Boundary Objects: Reimagining Design for Longevity and Gender Equality

Sheng-Hung Lee

Abstract In the era of longevity and experience economy, our social infrastructure has been reshaped by disruptive demographic shifts, the aging population, emerging immersive technologies, climate change, digital transformation, evolving education platforms, and many other factors. Consequently, the Design for Longevity (D4L) perspective has emerged as a pivotal lens, offering individuals comprehensive insights to navigate the complicated, systemic challenges that intertwine social, technological, cultural, and political issues, including gender equality. This study leveraged boundary objects, known for their interpretive flexibility, to enable the integration and exchange of knowledge. This flexibility allows for various interpretations to emerge from the same information and facilitates translation across individuals or communities from diverse backgrounds. Specifically, the author utilized 12 Design for Longevity (D4L) cards as boundary objects and applied a think-aloud methodology in six participatory workshops, combining the results with surveys and semi-structured interviews. These cards elicited participants' narratives and perceptions related to D4L and facilitated their collective sense-making and knowledge translation with respect to gender equality (GE). The research explored the potential and limitations of D4L cards as boundary objects in empowering individuals to envision their future selves within the contexts of D4L and GE from three studies in collaboration with the Taiwan Design Research Institute in Taipei, Taiwan, the Design Management program at Macromedia University in Cologne, Germany, and the Social Design Hub at the Moholy-Nagy University of Art and Design Innovation Center in Budapest, Hungary.

Keywords Longevity planning · Design for longevity · D4L cards · Gender equality · Boundary objects

S.-H. Lee (✉)
Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, MA, USA
e-mail: shdesign@mit.edu

AgeLab, Massachusetts Institute of Technology, Cambridge, MA, USA

C. Sedini (ed.), *Gender Perspectives for a Renewed Design Culture*, Springer Series in Design and Innovation 54, https://doi.org/10.1007/978-3-031-88554-9_8

1 Introduction

In an era marked by global aging [1], disruptive demographic shifts [2], the rise of service-and-experience-driven industries [3, 4], emerging technologies [5], and digital transformation [6], the question arises: How do we embrace, prepare for, and adapt to longevity economics within a multi-generational environment and workforce, and diverse cultures? This context has given rise to the concept of Design for Longevity (D4L), a holistic lens and approach that considers an individual's life stages across different ages [7, 8]. D4L emerges in response to the growing desire for a better quality of life among people worldwide [9]. Gender equality (GE) is one critical dimension to consider.

1.1 Boundary Objects: An Elephant in the Room

The inherent complexity and sensitivity of topics like D4L and GE have sparked the author's curiosity and motivation to employ the concept of boundary objects for exploration. Star and Griesemer first introduced the concept of boundary objects in 1989. Boundary objects possess "interpretive flexibility," enabling the integration and exchange of knowledge, allowing various interpretations to emerge from the same information, and facilitating the translation of information across individuals or communities from diverse backgrounds [8, 9].

A metaphorical way to grasp the concept of boundary objects is by picturing the scenario of the elephant in the room. Imagine several blind individuals, each touching different parts of the elephant, thus forming diverse interpretations and ideas based on their specific encounters. Without the elephant, there would be no common reference point for discussion or understanding of the experiences within the room. Hence, the elephant acts not merely as an object but as a boundary object, fostering collective sense-making, knowledge translation, and narrative construction. In this study, the concepts of D4L can be seen as our metaphorical elephant, representing boundary objects that materialize through 12 D4L cards. These cards serve to concretize the principles of D4L, facilitating their application across various domains and stimulating collaborative thoughts about GE.

1.2 The 4Es Framework and D4L Cards

The 4Es framework [10] is inspired by Coughlin's 8,000-day concept [11], an innovative model that divides an individual's retirement into four stages: managing ambiguity, making big decisions, managing complexity, and living solo. The 4Es framework organizes these concepts into four stages—ensure (foundation), evolve (transformation), empower (extension), and enjoy (result)—and acts as a tool to aid in

the generation of ideas through the layers of products, platforms, and services that address D4L and GE issues. A guiding question at each stage encourages participants to think deeply about the challenges and opportunities of longevity. This study also integrates GE as a key area of focus (Table 1).

The 12 D4L cards, a product of the 4Es framework, help participants project their future selves within the realms of D4L and GE across 12 dimensions: mobility, home, community, education, health, family, future, investment, risk, trust, care, and communication. Each card is composed of four essential elements: an illustration, a keyword, a thought-provoking question, and a scenario suggestion, all crafted to vividly VERB the context of D4L and GE (Fig. 1).

Table 1 The 4Es framework and D4L cards [12]

4Es	Ensure	Evolve	Empower	Enjoy
Stages	Foundation	Transformation	Extension	Result
Guiding questions	What do you need to ensure? What is basic to your future wellbeing?	What needs to evolve with you? What transforms with you over time?	What can empower you? How can you extend your impact?	What do you enjoy? What outcomes do you benefit from?
D4L cards keywords	Mobility, home, community	Education, health, family	Future, risk, investment	Trust, care, communication

Fig. 1 The 12 D4L cards are designed with four key elements: an illustration, a keyword, a thought-provoking question, and a scenario suggestion. These elements aid participants in navigating the complex, sensitive discussions related to D4L and GE

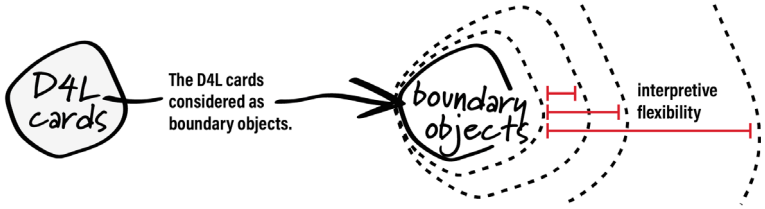

Fig. 2 In this study, the 12 D4L cards were employed as boundary objects to capture various interpretations of D4L and GE from participants with different backgrounds

As demonstrated in the three studies discussed in this article, the 12 D4L cards served not merely as effective research tools but also as boundary objects (Fig. 2). This dual function of D4L cards enabled the participants' engagement in collective sense-making, knowledge translation, and the articulation of meaningful narratives during the workshops.

1.3 Research Question and Hypothesis

The study seeks to assess the values and constraints of boundary objects, specifically D4L cards, in facilitating individuals' projection of their future selves in the context of D4L and GE. D4L cards, defined as boundary objects for this experiment, served as a prompt to elicit participants' narratives, perceptions, and ideas concerning D4L and GE.

The research operates under two guiding hypotheses:

1. Individuals from diverse demographic backgrounds will develop their interpretations of D4L and GE.
2. Employing D4L cards as boundary objects will enhance participants' articulation of their future selves, including needs and visions, while also supporting facilitators in navigating discussions more efficiently.

This preliminary study compiles results from six participatory workshops, surveys, and semi-structured interviews across three separate investigations in Taipei, Taiwan; Cologne, Germany; and Budapest, Hungary. Each investigation was descriptive research that employed a think-aloud methodology to integrate and synthesize findings (Table 2).

Table 2 The overviews of three studies from Asia and Europe

	Study 1	Study 2	Study 3
Major challenge	Design healthcare service for longevity	Apply D4L concept to different projects	Project future selves through D4L
Location	Taipei, Taiwan	Cologne, Germany	Budapest, Hungary
Format	In-person	Virtual	Hybrid
Time	Jun. 2023–Dec. 2023	Oct. 2023–Jan. 2024	Dec. 2023–Apr. 2024
Key collaborator	Taiwan Design Research Institute (TDRI)	Macromedia University of Applied Sciences	MOME Social Design Hub
Participant	25 participants	20 participants	20 participants
Research approach	1 participatory workshop, and 1 pre- and post-workshop survey	1 participatory workshop and 3 course lectures and discussion	4 participatory workshops and 4 semi-structured interviews

2 Literature Review

This section focuses on the concept of the boundary object, exploring its definitions, the characteristics of interpretive flexibility, examples, and its connection to and implications for D4L and GE.

2.1 The Notion of Boundary Objects

The concept of boundary objects, initially introduced by sociologists Star and Griesemer in 1989 [13], describes entities that hold different meanings in various social contexts but retain a structure that is universally identifiable across different communities [14]. Boundary objects are tools that facilitate the translation of information across the boundaries of different groups. This allows individuals from diverse groups to interpret and communicate distinct meanings from the same set of information, revealing significant differences and dependencies among these groups [12]. From an operational standpoint, a boundary object is a distinctly defined entity, whether it be an object, process, or interaction, that influences multiple domains. A boundary object can facilitate collective sense-making among individuals or communities by providing a common point of reference.

For instance, considering maps as boundary objects reveals a collective process of understanding and highlights the diverse requirements and interests of different users. Some may use a map to locate a movie theater, others to plan a family trip, and yet others to present the development of the local city's history. Each use case

reflects a distinct perspective and purpose, demonstrating the versatile role of maps as boundary objects in facilitating varied types of engagement and interpretation.

If we break down the term "boundary objects" into two parts, the term "boundary" can suggest the ideas of periphery, edge, or margin, implying separation. In this context, we use it to highlight a shared space where different individuals or communities intersect. The term "object" is understood not only as a tangible artifact but also through the interactions and responses it elicits from people, other objects, or programs, highlighting its role as a mediator or facilitator. Essentially, an object is defined by the interactions, behavior, or actions rather than by its inherent material properties or prefabricated things [15].

2.2 Interpretive Flexibility

Boundary objects offer the characteristic of interpretive flexibility since they can adapt to multiple interpretations across different knowledge boundaries while being rigid enough to maintain specific meanings within those boundaries. For example, maps can serve as a platform of diverse forms (e.g., printed, digital, audio) to encourage participation and the formation of collective identities. They guide various communities and stakeholders toward shared goals and ensure alignment with broader processes [16]. Interpretive flexibility allows individuals to identify objects or artifacts that facilitate bridging knowledge gaps.

Boundary objects should be defined with enough flexibility to enable effective integration of knowledge and processes across diverse groups within teams [13, 14]. Furthermore, Wenger [16] considered the concept of boundary objects through four dimensions: (1) abstraction, enabling cross-disciplinary communication; (2) multi-tasking, supporting a variety of activities or practices; (3) modularity, whereby different components of the object facilitate dialogue among key stakeholders; and (4) standardization, ensuring the object's information is understandable. Expanding upon this definition, boundary objects are interpreted to include a wide array of artifacts, such as tangible representations (e.g., D4L cards, maps), classifications, directories, and standardized approaches [17].

2.3 Transfer, Translation, and Transformation

Based on the literature review and the focus of this study, the concept of boundary objects can be distilled into the following three essential characteristics [16–19]:

1. Knowledge divergence transfer: Boundary objects involve actors engaged in managing information formats, values, and practices, allowing experts from various backgrounds not only to address challenges but also to form stable relationships through the alignment of shared visions.

2. Perspective translation: Boundary objects allow actors engaged in a joint activity to offer explanations from different viewpoints to foster the activation, mobilization, and maneuvering of practices in situations where concepts are unknown.
3. Knowledge and interest transformation: Boundary objects enable actors with differing interests to discuss and build consensus, aiming to reach acceptable compromises with the development of shared visions.

3 Research Methods and Case Studies

This section highlighted the findings from three case studies conducted during field research (Table 2). Each study illustrated our application of D4L cards as boundary objects to navigate the intricate subject of GE centered around D4L (Fig. 3). These case studies utilized participatory workshops and design methodologies, incorporating a think-aloud approach and semi-structured interviews to gather both verbal and non-verbal (behavioral) responses from participants. Analysis of these workshop discussions and interviews was conducted using ATLAS.ti, a computer-assisted qualitative data analysis software (CAQDAS).

3.1 Study 1-Healthcare Services in D4L

Study 1 aimed to use D4L cards to explore and envision healthcare services and systems in Taipei City, Taiwan (Fig. 4). It involved 25 participants, consisting of 10% medical professionals, 20% caregivers, 30% patients, and 40% medical suppliers. Each of the five teams was supported by a facilitator from TDRI throughout the

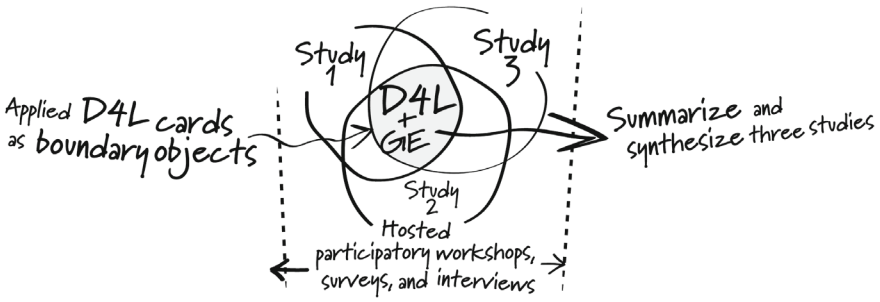

Fig. 3 The research structure involves defining and utilizing 12 D4L cards as boundary objects to facilitate five participatory workshops, conduct surveys and interviews, and compile and integrate the insights centered around D4L and GE from three studies conducted in Taiwan, Germany, and Hungary

Fig. 4 One team creatively utilized the combination of four posters and 12 D4L cards as a powerful tool for inspiration, enabling them to develop and articulate their scenario for envisioning a longevity service in healthcare

three-hour workshop; the D4L cards acted as a catalyst for fostering discussions among participants that were more productive, insightful, and engaging.

Moreover, each team was equipped with four boards, and they were guided through a four-step process as outlined on these boards: (1) Define the audience: Who is your D4L persona? Using this poster, participants developed a persona. (2) Clarify objectives: What values are significant to D4L? Here, participants prioritized keywords based on their relevance to their persona. (3) Identify design opportunities: When and where can D4L be integrated into healthcare services? Participants employed the four probing questions derived from the 4Es framework to generate ideas for healthcare services tailored to their persona. (4) Visualize concepts: Why is longevity significant to healthcare services? Participants used this board to storyboard their final concept.

The workshop concluded with each group delivering a five-minute presentation to showcase their design process and outcome, including (1) a D4L persona, (2) values relevant to D4L, (3) healthcare services integrated with D4L principles, and (4) their enhanced comprehension of longevity. Many teams expressed an interest in delving into long-term healthcare solutions, focusing on human-centered design strategies for managing conditions like dialysis or diabetes care. Additionally, our observations revealed that the default caregivers in most teams are female rather than male. This trend may perpetuate societal gender stereotypes. Surveys conducted before and after the workshop served as a valuable method for collecting feedback from participants.

3.2 Study 2-Education in D4L

Study 2 sought to showcase the educational benefit of utilizing D4L cards among 20 master's students specializing in communication and design at Macromedia University of Applied Sciences in Cologne, Germany. The curriculum included three virtual lectures, critiques, and discussions, augmented by post-course office hours. Furthermore, the author facilitated an accessible, participatory workshop environment by offering virtual D4L cards and a workspace on Miro, a digital collaboration platform, to enhance the learning process and outcomes. In Study 2, the 12 D4L cards served as virtual boundary objects, sparking participants' curiosity and motivating them to share reflections relevant to D4L and GE.

These sessions also aimed to examine how graduate students implemented D4L cards in their research projects, focusing on defining their own longevity planning, understanding the study process, and proposing potential design solutions in the context of D4L and GE. Five teams presented their final projects, offering reflections on their use of D4L. Notably, one team focused its research on gender and menopause (Fig. 5).

3.3 Study 3-Vulnerable Community in D4L

Study 3 aimed to show how vulnerable communities envision their future selves by employing D4L cards and learning how to make and prototype their ideas (Fig. 6). The participants were teenagers aged 18–25 from the Belvárosi Tanoda Foundation Secondary School, also known as The Helping School, located in Budapest, Hungary. The study included four three-hour in-person lectures and workshop sessions with the participants. Guided by their interests, participants formed three teams, each concentrating on distinct themes across products, services, and systems.

For instance, one team tackled the challenge of reforming existing education systems to enhance equity, accessibility, and respect for individuals from diverse socioeconomic backgrounds. Another team dedicated its efforts to developing a financial planning app aimed at boosting Hungary's low financial literacy rate. The final team crafted a holistic service experience that emphasized the significance of human-centered design. Regarding gender representation, one team noted that most figure drawings and targeted users in their design concepts were portrayed as gender-neutral, with no specific individual emphasized in the scenarios.

A week after finishing the four participatory workshops, we conducted four virtual semi-structured interviews lasting 15–20 minutes each with three teams of participants and one faculty member involved in the class. The results of these interviews were visualized using a Sankey diagram, which facilitated the identification of emerging themes and interconnections of 148 newly created codes stemming from 39 new coded quotations. This analysis leveraged the new AI-enhanced coding analysis function from ATLAS.ti and incorporated five prompt questions tied to five specific

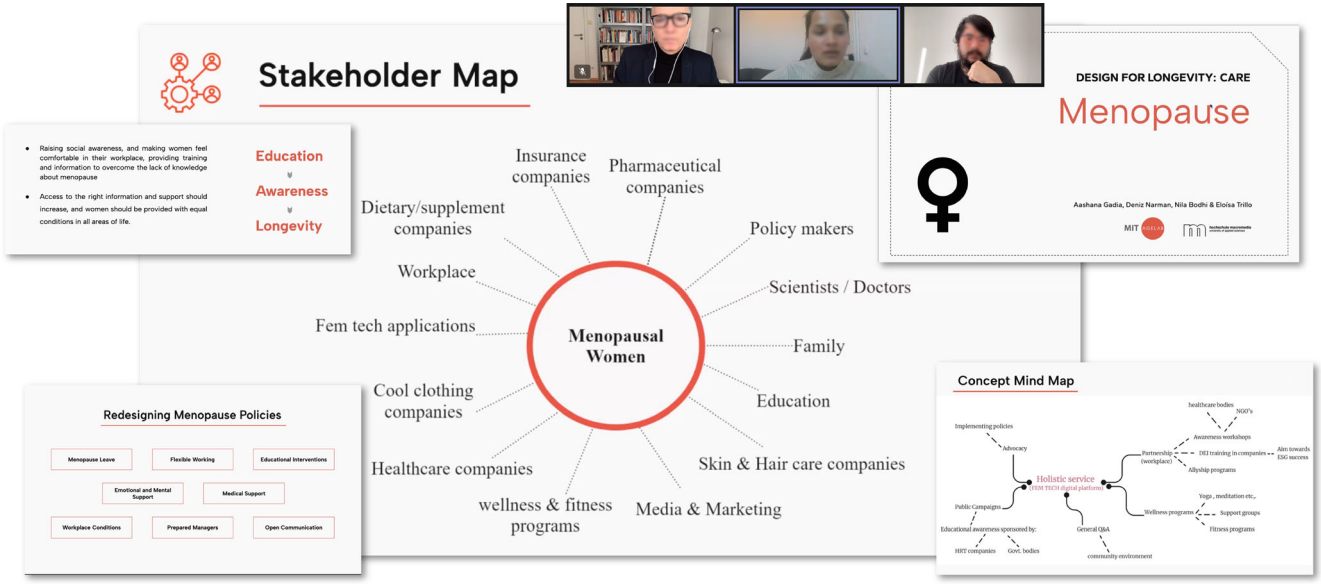

Fig. 5 The screenshot depicts a team's exploration of menopause using the D4L framework to examine insights related to gender equality, inclusive workplaces, governmental policies, social economics, and diverse cultures

Fig. 6 Conducting a participatory workshop with the teenagers to understand their goals, concerns, and challenges through the use of D4L cards

code categories: longevity, the impact of gender, gender roles, economic disparities, and social factors (Table 3).

We employed AI-enhanced coding analysis to refine our coding approach and assist researchers in synthesizing the results from four interview transcripts. They were also encouraged to complete pre- and post-workshop surveys. These surveys were designed to assess their understanding of D4L, personal interests, future aspirations, and their knowledge of design and prototyping.

Table 3 The five code categories are associated with prompt questions (the code and questions were co-designed with the researcher from MOME Social Design Hub)

Code categories	Prompt question for AI-empowered coding analysis
Longevity	How does the design process assist participants in envisioning their future selves?
Gender impact	How does gender influence participants' perceptions of the concept of longevity?
Gender roles	How do gender roles affect group dynamics or ideas development?
Economic disparities	How does gender react differently to various economic disparities?
Social factors	What are the social factors that participants believe impact the concept of longevity and gender?

4 Research Result and Discussion

Across six participatory workshops held in Asia and Europe, participants exhibited varying levels of engagement and comprehension with 12 D4L cards, which served as boundary objects. Their reflections were partly captured through semi-structured interviews (Fig. 7). Considering the scope of the three studies and the focus of this article, the author emphasized the analysis of four semi-structured interview transcripts that related to D4L and GE in Study 3.

4.1 Emerging Codes Mapping and Network

In the analysis of four interview transcripts in Study 3, the author collaborated with the researcher from Moholy-Nagy University of Art and Design (MOME) Innovation Center Social Design Hub to identify and apply five relevant code categories and five prompt questions as input (Table 3). This approach led to an AI-driven coding analysis using ATLAS.ti, which not only produced 148 relevant sub-codes but also generated five new code categories: future visions, adaptability, guidance, societal dynamics, and community impact. It was intriguing to observe that the analysis of the four interview results highlighted emerging themes that were closely aligned with the initial code categories of longevity, gender impact, gender roles, economic disparities, and social factors.

We identified new codes associated with D4L, GE, and longevity and mapped their interrelations using ATLAS.ti Networks, a tool aiding in conceptualizing data by visually and structurally connecting related components and elements, such as codes and quotations, in a diagram [20]. The link connections among these categories and their relation to the broader study objectives are illustrated, showcasing the synthesized outcomes (Fig. 8).

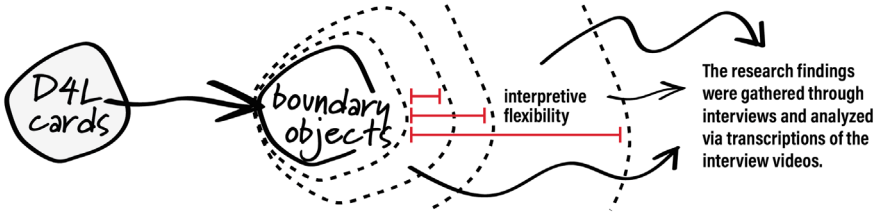

Fig. 7 The intention behind employing D4L cards as boundary objects was to facilitate collective sense-making, knowledge translation, and the articulation of stories among participants across six participatory workshops

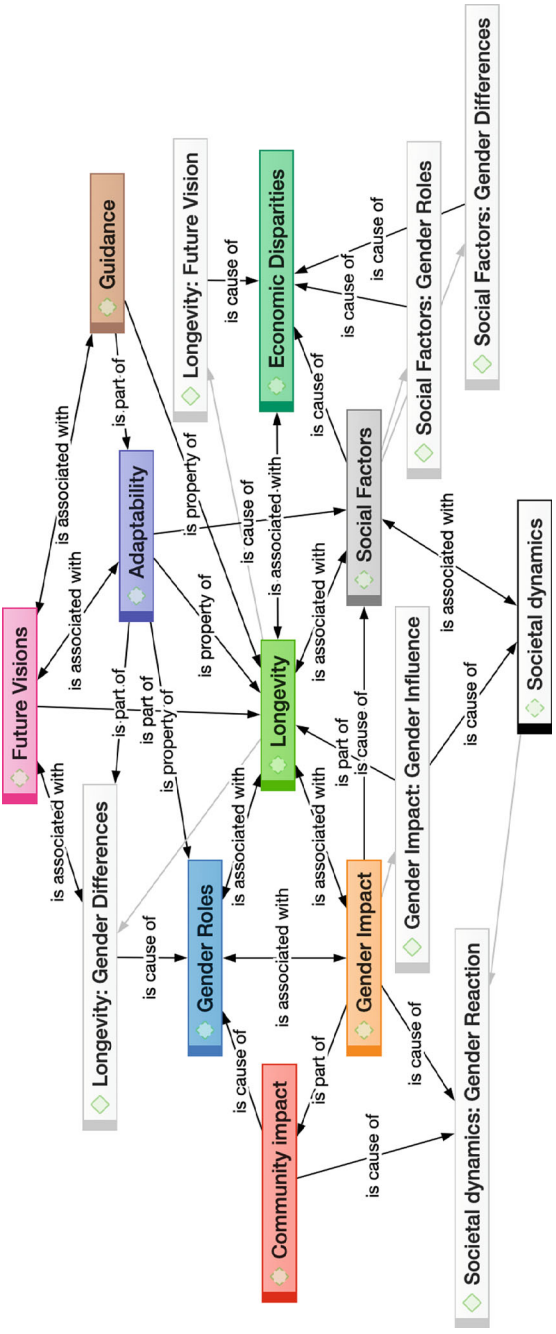

Fig. 8 In Study 3, the interview analysis led to the generation of ten code categories. These were derived from the AI-empowered coding function of ATLAS.ti and further curated and synthesized by researchers, focusing on themes related to D4L, gender equality (GE), and longevity, culminating in the creation of a network (map)

4.2 Longevity, Gender Impact, and Gender Roles

In Study 3, the Sankey diagram (Fig. 9) serves as a visual tool to represent complex analytical processes, focusing on a specific aspect highlighted by the research [20]. This analysis delved into the 10 code categories, examining the interactions between gender impact, gender roles, and longevity, along with all other emerging codes. The goal was to identify the prevailing factors. The analysis revealed that the code categories of gender impact (e.g., how gender affects participants' views on the concept of longevity) and gender roles (e.g., how gender roles influence group dynamics and the development of ideas) had relatively balanced relationships with the remaining categories, suggesting that the issue of gender equality requires a comprehensive perspective to fully understand its complex and private challenges. Similarly, the category of longevity showed strong connections with three specific code categories: future visions, adaptability, and social factors, indicating its significant role in the analysis.

5 Conclusion

In this study, the 12 Design for Longevity (D4L) cards, identified as boundary objects, functioned not only as catalysts for eliciting participants' narratives and perceptions related to D4L but also for facilitating their collective sense-making and knowledge translation regarding gender equality (GE). Therefore, the goal of the study is to investigate the potential and limitations of D4L cards as boundary objects in enabling individuals to envision their future selves within the realm of D4L and GE. This study aggregates insights from six participatory workshops, surveys, and semi-structured interviews conducted as part of three distinct investigations in Taipei, Taiwan; Cologne, Germany; and Budapest, Hungary. Each investigation constituted descriptive research utilizing a think-aloud approach to integrate and synthesize findings.

5.1 D4L and GE Are Inexplicit, Sensitive, and Personal Topic

Most participants often perceive the subjects of D4L and GE as vague, sensitive, and private. The terms D4L and GE are context-dependent, especially since participants from the three studies came from Asia or Europe. In this context, GE encompasses longevity, gender impact, gender roles, economic disparities, and social factors (Table 3). Utilizing 12 D4L cards as boundary objects facilitated the creation of a safe space and a friendly and accessible environment, enabling individuals to share their reflections and opinions through the use of these cards. Participants engaged with the cards in various ways, such as answering questions and scenarios presented

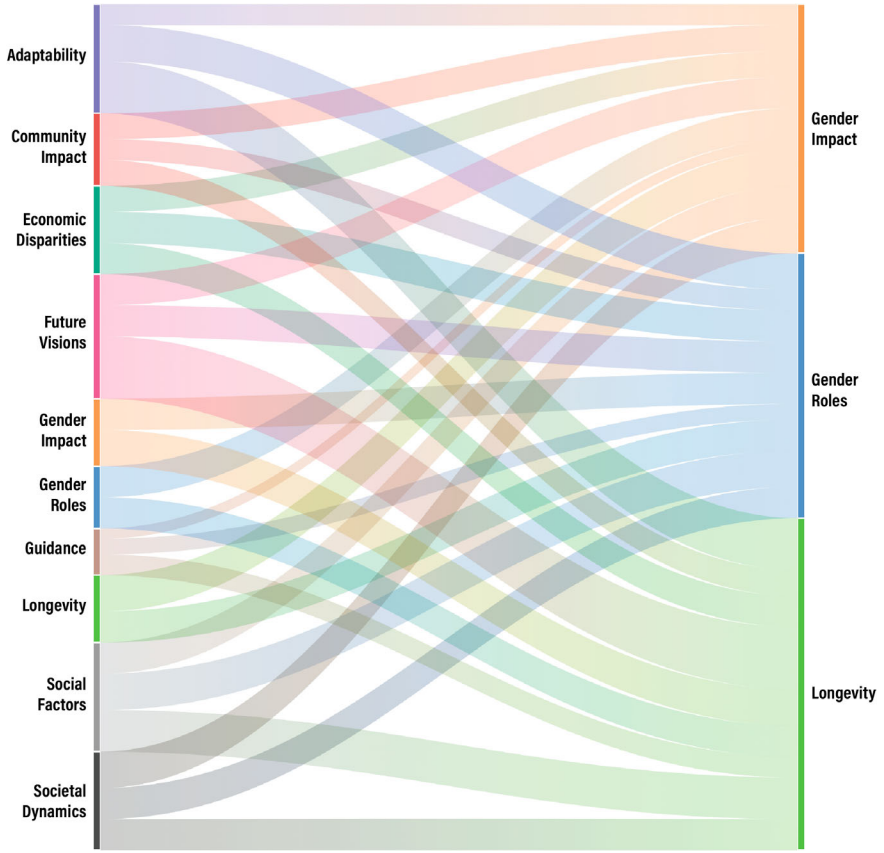

Fig. 9 The Sankey diagram depicts the interconnected relationships among 10 code categories derived from the analysis of four semi-structured interview transcripts

on them or interpreting the 12 keywords according to their own cultural background, language, life rituals, and personal experiences. As a result, despite the implicit, sensitive, and personal nature of D4L and GE topics, strategically leveraging D4L cards in workshops facilitates the transition from abstract concepts to narrative stories and from mere information to engaging discussions. D4L cards were pivotal as cognitive mediators, fostering interpretive flexibility that established a safe and inclusive space for individuals from diverse backgrounds [17]. Additionally, they can act as social mediators to address and resolve issues extending beyond GE and identity [21].

5.2 *The Value and Constraints of Using D4L Cards as Boundary Objects*

The value of leveraging 12 D4L cards offers individuals a sense of control, allowing them to physically handle the cards and decide what they wish to share or withhold from their peers, within their teams, or in diverse communities. The cards serve as a useful toolkit, empowering them to navigate and understand unfamiliar knowledge domains. Theoretically, the concept of boundary objects is dynamic, transforming over time, across different contexts, and among various actors or stakeholders. Effective boundary objects can evolve into a common language or shared standard [22]. However, the limited space and content on the tangible 12 D4L cards may restrict their ability to fully explore ideas related to D4L and GE. A key consideration for the future is devising ways to enhance the flexibility of D4L cards as boundary objects, thus broadening their interpretive potential and fostering a wider range of ideas and visions centered on D4L and GE.

Acknowledgements The author expresses gratitude for the significant support received from the MIT AgeLab, MIT Ideation Lab, Taiwan Design Research Institute (TDRI), Macromedia University of Applied Sciences, and the Innovation Center Social Design Hub at Moholy-Nagy University of Art and Design (MOME).

References

1. WHO (2022) Ageing and health. https://www.who.int/news-room/fact-sheets/detail/ageing-and-health. Last accessed 30 Jan 2025
2. Coughlin JF (2014) Disruptive demography: the new business of old age. In: Irving PH, Beamish R (eds) The upside of aging. Wiley, New Jersey, pp 51–62
3. Lee S-H, Yang MC, de Weck OL, Lee C, Coughlin JF, Klopfer E (2023) Macro-trend study under service system: preliminary research in service innovation and emerging technology. In: Hamid UZA, Suoheimo M (eds) Service design for emerging technologies product development: bridging the interdisciplinary knowledge gap. Springer International Publishing, Cham, pp 45–72
4. Pine BJ, Gilmore JH (2020) The experience economy: competing for customer time, attention, and money. Harvard Business Review Press, Boston, Massachusetts
5. Etkin K (2021) The AgeTech revolution: a book about the intersection of aging and technology. New Degree Press, Potomac, Maryland
6. Lee S-H, De Weck OL, Yang MC, Coughlin JF (2023) The transformation of design platform under system thinking. Int J Perform Arts Digit Media 19(3):507–535
7. Lee S-H, Coughlin JF, Balmuth A, Lee C, Cerino L, Yang M, Klopfer E, de Weck OL, Ochsendorf J (2023) Designing longevity planning blocks through experimental participatory observation and interviews. In: De Sainz Molestina D, Galluzzo L, Rizzo F, Spallazzo D (eds) IASDR 2023: life-changing design, 9–13 Oct, Milan, Italy
8. Golden S (2022) Stage (not age): how to understand and serve people over 60-the fastest growing, most dynamic market in the world. Harvard Business Review Press, Boston, Massachusetts
9. Carstensen LL (2011) A long bright future: happiness, health, and financial security in an age of increased longevity. Public Affairs, New York

10. Lee S-H, Hodara S, Coughlin JF, Yang M, Chen Y-C, Lin Y-C, Liou S-N (2023) Designing healthcare services for longevity. In: Liu Y, Li B, Chen F, Xu M, Hao N, Han T, Zhang X, Hu H, Gong M (eds) Narratives of love, 22–24 Nov, Cumulus, Beijing, China, pp 596–602
11. Coughlin JF (2019) Planning for 8000 days of retirement: advisor value in today's longevity economy. Investments & Wealth Institute, 3 April, Greenwood Village
12. Brubaker ER, Sheppard SD, Hinds PJ, Yang MC (2023) Objects of collaboration: roles and sequences of objects in spanning knowledge group boundaries in design. J Mech Des 145(3):031404
13. Star SL, Griesemer JR (1989) Institutional ecology, 'translations' and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. Soc Stud Sci 19(3):387–420
14. Johnson M, Anderson M (2020) Getting on the same page: bridging boundaries through mapping. In: Anderson M, Dijk GV (eds) Explorers: thoughts on mapping in design research. STBY Ltd., UK, pp 28–30
15. Star SL (2010) This is not a boundary object: reflections on the origin of a concept. Sci Technol Human Values 35(5):601–617
16. Wenger E (2010) Communities of practice and social learning systems: the career of a concept. In: Blackmore C (ed) Social learning systems and communities of practice. Springer, London, London, pp 179–198
17. Trompette P, Vinck D (2009) Revisiting the notion of boundary object. Revue d'anthropologie des connaissances 3(3–1)
18. Barrett MI, Oborn E (2010) Boundary object use in cross-cultural software development teams. Hum Relat 63:1199–1221
19. Vaast E, Levina N (2006) Multiple faces of codification: organizational redesign in an IT organization. Organ Sci 17(2):190–201
20. Friese S (2021) ATLAS.ti 9 user manual: sankey diagram (software instruction)
21. Sapsed J, Salter A (2004) Postcards from the edge: local communities, global programs and boundary objects. Organ Stud 25(9):1515–1534
22. Millo Y, Mackenzie D (2007) Building a boundary object: the evolution of financial risk management. CARR Discussion Papers (DP 48). ESRC Centre for Analysis of Risk and Regulation, London, UK
23. Caccamo M, Pittino D, Tell F (2023) Boundary objects, knowledge integration, and innovation management: a systematic review of the literature. Technovation 122:102645
24. Alamad S, Hidayah NN, Lowe A (2021) A shared boundary object: financial innovation and engineering in Islamic financial institutions. Br Account Rev 53(3):100958
25. Spee AP, Jarzabkowski P (2009) Strategy tools as boundary objects. Strateg Organ 7(2):223–232
26. Carlile PR (2004) Transferring, translating, and transforming: an integrative framework for managing knowledge across boundaries. Org Sci 15(5):555–568