governance-oriented tool for multidisciplinary HE teams—bridging engineers, clinicians, ethicists, and human-factors researchers—by making value implications explicit and negotiable during design iterations.

Overall, the theoretical and practical implications converge on a single claim: VSAF provides a structured means of incorporating intrinsic value into the core evaluative logic of health technologies, without overstating empirical promises or claiming evidential strength beyond what illustrative analysis can support.

5.2. Comparison with Existing Frameworks

While Section 2.2 offered a systematic comparison between DD-QoL/VSAF and established frameworks such as HRQoL instruments, the Capability Approach, Positive Health, and Value-Sensitive Design (VSD), the discussion here aims to draw out the broader implications of this comparison.

Most existing frameworks fall into one of two categories:

- Descriptive/Post-Design Assessment Models

HRQoL instruments (e.g., EQ-5D, WHOQOL) provide validated tools for measuring QoL outcomes but do not prescribe how engineering goals should be set or recalibrated. They operate downstream of design, and therefore cannot address goal-level misalignment.

- Normative but Non-Operational Frameworks

Philosophical models such as the Capability Approach or eudaimonic theories offer deep accounts of intrinsic value but lack methodological instructions for translating value commitments into engineering processes.

- Design-Phase but Non-Goal-Level Models

VSD is a valuable design methodology but remains focused on embedding values within design specifications, not on redefining the overarching engineering objective.

VSAF occupies a conceptual space that none of these frameworks individually cover. It integrates:

- the normative depth of classical value theories
- the operational structure of assessment frameworks
- the procedural guidance of design methodologies

This enables VSAF to function as a goal-reconstruction framework, not merely a design-phase supplement. Its conceptual engineering basis distinguishes it from VSD, while its explicit dual-dimension QoL model differentiates it from HRQoL scales and Positive Health.

6. Conclusion

This study advances two interconnected contributions to the theory and practice of Health Engineering.

- Conceptual Contribution: The DD-QoL Model

The Dual-Dimension Quality of Life (DD-QoL) model provides a conceptual structure in which both OFD and SVD are recognized as constitutive components of QoL. This model reframes the ultimate goal of HE from "maximizing functional outcomes" to "optimizing QoL," highlighting the irreducibility of subjective value dimensions such as autonomy, dignity, and emotional well-being.

- Methodological Contribution: The VSAF Framework

The Value-Sensitive Assessment Framework (VSAF) operationalizes this conceptual shift by offering a four-stage evaluative and recalibrative process that integrates normative theory, SVD operationalization, dual-dimension assessment, and value-constrained redesign. It provides an explicit methodological bridge between philosophical value theory and engineering practice.

- Applied Insight: Illustrative Demonstration

A qualitative case study of an AI-assisted care system shows how VSAF can inform concrete design decisions while protecting intrinsic value through SVD thresholds and veto conditions. Although not empirical, the example supports the claim that VSAF offers a promising trajectory for enhancing SVD without compromising OFD.

Together, these contributions articulate a coherent and operationally grounded framework for rethinking HE evaluation.

6.1. Conclusion Refinement and Future Outlook

Given the non-empirical nature of the demonstration, we intentionally moderate the inferential strength of our claims. Instead of asserting that VSAF empirically demonstrates superior performance, we adopt a more epistemically appropriate framing:

VSAF suggests a promising path for achieving SVD enhancement without compromising OFD.

The framework supports the incorporation of deontological constraints into HE evaluation, ensuring the protection of intrinsic value.

These revised statements remain strong enough to highlight the significance of the framework while avoiding overclaiming.

Looking forward, three major research directions emerge:

- Empirical Validation

Applying VSAF to real clinical datasets, prototype systems, or longitudinal deployments to assess how OFD–SVD trade-offs manifest and how recalibration rules perform in practice.

- Operational Refinement of SVD Indicators

Extending the operationalization of autonomy, dignity, emotional security, and social connectedness into validated measurement instruments and scalable assessment tools.

- Generality Across HE Domains

Examining VSAF's applicability beyond AD care—such as rehabilitation engineering, mental health technologies, paediatric assistive systems, or human–AI co-decision contexts—thus testing its robustness across diverse normative challenges.

In summary, the DD-QoL model and VSAF collectively provide a structured, philosophically grounded, and practice-oriented foundation for re-orienting Health Engineering toward QoL-cantered objectives. While further empirical work is required, the framework offers a compelling and defensible direction for future HE research and system development.

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