Analysing Characteristics of Smart Home Product Service System (SH-PSS) through Kano Model Approach

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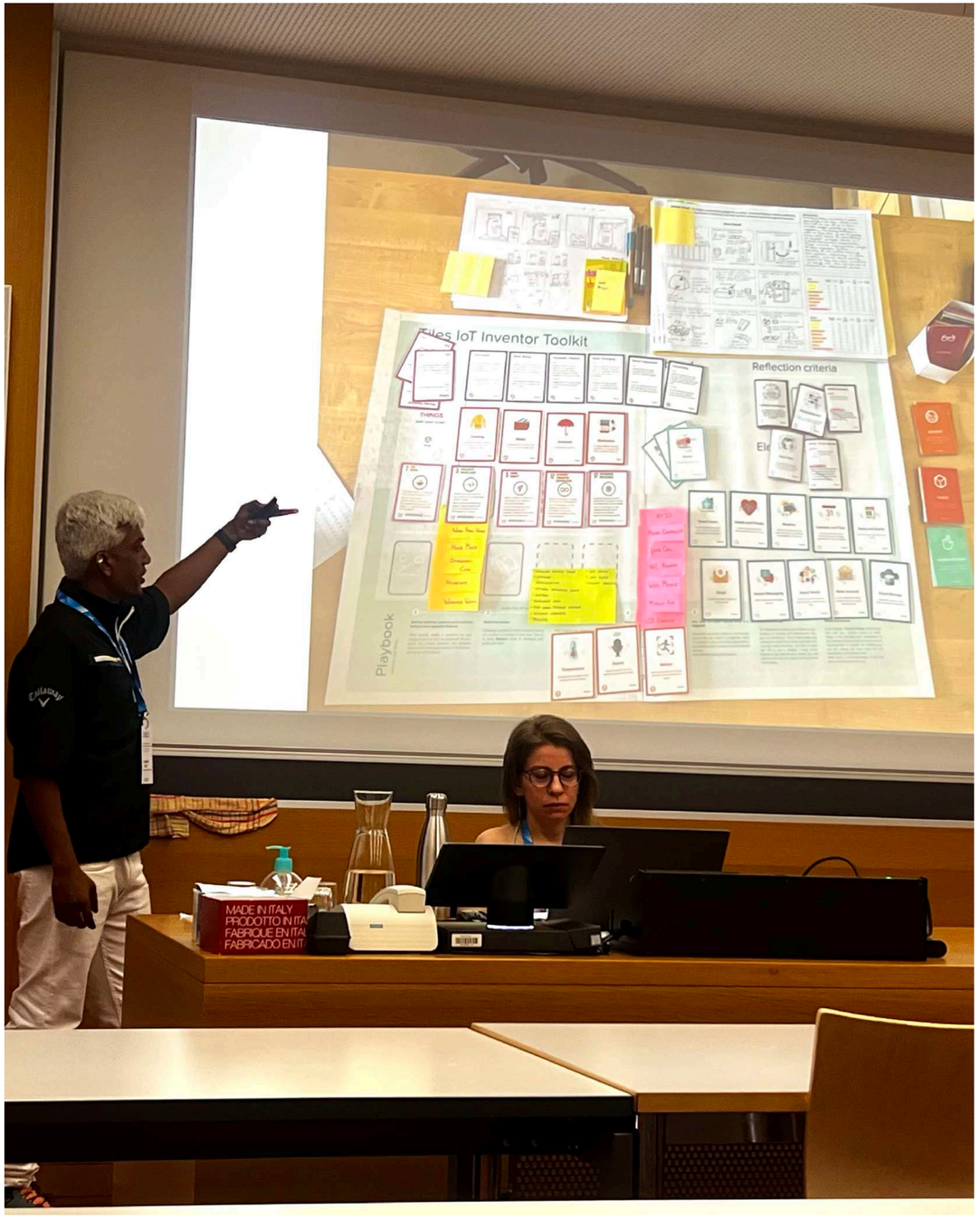

IoT Inventor Toolkit
Reflection criteria
Playbook
MADE IN ITALY

Research Question

RQ1, RQ2, RQ3 and RQ4

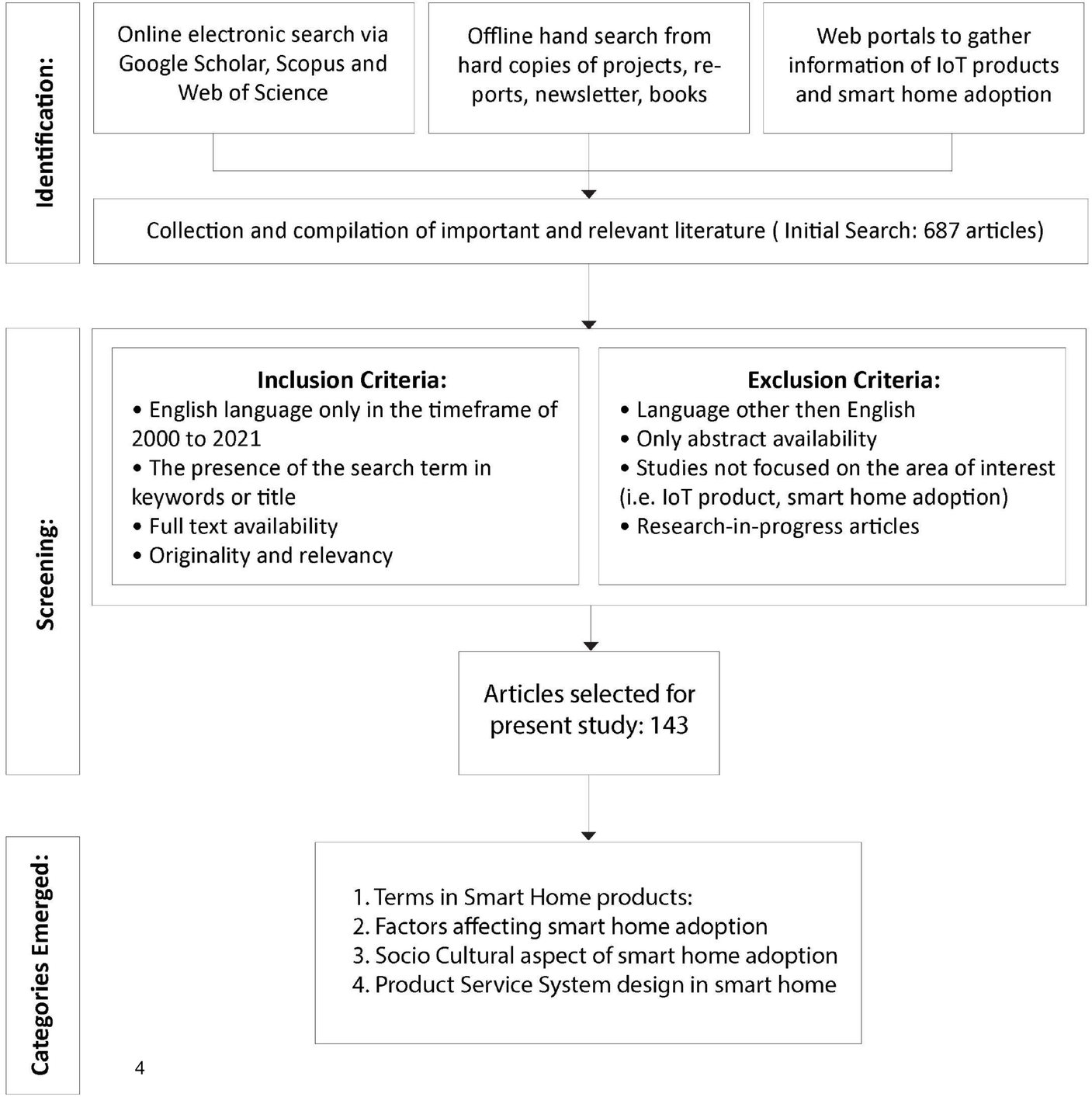
- **RQ1:** What are the characteristics contributing to customer satisfaction/dissatisfaction in a smart home product-service-system (SH-PSS)?

- **RQ2:** What are the key characteristics that customers perceive as Must be, Attractive, One dimensional, and Indifferent in a smart home product-service-system (SH-PSS) according to the Kano model?

- **RQ3:** What are the characteristics which impact achieving Sustainability through Product Service Systems in smart home?

Literature Review

Adoption of Socio-Cultural Aspects in PSS Design for Smart Home Products



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Consumer Benefits of Smart Home Adoption

Thematic Analysis

	Consumer Benefits	Themes	Source	
1	Health related Benefits	• Promoting the well-being of ageing and vulnerable people. • Care accessibility and comfort • Monitoring user safety • Consultancy for social connectivity and communication • Supporting the detection of life-threatening events • Therapy for the reduction of medical errors	Chan et al., 2008; Demiris et al., 2008; Demiris & Hensel, 2009; Reeder et al., 2013; Courtney et al., 2008; Rantz et al., 2005; Demiris et al., 2004; Finkelstein et al., 2004; Chan et al., 2009; Czaja, 2016; Mynatt et al., 2004; Celler et al., 2003; Finch et al., 2008; Walsh & Callan, 2011; Cavicchi & Vagnoni, 2017; Rahimpour et al., 2008; Matlabi et al., 2012; Kerbler, 2013	18
2	Environmental Benefits	• Environmental sustainability • Monitoring and reducing energy usage • Consultancy and feedback on energy and resource consumption • Suggestions on how to use electricity efficiently and comfortably	Balta-Ozkan et al., 2014; Chen et al., 2017; Elkhorchani & Grayaa, 2016; Zhou et al., 2016; Beaudin & Zareipour, 2015; Kyriakopoulos & Arabatzis, 2016; Kiesling, 2016; Aye & Fujiwara, 2014; El-hawary, 2014; Balta-Ozkan et al., 2013a; Paetz et al., 2011; Paetz et al., 2012	12
3	Financial Benefits	• Affordability of healthcare • Sustainable consumption • Cheaper consultancy and monitoring cost of virtual visits	Balta-Ozkan et al., 2013a; Darby & McKenna, 2012; Hargreaves et al., 2013; Paetz et al., 2012; Faruqui et al., 2010; Balta-Ozkan et al., 2014; Paetz et al., 2011; Park et al., 2018; Park et al., 2018; Steele et al., 2009; Ehrenhard et al., 2014; Kun, 2001	12
4	Psychological well-being and social inclusion	• Overcome the feeling of isolation • Support • Entertainment • Virtual interaction	Chan et al., 2008; Percival & Hanson, 2006; Demiris et al., 2004; Brandt et al., 2011; Damodaran & Olphert, 2010; Gaul & Ziefle, 2009; Kim et al., 2013; Balta-Ozkan et al., 2013a; Balta-Ozkan et al., 2013b; Khedekar et al., 2017	10

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Consumer Barriers of Smart Home Adoption

Thematic Analysis

	Consumer Barriers	Themes	Source	
1	Technological Barriers	• Security • Usability • Privacy intrusion • Reliability	Balta-Ozkan et al., 2013a; Park et al., 2018; Yang et al., 2017; Alsulami & Atkins, 2016; Czaja, 2016; Diegel, 2005; Kim & Shcherbakova, 2011	7
2	Financial, Ethical and Legal Barriers	• Price • Cost of installation • Cost of repair and maintenance • Concern about the misuse of private data	Balta-Ozkan et al., 2014; Chen et al., 2017; Elkhorchani & Grayaa, 2016; Zhou et al., 2016; Beaudin & Zareipour, 2015; Kyriakopoulos & Arabatzis, 2016; Kiesling, 2016; Aye & Fujiwara, 2014; El-hawary, 2014; Balta-Ozkan et al., 2013a; Paetz et al., 2011; Paetz et al., 2012	26
3	Knowledge Gap and Psychological Resistance	• Human barrier • Resistance to using innovative technology • Lack of prior knowledge and experience	Balta-Ozkan et al., 2013a; Darby & McKenna, 2012; Hargreaves et al., 2013; Paetz et al., 2012; Faruqui et al., 2010; Balta-Ozkan et al., 2014; Paetz et al., 2011; Park et al., 2018; Park et al., 2018; Steele et al., 2009; Ehrenhard et al., 2014; Kun, 2001	16

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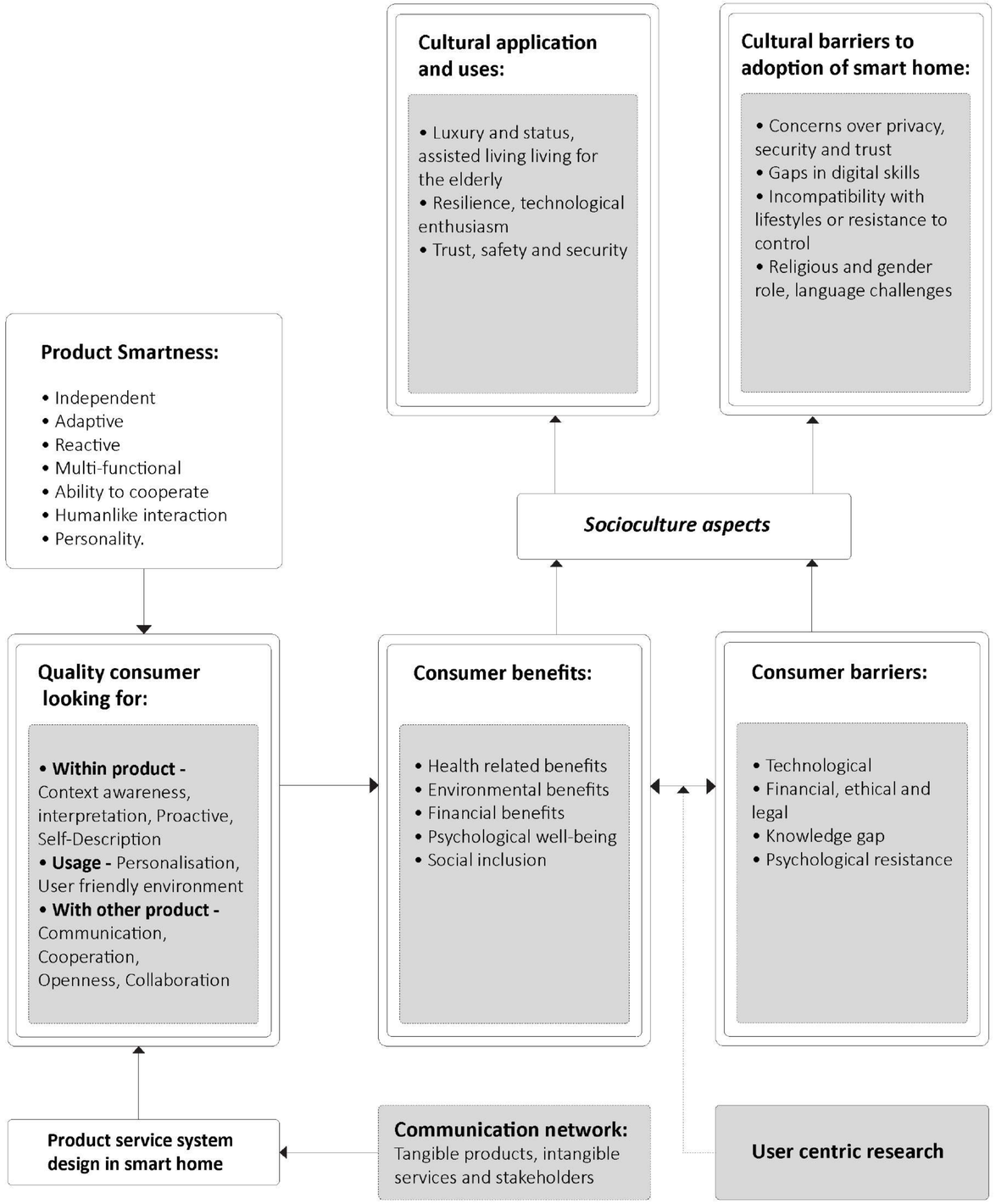
Result: Framework

Conceptual framework for factors affecting consumer's new technology acceptance



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Research Gap

Research Gap

	Research Gap	Themes	Source	
1	User centric research of smart home products	• User Perception of smart home technology • Demographics and geographic change • Smart home technology benefits for users • Focus on ageing population	Chan et al., 2008; Coughlan et al., 2013; Chan et al., 2009; Amiribesheli et al.,2015; Kim et al., 2013; Demiris & Hensel, 2008; Alam et al., 2012; Peek et al., 2014; Czaja, 2016; Balta-Ozkan et al., 2013a; Diegel et al., 2005; Bowes et al., 2012; Chen et al., 2017; Bhati et al., 2017; Balta-Ozkan et al., 2013b; Paetz et al., 2011; Demiris et al., 2008; Brandt et al., 2011; Stringer etal.,2006; Wu & Fu, 2012; Chan et al., 2012; Chiang & Wang, 2016; Matlabi et al., 2012; Paetz et al., 2012; Demiris et al., 2004; Gaul & Ziefle, 2009; Courtney et al., 2008; Yamazaki, 2006; Hong et al., 2016; Vilas et al., 2010	30
2	Smart home acceptance and adoption	• Price • Cost of installation • Cost of repair and maintenance • Concern about the misuse of private data	Chan et al., 2008; Dawid et al., 2017; Khedekar et al., 2017; Chan et al., 2009; Peetoom et al., 2015; Kim et al., 2013; Peek et al., 2014; Balta-Ozkan et al., 2013a; Diegel et al., 2005; Ehrenhard et al., 2014; Bowes et al., 2012; Balta-Ozkan et al., 2013b; Kleinberger et al., 2007; Demiris et al., 2008; Park et al., 2018; Yang et al., 2017; Alsulami & Atkins, 2016; Steele et al., 2009; Mayer et al., 2011; Paetz et al., 2012; Gaul & Ziefle, 2009; Courtney et al., 2008; Mani & Chouk, 2017; Chung et al., 2016	24

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New Technology Acceptance

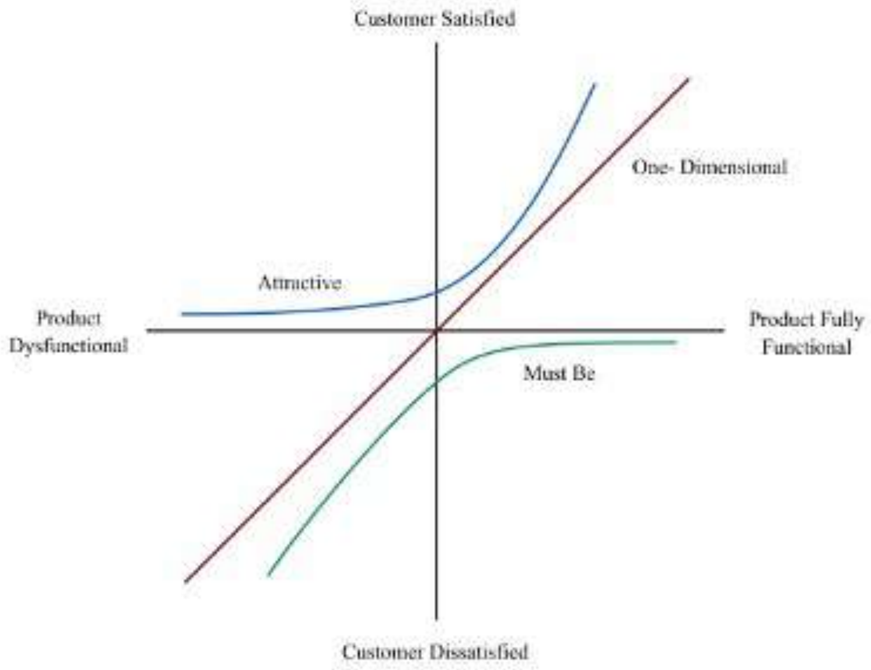
Theoretical Models

1. Theory of Reasoned Action (TRA)
2. Theory of Planned Behaviour (TPB)
3. Unified Theory of Acceptance and Use of Technology (UTAUT)
4. **Technology Acceptance Model (TAM)**
5. Norm Activation Model (NAM)
6. Value-based adoption model (VAM)
7. Technology Reediness Index (TRI)
8. Innovation Diffusion Theory (IDT)
9. Perceived Risk Theory (PRT)
10. Cognitive Dissonance Theory (CDT)
11. PAD Theory

Kano Model

Research Methodology

- The Kano model explains the relationship between the degree of sufficiency and **customer satisfaction/dissatisfaction** with respect to an characteristics of customer requirement.



Kano Model

Classification

The customer requirements can be classified into six categories:

- **Attractive**
- **One-dimensional**
- **Must be**
- **Indifferent**
- **Reverse**
- **Questionable**

$$\text{Potential for customer satisfaction} = \frac{(\textit{Attractive} + \textit{One Dimensional}) \times 100}{\textit{Attractive} + \textit{One Dimensional} + \textit{Must be} + \textit{Reverse} + \textit{Indifferent}}$$

$$\text{Potential for customer dissatisfaction} = \frac{(\textit{One Dimensional} + \textit{Must be} + \textit{Reverse}) \times 100}{\textit{Attractive} + \textit{One Dimensional} + \textit{Must be} + \textit{Reverse} + \textit{Indifferent}}$$

Kano Model

Sampling

- **Purposive sampling** is a sampling technique in which participants are selected **based on specific criteria** or characteristics that are relevant to the research objective.

- In the context of using the Kano Model for participant selection, purposive sampling can be employed to ensure that individuals **who have knowledge and experience related to the smart home products and services (SH-PSS)** being evaluated are included in the study.

Kano Model

Purposive Sampling

- **Define the target population:** Determine the specific group of individuals who possess the relevant knowledge and experience regarding SH-PSS.
- **Determine the criteria:** Identify the specific criteria or characteristics that participants must meet to be considered eligible for the study. These criteria should align with the research objective and the expertise required to evaluate the characteristics of the SH-PSS.
- **Select participants:** Using the defined criteria, purposefully select individuals who meet the criteria and have the necessary knowledge and experience. This could involve reaching out to experts in the field, professionals working in the smart home industry, or individuals who have extensive experience with using SH-PSS.
- **Sample size determination:** Decide on the appropriate sample size based on the resources available and the depth of analysis required. The sample size should be sufficient to capture diverse perspectives and provide meaningful insights into the characteristics being evaluated.
- **Data collection:** Conduct interviews, surveys, or other data collection methods to gather participants' opinions and feedback on the characteristics of the SH-PSS. Utilize the Kano Model questionnaire or other suitable tools to assess participant satisfaction and dissatisfaction with the characteristics.
- **Data analysis:** Analyse the collected data using appropriate statistical techniques, such as calculating satisfaction and dissatisfaction coefficients, to categorize the characteristics into different Kano Model categories.

Kano Survey
Five Point Likert Scale

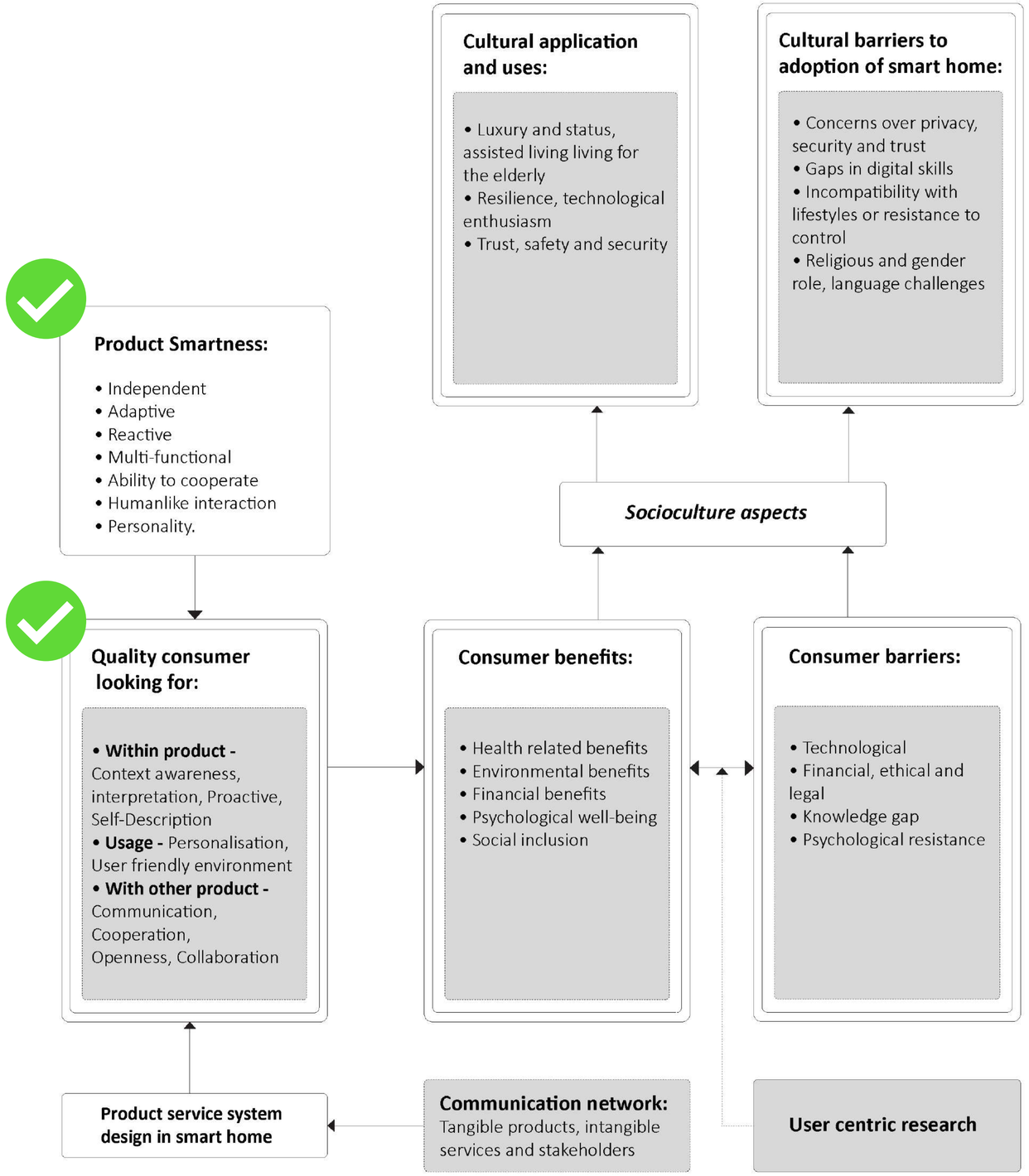
N= 226

Male 63%
Female 37%

27% (n=61) of the respondents were above 40 years old

- **Five-point Likert scale**

Choice of answer:
1) Like (I like it this way);
2) Must (I expect it this way);
3) Neutral (I am neutral);
4) Can live with it (I can live with it this way);
5) Dislike (I don’t like it this way)


Cultural application and uses:
• Luxury and status, assisted living living for the elderly
• Resilience, technological enthusiasm
• Trust, safety and security
Cultural barriers to adoption of smart home:
• Concerns over privacy, security and trust
• Gaps in digital skills
• Incompatibility with lifestyles or resistance to control
• Religious and gender role, language challenges
Product Smartness:
• Independent
• Adaptive
• Reactive
• Multi-functional
• Ability to cooperate
• Humanlike interaction
• Personality.
Socioculture aspects
Quality consumer looking for:
• Within product - Context awareness, interpretation, Proactive, Self-Description
• Usage - Personalisation, User friendly environment
• With other product - Communication, Cooperation, Openness, Collaboration
Consumer benefits:
• Health related benefits
• Environmental benefits
• Financial benefits
• Psychological well-being
• Social inclusion
Consumer barriers:
• Technological
• Financial, ethical and legal
• Knowledge gap
• Psychological resistance
Product service system design in smart home
Communication network: Tangible products, intangible services and stakeholders
User centric research

Kano Questionnaire

C.9.2: Multi-functional (2 Examples)

C.9.2: SH-PSS television giving updates of surrounding and who is on door apart from their main purpose

- **Functional Question**
- **Dysfunctional Question**

Example 13.1: SH-PSS are aware about their surrounding; e.g.: smart home door welcomes the owner and alerts when it detects unauthorized entry.

Functional Question: If smart products are aware about their surroundings like shown above, how would you feel?

Dysfunctional Question: If smart products are not aware about their surroundings like shown above, how would you feel?

Example 13.2: SH-PSS automatically perform a function based on their surroundings; e.g.: garage door opens up when it detects car coming.

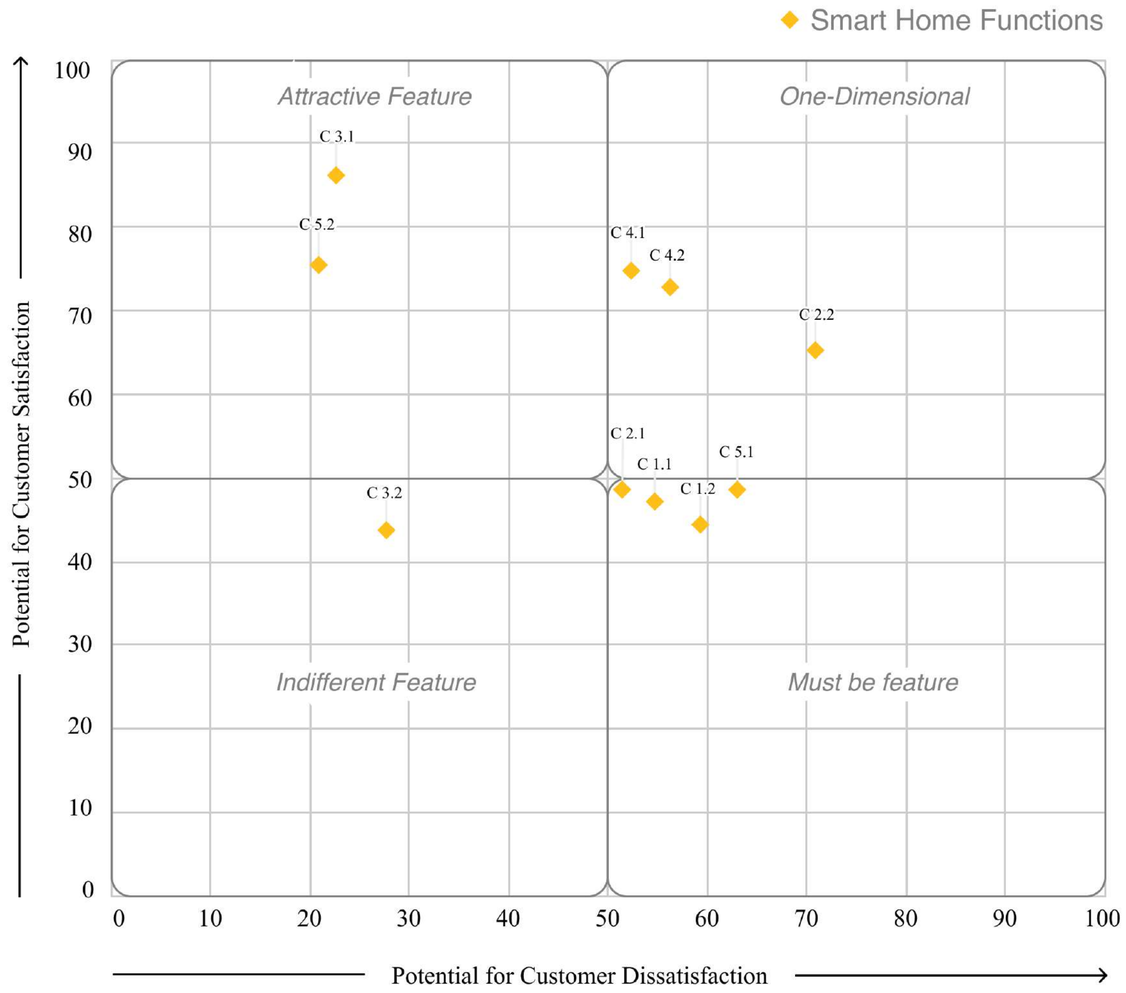
Functional Question: If smart products automatically perform a function based on their surroundings like shown above, how would you feel?

Dysfunctional Question: If smart products do not automatically perform a function based on their surroundings like shown above, how would you feel?

Characteristics and its category					**x-axis**	**y-axis**	**Result**
C.1: Comfort	C.1.1:	A=34.51%	M=38.05%	O=10.18%	47.20	54.67	Must Be
		I=8.41%	R=3.54%	Q=5.31%			
	C.1.2:	A=31.42%	M=42.48%	O=11.06%	44.44	59.26	Must Be
		I=7.52%	R=3.10%	Q=4.42%			
C.2: Monitor	C.2.1:	A=36.28%	M=36.28%	O=10.18%	48.62	51.37	Must Be
		I=10.62%	R=3.10%	Q=3.54%			
	C.2.2:	A=22.12%	M=24.78%	O=40.27%	65.27	70.83	One Dimensional
		I=5.75%	R=2.65%	Q=4.42%			
C.3: Health therapy	C.3.1:	A=56.64%	M=4.87%	O=15.93%	86.17	22.58	**Attractive**
		I=17.70%	R=0.88%	Q=3.98%			
	C.3.2:	A=30.09%	M=11.06%	O=11.95%	43.77	27.65	Indifferent
		I=39.38%	R=3.54%	Q=3.98%			
C.4: Support	C.4.1:	A=38.05%	M=13.72%	O=34.07%	74.77	52.29	One Dimensional
		I=7.96%	R=2.65%	Q=3.54%			
	C.4.2:	A=37.61%	M=19.03%	O=32.30%	72.81	56.22	One Dimensional
		I=4.42%	R=2.65%	Q=3.98%			
C.5: Consultancy	C.5.1:	A=27.43%	M=37.61%	O=19.03%	48.61	62.96	Must Be
		I=7.96%	R=3.54%	Q=4.42%			
	C.5.2:	A=65.04%	M=10.18%	O=7.08%	75.46	20.83	**Attractive**
		I=10.62%	R=2.65%	Q=4.42%			

Smart Home Functions

Kano Model Graph



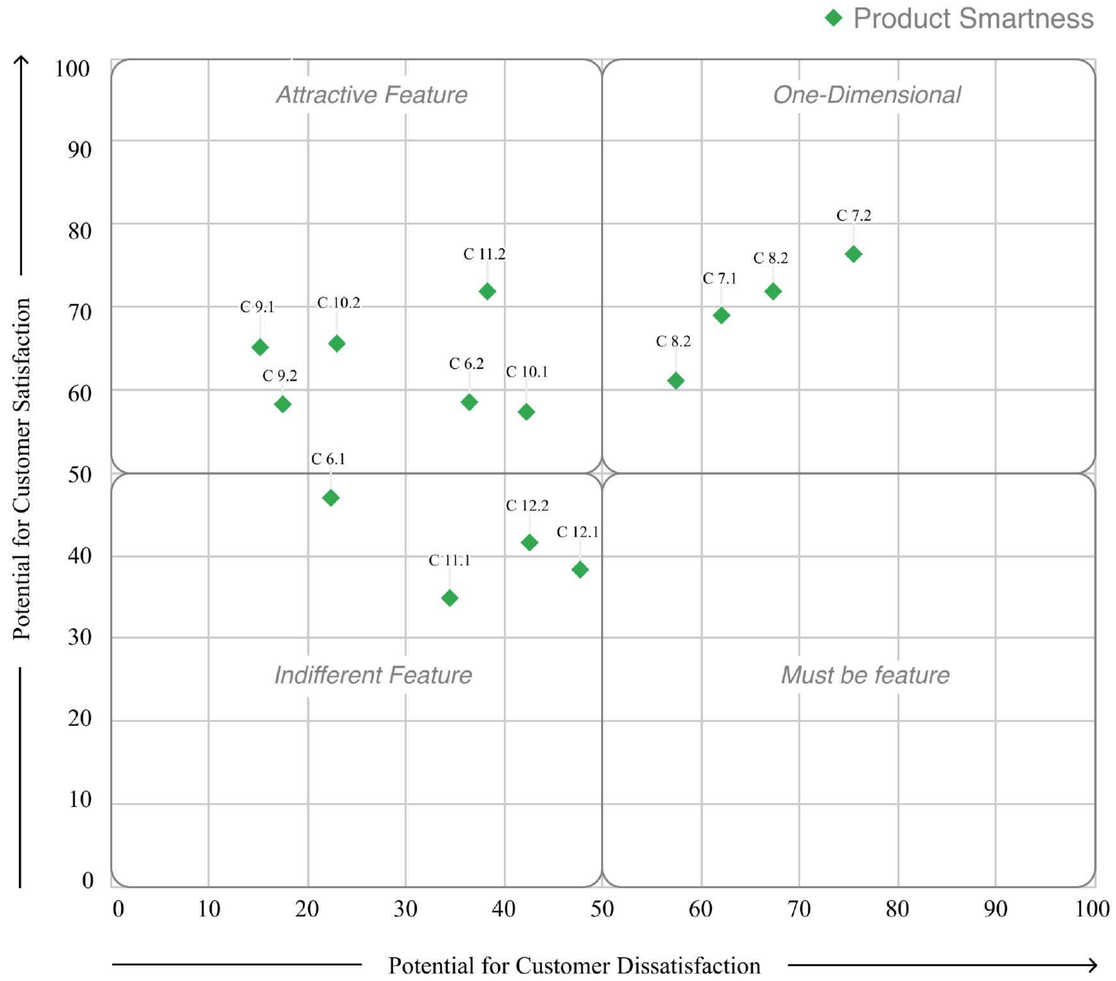
- **Attractive:**

  C3.1: Health therapy
  C5.2: Consultancy

Characteristics and its category					x-axis	y-axis	Result
C.6: Independent	C.6.1:	A=36.28%	M=10.62%	O=8.41%	46.97	22.32	Indifferent
		I=37.61%	R=2.21%	Q=4.87%			
	C.6.2:	A=43.36%	M=19.47%	O=12.83%	58.52	36.40	**Attractive**
		I=17.70%	R=2.65%	Q=3.98%			
C.7: Adaptive	C.7.1:	A=26.99%	M=19.47%	O=38.94%	68.98	62.03	One Dimensional
		I=9.29%	R=0.88%	Q=4.42%			
	C.7.2:	A=16.37%	M=12.39%	O=56.64%	76.38	75.46	One Dimensional
		I=7.08%	R=3.10%	Q=4.42%			
C.8: Reactive	C.8.1:	A=30.53%	M=23.01%	O=38.50%	71.88	67.28	One Dimensional
		I=0.88%	R=3.10%	Q=3.98%			
	C.8.2:	A=27.43%	M=20.35%	O=30.97%	61.11	57.40	One Dimensional
		I=13.27%	R=3.54%	Q=4.42%			
C.9: Multi-functional	C.9.1:	A=55.31%	M=6.19%	O=7.52%	65.13	15.13	**Attractive**
		I=26.55%	R=0.88%	Q=3.54%			
	C.9.2:	A=49.56%	M=9.73%	O=6.19%	58.25	17.43	**Attractive**
		I=30.09%	R=0.88%	Q=3.54%			
C.10: Ability to co-operate	C.10.1:	A=38.05%	M=20.35%	O=17.26%	57.33	42.20	**Attractive**
		I=17.70%	R=3.10%	Q=3.54%			
	C.10.2:	A=51.77%	M=8.41%	O=11.50%	65.59	22.93	**Attractive**
		I=22.57%	R=2.21%	Q=3.54%			
C.11: Humanlike Interaction	C.11.1:	A=22.57%	M=19.47%	O=10.62%	34.88	34.41	Indifferent
		I=39.82%	R=2.65%	Q=4.87%			
	C.11.2:	A=51.77%	M=15.93%	O=17.26%	71.88	38.24	**Attractive**
		I=7.52%	R=3.54%	Q=3.98%			
C.12: Personality	C.12.1:	A=30.09%	M=16.37%	O=6.19%	38.31	47.66	Indifferent
		I=19.47%	R=22.57%	Q=5.31%			
	C.12.2:	A=27.43%	M=8.41%	O=11.95%	41.58	42.52	Indifferent
		I=26.99%	R=19.91%	Q=5.31%			

Product Smartness

Kano Model Graph



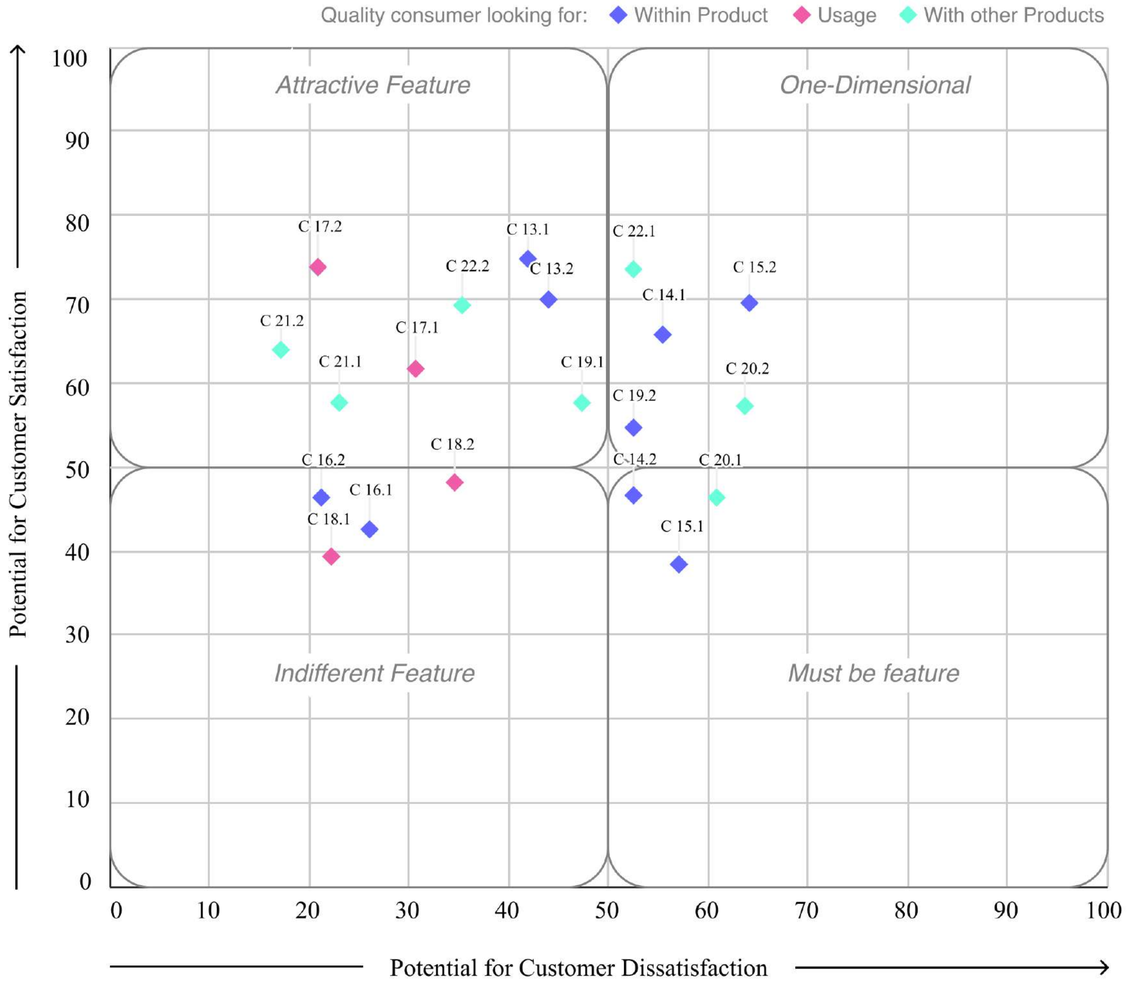
- **Attractive:**

C6.2: Independent
C9.1, C9.2: Multi-functional
C10.1, C10.2: Ability to Co-operate
C11.2: Humanlike interaction

Characteristics and its category					x-axis	y-axis	Result
C.13: Context Awareness	C.13.1:	A=42.78%	M=9.79%	O=33.51%	77.49	47.12	**Attractive**
		I=9.28%	R=3.09%	Q=1.55%			
	C.13.2:	A=36.08%	M=9.28%	O=32.47%	70.37	44.44	**Attractive**
		I=18.04%	R=1.55%	Q=2.58%			
C.14: Interpretation	C.14.1:	A=27.84%	M=14.95%	O=36.60%	66.49	55.85	One Dimensional
		I=14.95%	R=2.58%	Q=3.09%			
	C.14.2:	A=31.96%	M=35.05%	O=13.40%	46.81	52.66	Indifferent
		I=13.92%	R=2.58%	Q=3.09%			
C.15:	C.15.1:	A=23.71%	M=39.69%	O=13.92%	38.62	57.14	Indifferent
		I=18.04%	R=2.06%	Q=2.58%			
	C.15.2:	A=27.32%	M=18.56%	O=40.21%	69.68	64.36	One Dimensional
		I=7.22%	R=3.61%	Q=3.09%			
C.16: Self-description	C.16.1:	A=35.05%	M=9.28%	O=10.82%	46.84	21.58	Indifferent
		I=41.75%	R=1.03%	Q=2.06%			
	C.16.2:	A=32.99%	M=12.89%	O=9.28%	42.49	26.18	Indifferent
		I=39.69%	R=3.61%	Q=1.55%			
C.17: Personalization	C.17.1:	A=44.85%	M=11.86%	O=15.98%	62.11	31.05	**Attractive**
		I=22.68%	R=2.58%	Q=2.06%			
	C.17.2:	A=58.25%	M=5.67%	O=13.92%	74.07	21.16	**Attractive**
		I=18.56%	R=1.03%	Q=2.58%			
C.18: User friendly	C.18.1:	A=26.29%	M=6.70%	O=12.37%	39.68	22.22	Indifferent
		I=49.48%	R=2.58%	Q=2.58%			
interaction	C.18.2:	A=32.47%	M=15.98%	O=14.43%	48.40	34.57	Indifferent
		I=30.93%	R=3.09%	Q=3.09%			
C.19: Communication	C.19.1:	A=36.60%	M=22.68%	O=20.10%	57.89	47.37	**Attractive**
		I=14.95%	R=3.61%	Q=2.06%			
	C.19.2:	A=35.57%	M=27.32%	O=18.56%	54.97	52.88	One Dimensional
		I=10.82%	R=6.19%	Q=1.58%			
C.20: Co-operation	C.20.1:	A=31.96%	M=40.21%	O=13.92%	46.84	61.05	Must-Be
		I=6.19%	R=5.67%	Q=2.06%			
	C.20.2:	A=23.20%	M=24.74%	O=32.47%	57.45	63.83	One Dimensional
		I=11.86%	R=4.64%	Q=3.09%			
C.21: Openness	C.21.1:	A=44.85%	M=8.76%	O=11.86%	57.89	23.16	**Attractive**
		I=30.41%	R=2.06%	Q=2.06%			
	C.21.2:	A=55.15%	M=8.25%	O=7.73%	64.21	17.37	**Attractive**
		I=25.77%	R=1.03%	Q=2.06%			
C.22: Collaboration	C.22.1:	A=34.02%	M=11.34%	O=38.66%	73.82	52.88	One Dimensional
		I=12.37%	R=2.06%	Q=1.55%			
	C.22.2:	A=46.91%	M=12.37%	O=20.62%	69.31	35.45	**Attractive**
		I=15.98%	R=1.55%	Q=2.58%			

Quality Consumer Looking For

Kano Graph



- **Attractive:**

C13.1, C13.2: Context Awareness
C17.1, C17.2: Personalisation
C19.1: Communication
C21.1, C21.2: Openness
C22.1: Collaboration

Conclusion : Kano Results

Attractive

	Characteristics
C.3.1	Health Therapy
C.5.2	Consultancy
C.6.2	Independent
C.9.1; C.9.2	**Multi-functional**
C.10.1; C.10.2	**Ability to cooperate**
C.11.2	Humanlike Interaction
C.13.1; C.13.2	**Context Awareness**
C.17.1; C.17.2	**Personalisation**
C.19.1	Communication
C.21.1; C.21.2	**Co-operation**
C.22.2	Collaboration

Conclusion : Kano Results

Must Be

	Characteristics
C.1.1, C.1.2	Comfort
C.2.1	Monitor
C.5.1	Consultancy
C.14.2	Interpretation
C.15.1	Proactive
C.20.1	Co-operation

Conclusion : Kano Results

One Dimensional

	Characteristics
C.2.2	Monitor
C.4.1; C.4.2	Support
C.7.1; C.7.2	Adaptive
C.8.1; C.8.2	Reactive
C.14.1	Interpretation
C.15.2	Proactive
C.19.2	Communication
C.20.2	Co-operation
C.22.1	Collaboration

Conclusion : Kano Results

Indifferent

	Characteristics
C.3.2	Health Therapy
C.6.1	Independent
C.11.1	Humanlike Interaction
C.12.1; C.12.2	Personality
C.16.1; C.16.2	Self-description
C.18.1; C.18.2	User Friendly Interaction

Smart-Home Product-Service-System Design

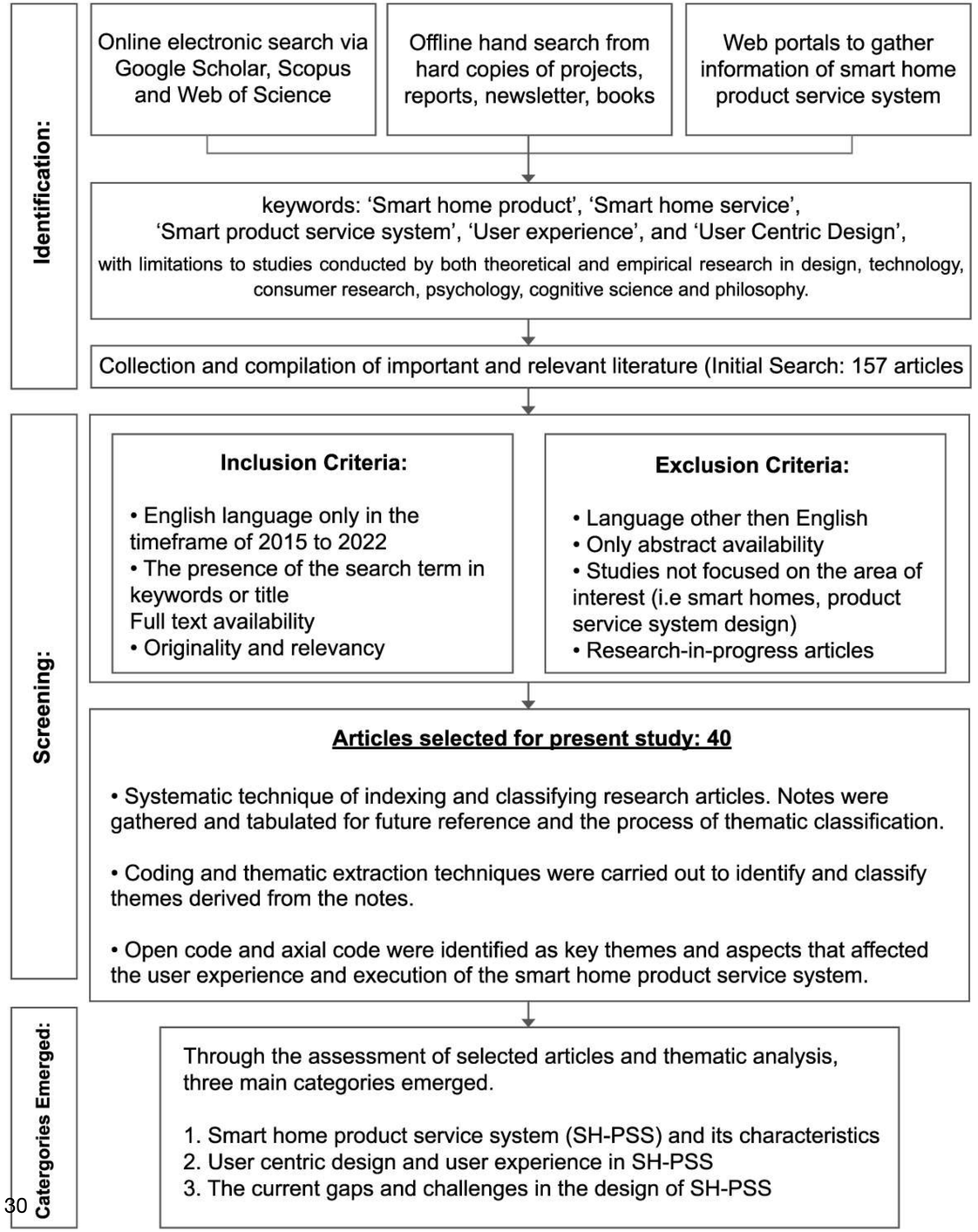
Definition

“SH-PSS is an IT-driven value co-creation business strategy consisting of various stakeholders as the players and residents, smart systems as the infrastructure and home, smart and connected products as the media and tools, and their generated e-services as the key values delivered that continuously strives to meet individual consumer needs sustainably within the context of residence."

Ganvir, L., & Kalita, C. P. International Symposium on Industrial Engineering and Automation**.** University of Bozen-Bolzano., 2023

Design of SH-PSS

Literature Review



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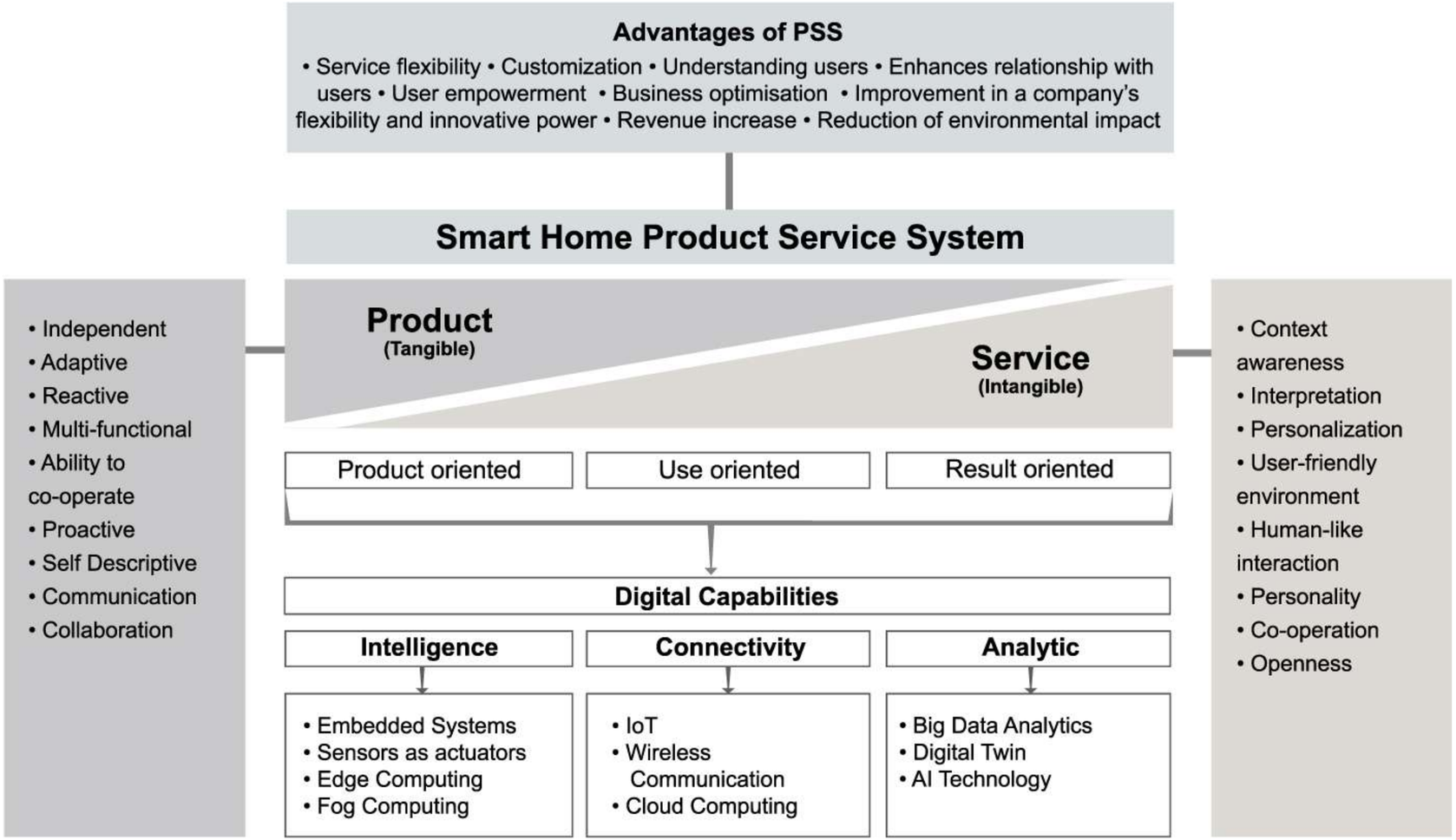
SH-PSS Conceptual Framework

Smart Home Product Service System



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User Centric Design in SH-PSS

Research Gap

Smart Home Product-Service-System Lifecycle:

- **Service-Dominant (S-D) Design**
- Data-driven Value Co-creation
- Closed-loop design (SH-PSS Closed-loop design and co-creation roles)

Other contribution in paper: User-centered approaches and tools for SH-PSS.

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Design of Smart Home Product Service System

Literature Review and Expert Interview

- Co-create the Internet of Things (IoT)
- IoT Design Deck
- IoT Design Kit
- KnowCards
- Mapping the IoT
- **Tiles IoT Toolkit**

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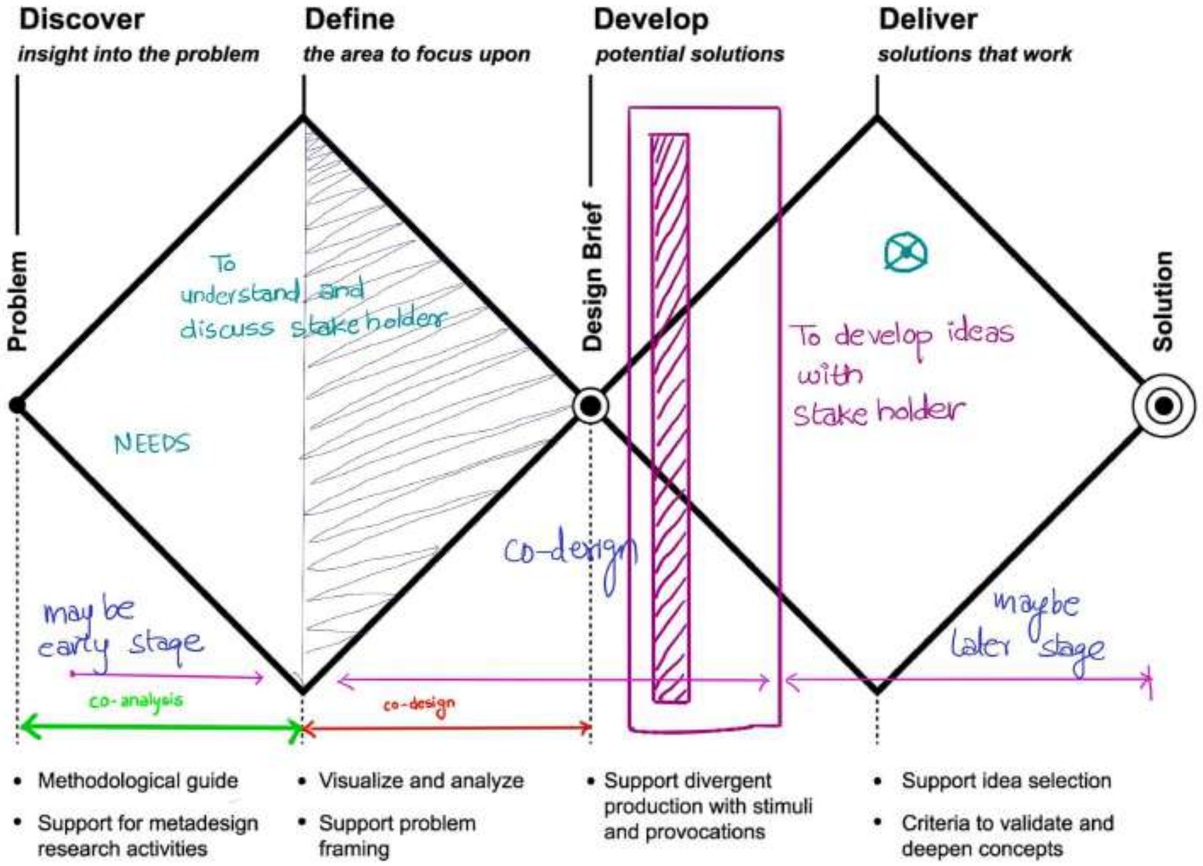
Context

1. Problems
2. Inspiration
3. Technical Capabilities
4. Ideas
5. Planning Implementation
6. Mitigating Implementation Problem



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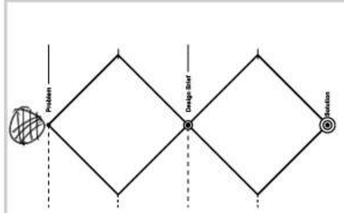
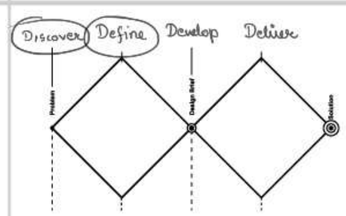
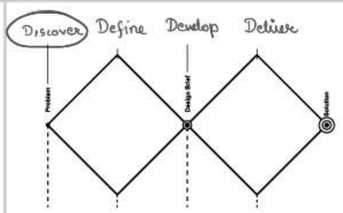
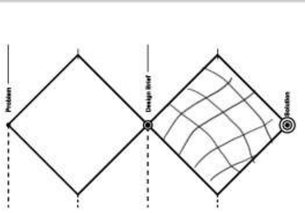
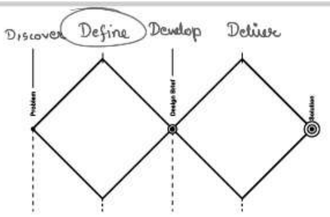
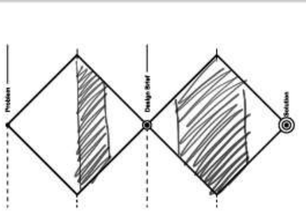
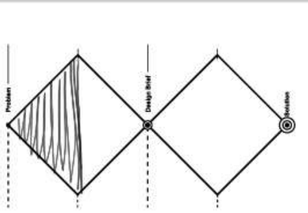
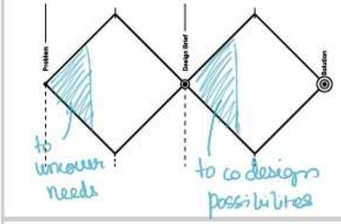
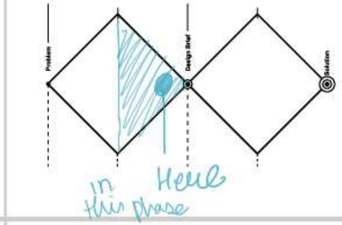
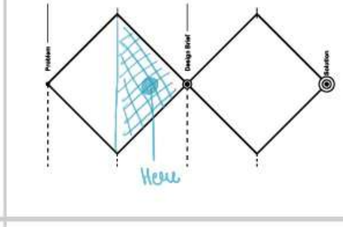
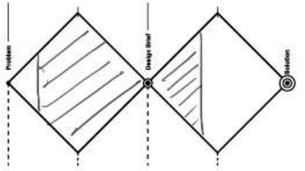
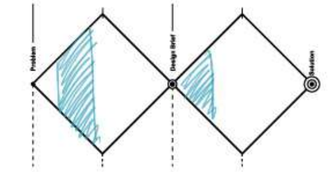
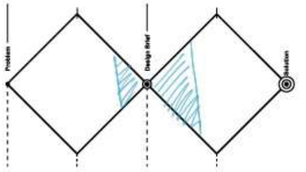
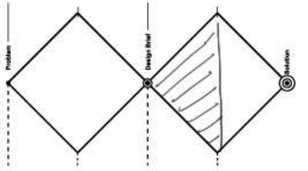
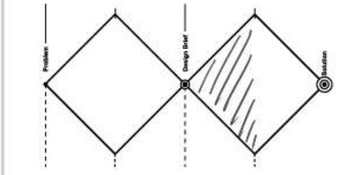
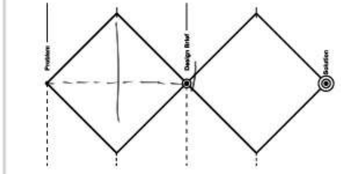
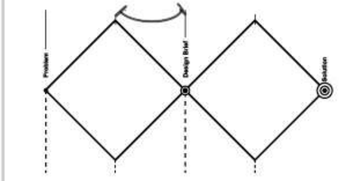
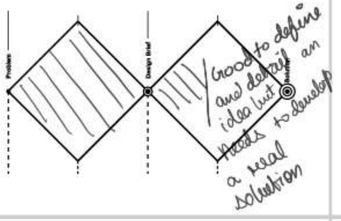
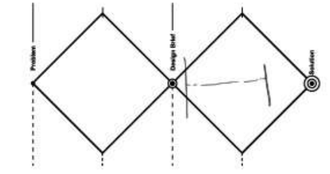
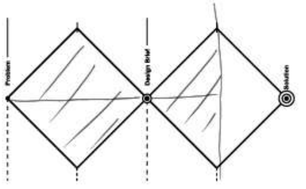
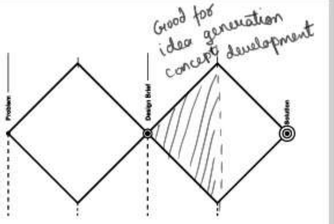
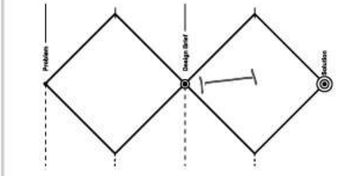
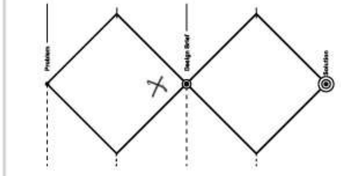
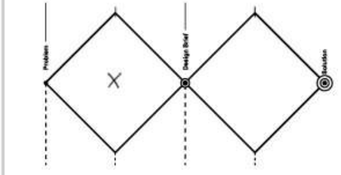
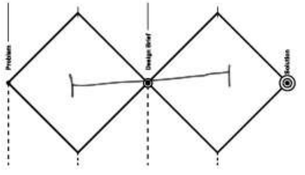
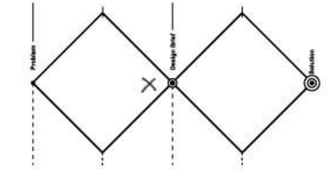
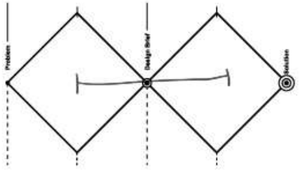
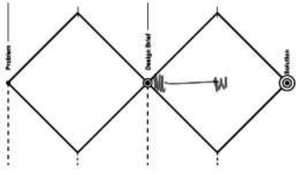
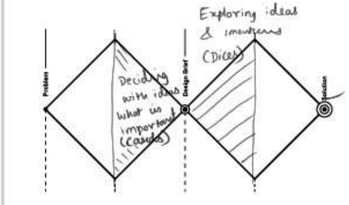
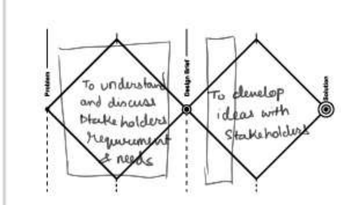
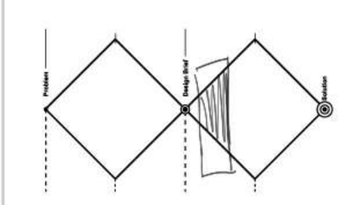
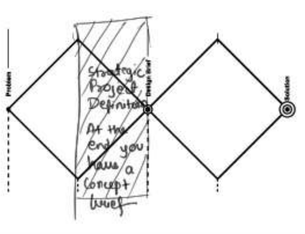
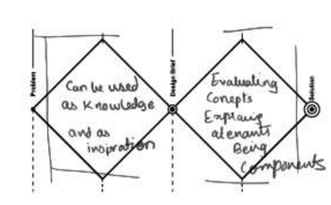
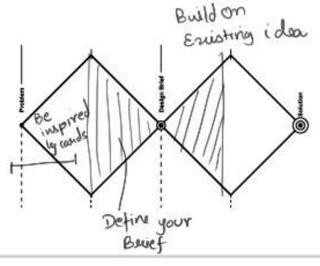
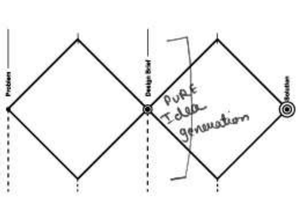
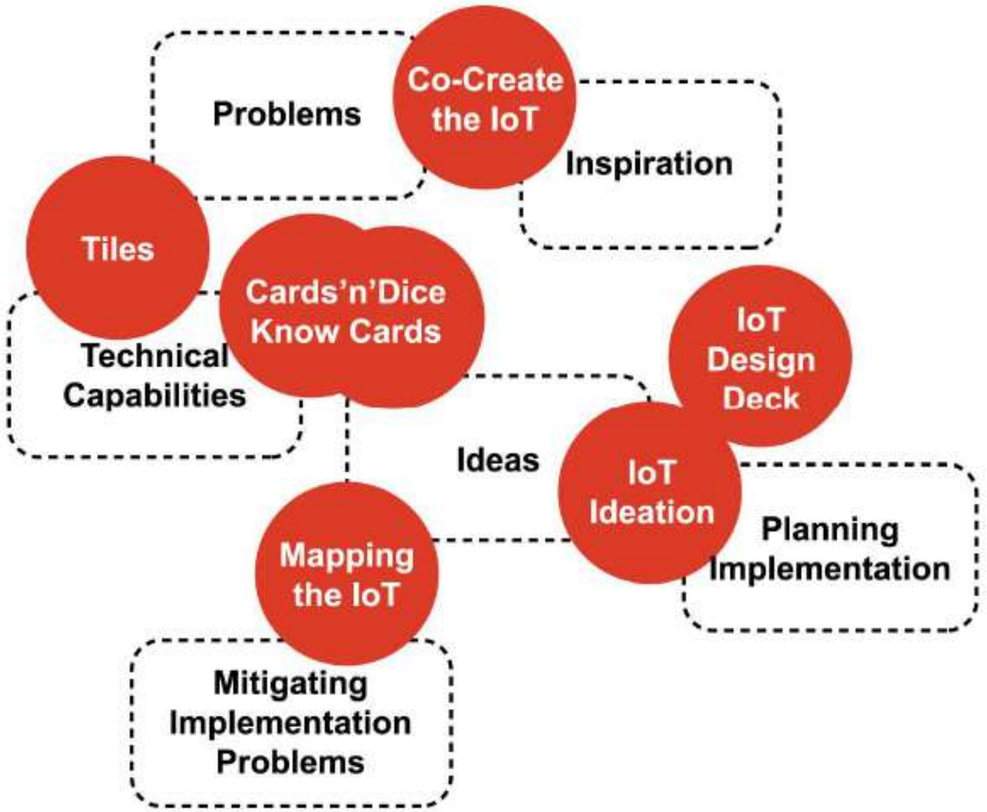
Cards'n'Dice	Co-create the IoT	IoT Design Deck	IoT Design Kit	KnowCards	Mapping the IoT	Tiles IoT Toolkit
						
						
						
						
						

Discussions



	Design Methods	Context
1	Card 'n' Dice	• Technical Capabilities • Ideas
2	Co-create the IoT	• Problems • Inspiration
3	IoT Design Deck	• Ideas • Planning Implementation
4	IoT Ideation Design Kit	• Ideas • Planning Implementation
5	Know Cards	• Technical Capabilities • Ideas
6	Mapping the IoT	• Ideas • Mitigating Implementation Problem
7	Tiles IoT Toolkit	• Problems • Technical Capabilities

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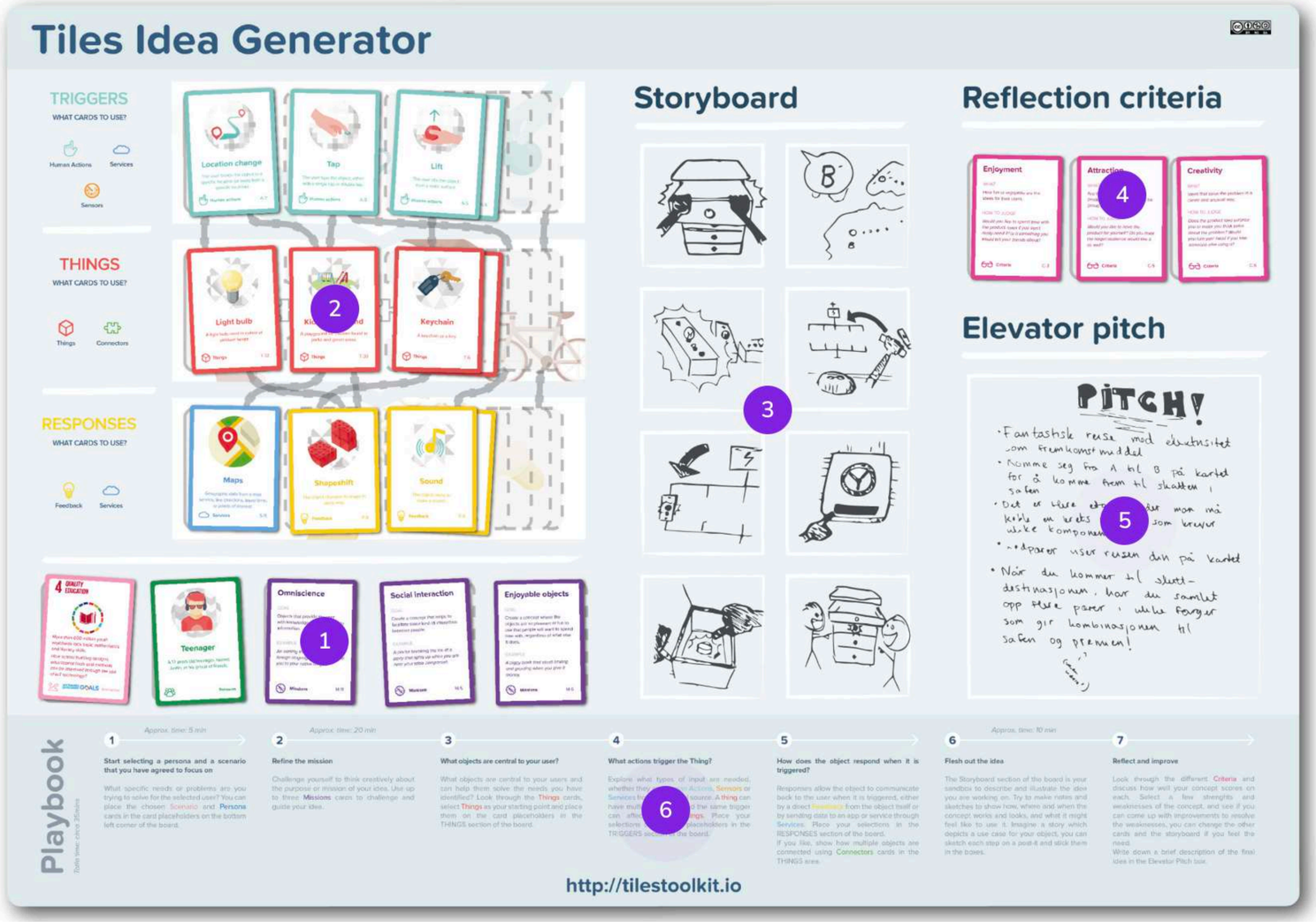
SH-PSS Innovator Toolkit

A card-based brainstorming game



Physical tiles and cards

Brainstorming Card

- Domain cards (scenarios, persona) summarise the goals and the people who will be impacted by your invention.
- Technology cards (things, sensors, services, human action, feedback) provide simple descriptions of technology like: things, sensors, data and user interfaces.
- Mission cards spice up your mix by providing provocative design goals.
- Criteria cards help to reflect and converge towards meaningful ideas.

Physical tiles and cards

Tiles IoT Innovator Toolkit

Activities

Participants are asked to perform in the Tiles IoT Inventor Toolkit

- *Start by selecting a **Persona** and a **Scenario** that you have agreed to focus on*: What specific needs or problems are you trying to solve for the user selected? You can place the chosen Scenario and Persona cards in the card placeholders at the bottom left corner of the board

- *Refine the **Mission**:* Challenge yourself to think creatively about the purpose or mission of your idea. Use up to three Missions cards to challenge and guide your idea.

- *What objects are central to your user?* What objects are central to your users and how they can help solving the needs you have identified? Look through the **Things** cards, select a few of them as your starting point and place them on the card placeholders in the THINGS section of the board.

Activities

Participants are asked to perform in the Tiles IoT Inventor Toolkit

- *What actions trigger the Thing?* Explore what types of input are needed, whether they are **Human Actions, Sensors or Services** from a connected source. A **thing** can have multiple triggers, and the same trigger can affect multiple **things**. Place your selections on the card placeholders in the TRIGGERS section of the board.

- *How does the object respond when it is triggered?* Responses allow the object to communicate back to the user when it is triggered, either by a direct **Feedback** from the object itself or by sending data to an app or service through **Services**. (RESPONSES section of the board)

Activities

Participants are asked to perform in the Tiles IoT Inventor Toolkit

- ***Flesh out the idea:*** The Storyboard section of the board is your sandbox to describe and illustrate the idea you are working on. Try to make notes and sketches to show how, where and when the concept works and looks, and what it might feel like to use it. Imagine a story which depicts a use case for your object, you can sketch each step on a post-it and stick them in the boxes.

- *Reflect and improve:* Look through different **Criteria** and discuss how well your concept scores on each. Select a few strengths and weaknesses of the concept, and see if you can come up with improvements to resolve the weaknesses, you can change the other cards and the storyboard if you feel the need. Write down a brief description of the final idea in the Elevator Pitch box.

SH-PSS
Reflection Criteria Cards

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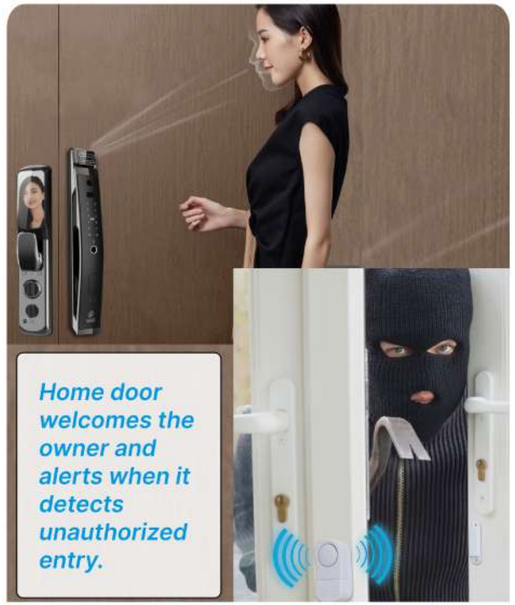
Context Awareness

SH-PSS Reflection Criteria Cards

CRITERIA

Product Smartness

DTM



Smart products are aware about their surroundings

Criteria

Smart products automatically performs the function based on their surrounding

Criteria

Context Awareness

WHAT

Ability of a system or system component to gather information about its environment at any given time & adapt behaviors accordingly.

HOW TO JUDGE

Does your smart home product sense the environment and provide services accordingly?

Criteria

Multi-functional

SH-PSS Reflection Criteria Cards

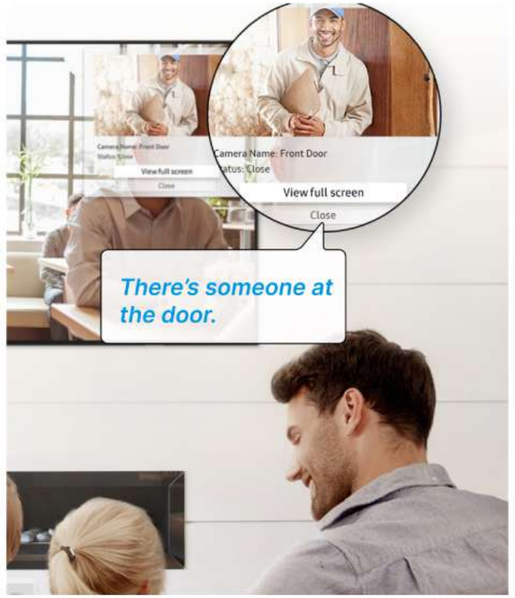
CRITERIA

Product Smartness

DTM

Smart products do a lot of things along with its main purpose

Criteria



Smart products give updates of the surrounding apart from their main purpose

Criteria

Multi-Functional

WHAT

Capability of performing more than one function.

HOW TO JUDGE

Does your smart home prodct system perfom other task apart from it's main purpose?

Criteria

Ability to co-operate

SH-PSS Reflection Criteria Cards

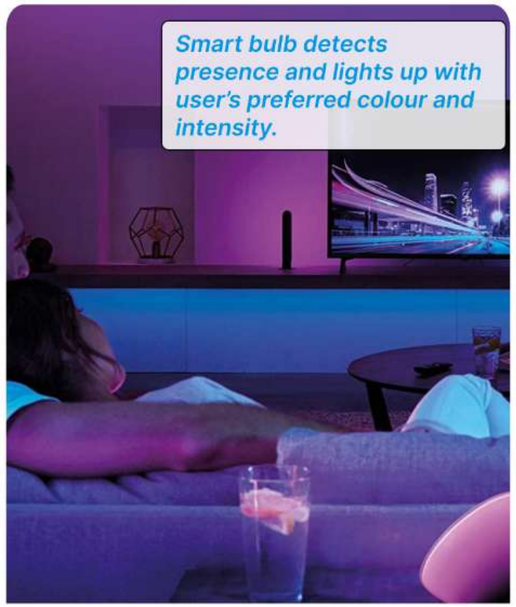
CRITERIA

Product Smartness

DTM

Smartphone automatically sharing the Wifi password with the smart speaker

Criteria



Smart products co-operate with each other to provide a personalized experienced

Criteria

Ability to Co-operate

WHAT

To work with other products to achieve a result that is beneficial.

HOW TO JUDGE

Is your smart home product able to communicate with other SH-PSS?

Criteria

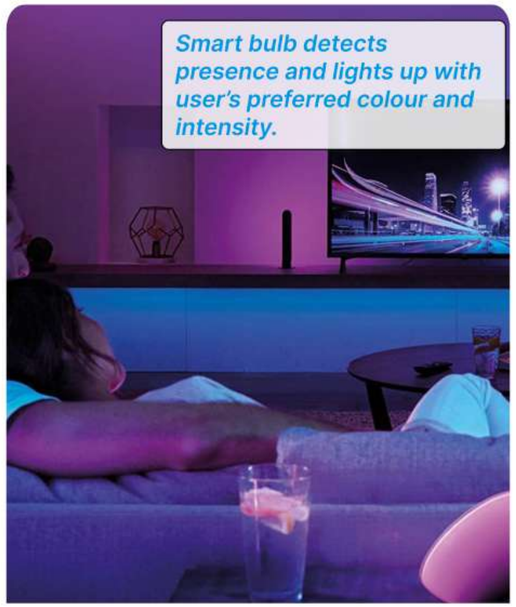
Personalisation

SH-PSS Reflection Criteria Cards

CRITERIA

Product Smartness

DTM



Smart products customize

Criteria

Smart products you apparel based on your choices

Criteria

Personalisation

WHAT

Tailored product to accommodate a specific individual or group.

HOW TO JUDGE

Is your SH-PSS is able to understand your mood and feelings and able to alter the environment accordingly.

Criteria

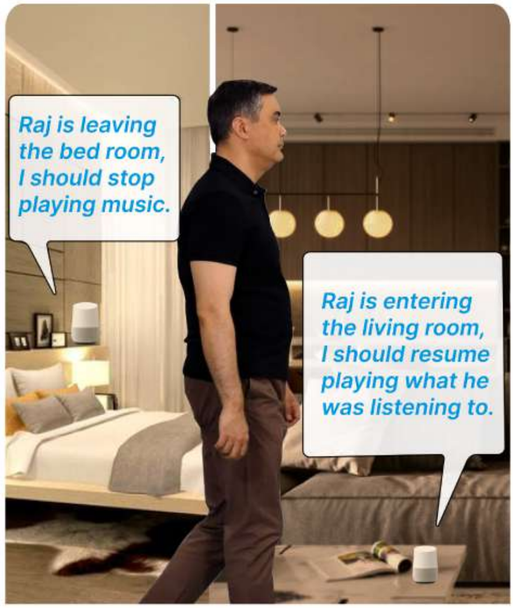
Openness

SH-PSS Reflection Criteria Cards

CRITERIA

Product Smartness

DTM



Smart products transfer Movies, TV shows or music with each other seamlessly

Criteria

Smart products share your open data with other smart products

Criteria

Openness

WHAT

Accessibility of knowledge, technology and other resources; the transparency of action.

HOW TO JUDGE

Is your smart home product able to detect and connect with other SH-PSS? Would your other smart products be able to perform task by a single command.

Criteria

Design Brief

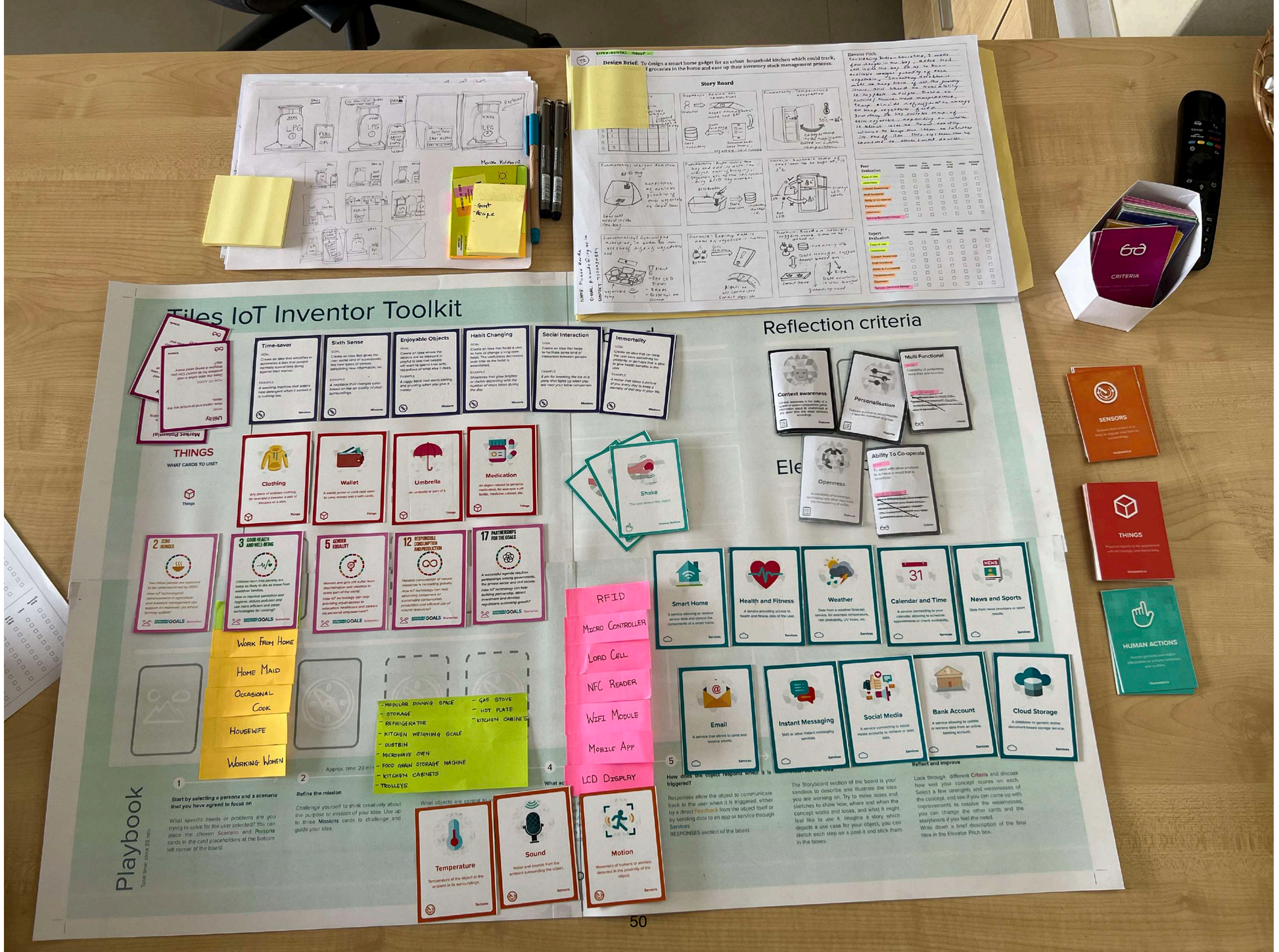
Smart Home Product Service System (SH-PSS)

To design a smart gadget for an urban household kitchen which could track, detect the usage of groceries in the home, and ease up their inventory stock management process.

Treatment 1: **Control Group**: Without SH-PSS Toolkit

Treatment 2: **Experimental Group**: With SH-PSS Toolkit

N=15


Tiles IoT Inventor Toolkit
Reflection criteria
Playbook
THINGS
Clothing
Wallet
Umbrella
Medication
Shake
Time-saver
Sixth Sense
Enjoyable Objects
Habit Changing
Social Interaction
Immortality
Context awareness
Personalisation
Multi-Functional
Openness
Ability To Co-operate
Smart Home
Health and Fitness
Weather
Calendar and Time
News and Sports
Email
Instant Messaging
Social Media
Bank Account
Cloud Storage
Temperature
Sound
Motion
RFID
Micro Controller
Load Cell
NFC Reader
Wifi Module
Mobile App
LCD Display
Work From Home
Home Maid
Occasional Cook
Housewife
Working Women
SENSORS
THINGS
HUMAN ACTIONS
CRITERIA


SENSORS
THINGS
PERSONAS
FEEDBACK
HUMAN ACTIONS
SCENARIOS
Mobile App
Wifi Module
NFC Reader
Load Cell
Micro Controller


CRITERIA
FEEDBACK
HUMAN ACTIONS
SENSORS
SERVICES
LCD Display
Mobile App
Wifi Module
NFC Reader
Load Cell


Tiles for Inventor Toolkit

Evaluation Sheet

Peer and Expert Evaluation

	Extremely Unlikely	Unlikely	More or less Unlikely	Neutral	More or less likely	Likely	Extremely llikely
Ease of Use	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Usefulness	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Context Awareness	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Multi-functional	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Ability to Co-operate	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Personalization	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Openness	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
Service-Dominant Design	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7

1: Perceived Ease of Use

Technology Adoption

Null Hypothesis 1.1 (**$H_{1.1}$**):	In the ideations, there is no significant difference between the ratings of peers on the Perceived Ease-of-use attribute, for a design concept in T1 and T2.
Alternate Hypothesis 1.1a (H_{1a}):	In the ideations, there is significant difference between the ratings of peers on the Perceived Ease-of-use attribute, for a design concept in T1 and T2.

Null Hypothesis 1.2 (**H_1**):	In the ideations, there is no significant difference between the ratings of experts on the Perceived Ease-of-use attribute, for a design concept in T1 and T2.
Alternate Hypothesis 1.2a ($H_{1.2a}$):	In the ideations, there is significant difference between the ratings of experts on the Perceived Ease-of-use attribute, for a design concept in T1 and T2.

2: Perceived Usefulness

Technology Adoption

Null Hypothesis 2.1 (**$H_{2.1}$**):	In the ideations, there is no significant difference between the ratings of peers on the Perceived Usefulness attribute, for a design concept in T1 and T2.
Alternate Hypothesis 2.1a ($H_{2.1a}$):	In the ideations, there is significant difference between the ratings of peers on the Perceived Usefulness attribute, for a design concept in T1 and T2.

Null Hypothesis 2.2 (**$H_{2.2}$**):	In the ideations, there is no significant difference between the ratings of experts on the Perceived Usefulness attribute, for a design concept in T1 and T2.
Alternate Hypothesis 2.2a ($H_{2.2a}$):	In the ideations, there is significant difference between the ratings of experts on the Perceived Usefulness attribute, for a design concept in T1 and T2.

3: Context Awareness

Idea Generation Ability

Null Hypothesis 3.1 (**$H_{3.1}$**):	In the ideations, there is no significant difference between the ratings of peers on the Context Awareness attribute, for a design concept in T1 and T2.
Alternate Hypothesis 3.1a ($H_{3.1a}$):	In the ideations, there is significant difference between the ratings of peers on the Context Awareness attribute, for a design concept in T1 and T2.

Null Hypothesis 3.2 (**$H_{2.2}$**):	In the ideations, there is no significant difference between the ratings of experts on the Context Awareness attribute, for a design concept in T1 and T2.
Alternate Hypothesis 3.2a ($H_{3.2a}$):	In the ideations, there is significant difference between the ratings of experts on the Context Awareness attribute, for a design concept in T1 and T2.

4: Multi-functional

Idea Generation Ability

Null Hypothesis 4.1 (**$H_{4.1}$**):	In the ideations, there is no significant difference between the ratings of peers on the Multi-functional attribute, for a design concept in T1 and T2.
Alternate Hypothesis 4.1a ($H_{4.1a}$):	In the ideations, there is significant difference between the ratings of peers on the Multi-functional attribute, for a design concept in T1 and T2.

Null Hypothesis 4.2 (**$H_{4.2}$**):	In the ideations, there is no significant difference between the ratings of experts on the Multi-functional attribute, for a design concept in T1 and T2.
Alternate Hypothesis 4.2a ($H_{4.2a}$):	In the ideations, there is significant difference between the ratings of experts on the Multi-functional attribute, for a design concept in T1 and T2.

5: Ability to Co-operate

Idea Generation Ability

Null Hypothesis 5.1 (**$H_{5.1}$**):	In the ideations, there is no significant difference between the ratings of peers on the Ability to Co-operate attribute, for a design concept in T1 and T2.
Alternate Hypothesis 5.1a ($H_{5.1a}$):	In the ideations, there is significant difference between the ratings of peers on the Ability to Co-operate attribute, for a design concept in T1 and T2.

Null Hypothesis 5.2 (**$H_{4.2}$**):	In the ideations, there is no significant difference between the ratings of experts on the Ability to Co-operate attribute, for a design concept in T1 and T2.
Alternate Hypothesis 5.2a ($H_{4.2a}$):	In the ideations, there is significant difference between the ratings of experts on the Ability to Co-operate attribute, for a design concept in T1 and T2.

6: Personalisation

Idea Generation Ability

Null Hypothesis 6.1 (**$H_{6.1}$**):	In the ideations, there is no significant difference between the ratings of peers on the Personalisation attribute, for a design concept in T1 and T2.
Alternate Hypothesis 6.1a ($H_{6.1a}$):	In the ideations, there is significant difference between the ratings of peers on the Personalisation attribute, for a design concept in T1 and T2.

Null Hypothesis 6.2 (**$H_{6.2}$**):	In the ideations, there is no significant difference between the ratings of experts on the Personalisation attribute, for a design concept in T1 and T2.
Alternate Hypothesis 6.2a ($H_{6.2a}$):	In the ideations, there is significant difference between the ratings of experts on the Personalisation attribute, for a design concept in T1 and T2.

7: Openness

Idea Generation Ability

Null Hypothesis 7.1 **($H_{7.1}$):**	In the ideations, there is no significant difference between the ratings of peers on the Openness attribute, for a design concept in T1 and T2.
Alternate Hypothesis 7.1a ($H_{7.1a}$):	In the ideations, there is significant difference between the ratings of peers on the Openness attribute, for a design concept in T1 and T2.

Null Hypothesis 7.2 ($H_{7.2}$):	In the ideations, there is no significant difference between the ratings of peers on the Openness attribute, for a design concept in T1 and T2.
Alternate Hypothesis 7.2a ($H_{7.2a}$):	In the ideations, there is significant difference between the ratings of peers on the Openness attribute, for a design concept in T1 and T2.

8: SD Design

Service Dominant Design Ability Enhancement

Null Hypothesis 8.1 ($H_{8.1}$):	In the ideations, there is no significant difference between the ratings of peers on the Service dominant attribute, for a design concept in T1 and T2.
Alternate Hypothesis 8.1a ($H_{8.1a}$):	In the ideations, there is significant difference between the ratings of peers on the Service dominant attribute, for a design concept in T1 and T2.

Null Hypothesis 8.2 ($H_{8.2}$):	In the ideations, there is no significant difference between the ratings of peers on the Service dominant attribute, for a design concept in T1 and T2.
Alternate Hypothesis 8.2a ($H_{8.2a}$):	In the ideations, there is significant difference between the ratings of peers on the Service dominant attribute, for a design concept in T1 and T2.

		p-value	Result	T1 Peer-Mean	T2 Peer-Mean
H1.1	**Perceived Ease of Use**	<0.001	Null Hypothesis Rejected	3.13	5.67
H2.1	**Perceived Usefulness**	<0.001	Null Hypothesis Rejected	3.40	5.27
H3.1	**Context Awareness**	<0.001	Null Hypothesis Rejected	2.73	5.53
H4.1	**Multi-functional**	<0.001	Null Hypothesis Rejected	2.20	4.73
H5.1	**Ability to Co-operate**	<0.001	Null Hypothesis Rejected	1.80	4.60
H6.1	**Personalisation**	<0.001	Null Hypothesis Rejected	2.40	5.00
H7.1	**Openness**	<0.001	Null Hypothesis Rejected	1.87	4.27
H8.1	**Service Dominant Design**	<0.001	Null Hypothesis Rejected	2.47	5.80

		p-value	Result	T1 Expert-Mean	T2 Expert-Mean
H1.2	**Perceived Ease of Use**	<0.001	Null Hypothesis Rejected	3.33	5.27
H2.2	**Perceived Usefulness**	<0.001	Null Hypothesis Rejected	3.07	5.33
H3.2	**Context Awareness**	<0.001	Null Hypothesis Rejected	2.93	5.60
H4.2	**Multi-functional**	<0.001	Null Hypothesis Rejected	2.87	5.07
H5.2	**Ability to Co-operate**	<0.001	Null Hypothesis Rejected	2.13	4.80
H6.2	**Personalisation**	<0.001	Null Hypothesis Rejected	3.27	5.73
H7.2	**Openness**	<0.001	Null Hypothesis Rejected	1.80	4.07
H8.2	**Service Dominant Design**	<0.001	Null Hypothesis Rejected	2.60	6.13

9: Perceived Ease of Use

Technology Adoption

Null Hypothesis 9.1 ($H_{9.1}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Perceived Ease-of-use attribute, for a design concept in T1.
Alternate Hypothesis 9.1a (H_{1a}):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Perceived Ease-of-use attribute, for a design concept in T1.

Null Hypothesis 9.2 ($H_{9.2}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Perceived Ease-of-use attribute, for a design concept in T2.
Alternate Hypothesis 9.2a ($H_{9.2a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Perceived Ease-of-use attribute, for a design concept in T2.

10: Perceived Usefulness

Technology Adoption

Null Hypothesis 10.1 (**$H_{10.1}$**):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Perceived Usefulness attribute, for a design concept in T1.
Alternate Hypothesis 10.1a ($H_{10.1a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Perceived Usefulness attribute, for a design concept in T1.

Null Hypothesis 10.2 ($H_{10.2}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Perceived Usefulness attribute, for a design concept in T2.
Alternate Hypothesis 10.2a ($H_{10.2a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Perceived Usefulness attribute, for a design concept in T2.

11: Context Awareness

Idea Generation Ability

Null Hypothesis 11.1 ($H_{11.1}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Context Awareness attribute, for a design concept in T1.
Alternate Hypothesis 11.1a ($H_{11.1a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Context Awareness attribute, for a design concept in T1.

Null Hypothesis 11.2 ($H_{11.2}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Context Awareness attribute, for a design concept in T2.
Alternate Hypothesis 11.2a ($H_{11.2a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Context Awareness attribute, for a design concept in T2.

12: Multi-functional

Idea Generation Ability

Null Hypothesis 12.1 ($H_{12.1}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Multi-functional attribute, for a design concept in T1.
Alternate Hypothesis 12.1a ($H_{12.1a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Multi-functional attribute, for a design concept in T1.

Null Hypothesis 12.2 ($H_{12.2}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Multi-functional attribute, for a design concept in T2.
Alternate Hypothesis 12.2a ($H_{12.2a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Multi-functional attribute, for a design concept in T2.

13: Ability to Co-operate

Idea Generation Ability

Null Hypothesis 13.1 ($H_{13.1}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Ability to Co-operate attribute, for a design concept in T1.
Alternate Hypothesis 13.1a ($H_{13.1a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Ability to Co-operate attribute, for a design concept in T1.

Null Hypothesis 13.2 ($H_{13.2}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Ability to Co-operate attribute, for a design concept in T2.
Alternate Hypothesis 13.2a ($H_{13.2a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Ability to Co-operate attribute, for a design concept in T2.

14: Personalisation

Idea Generation Ability

Null Hypothesis 14.1 ($H_{14.1}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Personalisation attribute, for a design concept in T1.
Alternate Hypothesis 14.1a ($H_{14.1a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Personalisation attribute, for a design concept in T1.

Null Hypothesis 14.2 ($H_{14.2}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Personalisation attribute, for a design concept in T2.
Alternate Hypothesis 14.2a ($H_{14.2a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Personalisation attribute, for a design concept in T2.

15: Openness

Idea Generation Ability

Null Hypothesis 15.1 ($H_{15.1}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Openness attribute, for a design concept in T1.
Alternate Hypothesis 15.1a ($H_{15.1a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Openness attribute, for a design concept in T1.

Null Hypothesis 15.2 ($H_{15.2}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Openness attribute, for a design concept in T2.
Alternate Hypothesis 15.2a ($H_{15.2a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Openness attribute, for a design concept in T2.

16: SD Design

Service Dominant Design Ability Enhancement

Null Hypothesis 16.1 ($H_{16.1}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Service Dominant Design attribute, for a design concept in T1.
Alternate Hypothesis 16.1a ($H_{16.1a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Service Dominant Design attribute, for a design concept in T1.

Null Hypothesis 16.2 ($H_{16.2}$):	In the evaluation ratings, there is no significant difference between the ratings of peer and the rating of expert on the Service Dominant Design attribute, for a design concept in T2.
Alternate Hypothesis 16.2a ($H_{16.2a}$):	In the evaluation ratings, there is significant difference between the ratings of peer and the rating of expert on the Service Dominant Design attribute, for a design concept in T2.

		p-value	Result	T1 Peer-Mean	T1 Expert-Mean
H9.1	**Perceived Ease of Use**	0.486	Null Hypothesis Accepted	3.13	3.33
H10.1	**Perceived Usefulness**	0.313	Null Hypothesis Accepted	3.40	3.07
H11.1	**Context Awareness**	0.458	Null Hypothesis Accepted	2.73	2.93
H12.1	**Multi-functional**	0.012	Null Hypothesis Accepted	2.20	2.87
H13.1	**Ability to Co-operate**	0.173	Null Hypothesis Accepted	1.80	2.13
H14.1	**Personalisation**	0.032	Null Hypothesis Accepted	2.40	3.27
H15.1	**Openness**	0.751	Null Hypothesis Accepted	1.87	1.80
H16.1	**Service Dominant Design**	0.610	Null Hypothesis Accepted	2.47	2.60

		p-value	Result	T2 Peer-Mean	T2 Expert-Mean
H9.2	**Perceived Ease of Use**	0.138	Null Hypothesis Accepted	5.67	5.27
H10.2	**Perceived Usefulness**	0.774	Null Hypothesis Accepted	5.27	5.33
H11.2	**Context Awareness**	0.818	Null Hypothesis Accepted	5.53	5.60
H12.2	**Multi-functional**	0.334	Null Hypothesis Accepted	4.73	5.07
H13.2	**Ability to Co-operate**	0.510	Null Hypothesis Accepted	4.60	4.80
H14.2	**Personalisation**	0.077	Null Hypothesis Accepted	5.00	5.73
H15.2	**Openness**	0.486	Null Hypothesis Accepted	4.27	4.07
H16.2	**Service Dominant Design**	0.096	Null Hypothesis Accepted	5.80	6.13

Research Question

RQ1: Answer

- **RQ1:**
  What framework and toolkit Product-Service-System (PSS) designers can use in Smart Home PSS Design to ensure new technology acceptance and adoption by the target consumer?

- **Result:**
  Technology Acceptance Model (TAM).
  (i) Perceived Ease of Use and
  (ii) Perceived Usefulness

Research Question

RQ2: Answer

- **RQ2:**
  Can existing technology adoption model be considered as a mean to adapt a new framework and toolkit for product service system designers in the context of smart home.

- **Result:**
  Through literature review and interview with the experts we have identified 7 toolkits.
  Tiles IoT Inventor Toolkit

Research Question

RQ3: Answer

- **RQ3:**
  What is the smart home PSS design framework with special emphasis to service dominance.

- **Result:**
  We have evolved a Service-Dominant SH-PSS design framework. This framework was considered in the development of proposed “SH-PSS *IoT Inventor Toolkit*”. We have included service dominance as criteria in the list of criterions for evaluating our proposed toolkit.

Research Question

RQ4: Answer

- **RQ4:**
  How to customise the generic PSS design toolkit in the context of smart home PSS design considering context awareness, multi-functionality, ability to co-operate, personalisation, openness.

- **Result:**
  We have selected “Tiles IoT toolkit” for customisation in the context of smart home projects. The proposed toolkit is “***SH-PSS Innovator Toolkit*** ”. In this new toolkit we have developed new SH-PSS Things Card, Persona, Mission Card, Sensors Card, Service Card and Reflection Criteria Cards. We conducted a study to analyse characteristics of SH-PSS through Kano Model approach. On the basic of this study, reflection criterion was defined viz. context awareness, multi-functionality, ability to co-operate, personalisation, openness. We have included all the five reflection criteria in the list of criterions for evaluating our proposed toolkit.

Publication

Journal

- **Archive of Design Research**

  Ganvir, L., & Kalita, C. P. (2022). Adoption of Socio-Cultural Aspects in PSS Design for Smart Home Products: An Integrative Review. *Archives of Design Research*, *35*(4), 7-29. (Published)

Publication

Conference

1. Ganvir, L., Kalita, P.C., (2020). User-Centric Product Design Strategy For Grocery Monitoring in Indian Context. In: Digital Proceedings of **TMCE 2020**, 469-476, at tmce.io.tudelft.nl/proceedings

2. Ganvir, L., & Kalita, P. C. (2021). Design Thinking Approach in Identification of Service Design Based on User Interface for Grocery Monitoring System in Indian Context. In Design for Tomorrow—Volume 3: Proceedings of **ICoRD 2021** (pp. 881-893). Singapore: Springer Singapore.

3. Ganvir, L., & Kalita, P. C. (2023). Design of Smart Home Product Service System in Indian context. International Conference on Research into Design. **ICoRD 2023**. Springer, Singapore.

4. Ganvir, L., & Kalita, P. C. (2023). Design of Smart Home Product Service Systems (SH-PSS). International Symposium on Industrial Engineering and Automation. **ISIEA 2023.** University of Bozen-Bolzano.

5. Ganvir, L., & Kalita, P. C. (2023). Analysing Characteristics of Smart Home Product Service System through Kano Model Approach. International Symposium on Industrial Engineering and Automation. **ISIEA 2023.** University of Bozen-Bolzano.

6. Ganvir, L., & Kalita, P. C. (2023). Shaping Smart Home Product Service System (SH-PSS)Reflection Criteria Cards for Tiles Not Inventor Toolkit. International Conference on Engineering & Product Design Education. **E&PDE 2023,** Elisava Barcelona School of Design and Engineering.

Thank You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