

Can technology adoption for older adults be co-created?

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Y. Lu, C. Valk, J. Steenbakkens, T. Bekker, T. Visser, G. Proctor, O. Toshniwal, H. Langberg. Can technology adoption for older adults be co-created? Gerontechnology 2017;16(3):151-159; <https://doi.org/10.4017/gt.2017.16.3.004.00> Technology can be very valuable to support older adults to remain healthy and active in their daily living. How to design technological product and service systems that will be adopted by older adults however still remains a challenge. This paper reports on an empirical study on how a co-creation ideation process can contribute to the technology adoption of older adults conducted in an EU project with multi-stakeholder teams with the aim of promoting physical activities of older adult citizens. This ideation process is adapted from Method A. By analyzing the co-creation ideation process from three different processes: the end user value-creation process, the stakeholder value-creation process and the encounter process in relation to the technology adoption process, i.e., the domestication adoption process, this paper demonstrates which technology adoption issues can be already addressed using this co-creation ideation process and which aspects still need to be taken further into account.

Keywords: technology adoption; domestication adoption process; co-creation; value creation; product-service-system; ageing

Our society is aging at a tremendous pace. The aging of society is a global trend that is most prevalent in today's developed countries. According to Eurostat¹, the EU-28's population is continuously ageing; the percentage of older adults above 65 years old has a 19.2% share of the total population, which is an increase of 0.3% compared with the previous year and an increase of 2.4% compared with 10 years earlier.

This development presents interesting challenges and opportunities for the development of products, services and product service systems. Eurostat² reported that about 31% older adults above 65 live independently in EU-28 countries. How to create appealing technical products, systems and related services for people over 65 to support their independent living poses a very important chal-

lenge and opportunity. Furthermore, according to Eurostat² in 2015 about 41% of the older adult population aged above 65 in the EU-28 countries are using the Internet at least once a week. These trends strongly motivate the already challenged healthcare policy makers in the EU to look for (assistive) technologies that can provide better care with the currently limited healthcare resources. However, how to create these technology products and services that the older adults are willing to adopt still remains a challenge question.

Despite the increasing research and business attention on the ageing society and its related fields, knowledge about the aging population is both incomplete and contradictory. On the one hand, it is genuinely difficult to develop appropriate technological products and services for the age-

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ing population due to their different and diverse physical, mental status, needs and wants in the stage of their lives they have reached, different environments in which they live and work, and their access to a much wider experiences and knowledge of the world than younger people^{3,4}. On the other hand, In order to provide good quality of care to the older adults, involvement of other groups in society is desired. For example, while professional caregivers focus on providing optimal medical care to older adults based on newly developed solutions from biomedical research, informal care providers take care of the emotional wellbeing and help manage the increasing care costs and limited care budgets. Therefore to develop and deliver a good quality of care that can be adopted by older adults, additional people/stakeholders other than older adults themselves are needed. Because of this, creating products and services to be adopted by the older adults construes a class of social systems problems with a fundamental indeterminacy for which there is not a single solution. Technology adoption in this context is not only the problem for older adult users due to the number of people/stakeholders that are involved and the interconnectedness with other problems. Technology adoption for older adults becomes a 'wicked problem'^{5,6}.

To get a better understanding of these problems, the collective action strategies are often required from multi-stakeholders with conflicting beliefs and values^{6,7}. According to Freeman's stakeholder theory, these strategies can provide effective benefits to a broader range of stakeholders that is of great importance for the long-term growth and survival of different stakeholder organizations⁸. These stakeholders are only motivated to take the multi-stakeholder strategies if the values created for the stakeholders are well understood. Consequently, the desired multi-stakeholder values should be well embedded in the resulting technological innovations in order to support technology adoption of the older adults. This paper is interested in investigating how co-creation with multiple stakeholders can support technology adoption of older adults.

REACH⁹ is an EU funded project focused on ageing. The objective is to prevent chronic diseases and reduce long-term care costs by promoting physical activity among older adults. 17 partners from more than four different EU countries such as knowledge providers (research institutes, universities), technology providers (sensors technologies, prediction software, intervention mechanisms), multipliers (insurance companies, standardization organizations, etc. who are able to multiply the impact of the project in long term), and solution operators (clinics, rehabilitation centers, and home care providers)⁹, form the

project consortium. The ambition is to create a product service system (PSS) that "will turn clinical and care environments into personalisable modular sensing, prevention, and intervention systems that encourage older adults to become healthy via activity (physical, cognitive, mobility, personalized food, etc.)"⁹.

In the first phase of the project, a co-creation method based on Method A¹⁰ was developed and applied to a number of co-creation workshops at the testbeds in four different European countries¹¹. This paper takes the project as a case study and analyses the ideation process of the co-creation process from these workshops-in order to determine to what extent this process supports technology adoption of older adults in promoting physical activities. With this insight, this paper aims to derive the right questions to be addressed further in the co-creation process to support technology adoption for older adults.

The paper is therefore organized as following. Section 2 discusses the related work on technology adoption and co-creation. Section 3 explains the research method in details. Section 4 reports the case study results and analysis. Section 5 concludes on the study and points out future research direction.

RELATED WORK

Technology Adoption

Studying and understanding older adults' technology adoption is very critical for both researchers and practitioners who aim to use technology to support older adults' independent living. Identifying key factors that influence adoption of these technologies by older adults helps to explain and predict their attitude toward adopting or rejecting new technologies. Before explaining the concept of technology adoption, it is necessary to make a clear distinction with the concept of technology acceptance. Renaud and van Biljon¹² explained that technology adoption is a process starting from user technology awareness and ending with the user embracing the technology and making full use of it while technology acceptance is an attitude towards a technology. Lack of technology acceptance leads to lack of technology adoption. Technology adoption concerns the decision about technology selection, purchasing and commitment to use. Technology acceptance orients itself very much from the user experience and has impact on the decision about re-selecting and re-purchasing. This paper is interested in the concept of technology adoption.

To develop technological products and services that older adults will actually adopt, it is important to understand the user adoption process^{12,13}. Knowledge on purchasing motivation, what

functionalities and attributes that are important to older adults, what motivates them to use the products, usability issues, how the products can conceptually improve the life of older adults, how these products and services contents are made available and accessible to older adults, and etc. becomes vital for the acceptance and use of the developed solutions^{12,13}. Technology adoption models have developed from both a positivistic epistemology and an interpretivistic epistemology¹². The past studies on technology adoptions were carried out both at an organizational level and individual level¹³. This paper is interested in technology adoption at an individual level. Rogers¹³ proposed a five-stage process of product adoption consisting of the knowledge phase, the persuasion phase, the decision phase, the implementation phase and the confirmation phase with strong focus on the buying behavior. Silverstone and Haddon¹⁴ proposed the domestication adoption model to describe the technology adoption process. They view users as social entities and use the model to provide a framework for understanding how technology innovations change, and are changed, by their social contexts. The domestication adoption process consists of four dimensions¹⁴:

- Appropriation: Process of possession or ownership of the artifact.
- Objectification: Process of determining roles product will play.
- Incorporation: Process of interacting with a product.
- Conversion: Process of converting technology to intended feature use or interaction.

Since this paper is interested in creating intelligent product service systems that older adults will adopt, and not just interested in the purchase decision the domestication adoption process is more suitable for our purpose.

Co-creating values in multi-stakeholder innovation

Co-creation is known as a creative and collaborative activity. People with shared goals, but different skills and knowledge, collaborate together through an interdisciplinary process¹⁵. Often it can be observed that in network innovations values are created through co-creation for the end users via direct or indirect interactions between many different partners at the network level¹⁶. Knowledge, resources and expectations to understand and address wicked problems and develop propositions and realization plans are integrated in network innovations^{17,18}. Therefore, co-creation is considered as a very useful network innovation approach. By synchronizing the different expectations of the stakeholders and focusing on the end user insights, shared values and joint propositions for the intended target users can be created.

Results of co-created network innovations are often seen in the form of product service systems (PSS). The concept of designing PSS rather than physical products or services alone has been recognized as one of the promising approaches that have been developed to address wicked problems in the past decade because of its design-oriented approach in a multi-stakeholder context^{11,19-21}. Tukker and Tischner²² defined PSS as a specific type of value proposition consisting of a mix of tangible products and intangible services that a business (network) offers to (or co-produces with) its end users.

The Value Design Method¹⁰ was adapted with a number of generative design research tools and applied these in four co-creation workshops to create PSS ideas for REACH¹¹. The co-creation process used in the early ideation phase of the project consists of three different processes, namely the end user value-creating process, the stakeholder value-creating processes and the encounter processes, based on service-dominant logic^{23,24}. This paper investigates how these processes can support technology adoption of older adults in the earlier ideation process.

Visualizing values created in PSS

Visualizing values created in products is a very different task compared to visualizing them in services due to the intangibility in services. The nature of PSS suggests that visualization tools in service design are more suitable for visualizing PSS. Diana et al.²⁵ proposed a structure to visualize services in two dimensions: the level of iconicity and the relation with time. *The level of iconicity*²⁵ focuses on how close the representation of a service is compared to its real appearance/experience. For example, a flowchart of a service process is very abstract compared to a service experience video or photo. *The relation with time*²⁵ is the other aspect that helps to understand the created services. The visualization can be an instantaneous picture of the service (*synchronic*²⁵) or a sequence of actions and phases that formulate the service experiences (*diachronic*²⁵). Service blueprint²⁶ is a typical tool that falls into the category of abstract and diachronic with focus on interaction between the end users and the related stakeholders. The user experience flow²⁷ belongs then to the category of realistic and diachronic as it combines both the quality of customer journey map (abstract and diachronic) and storyboarding technique (realistic and diachronic). This paper is interested in analyzing how the co-created PSS concepts by multi-stakeholders support technology adoption of older adults. It needs a visualization method from both a process (diachronic) and multi-stakeholder perspective. Service design blueprint with a multi-stakeholder perspective is therefore a very appropriate method to be applied here.

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RESEARCH APPROACH

This paper analyses to what extent the early ideation process of the co-creation process in multi-stakeholder innovation can support technology adoption of older adults to promote physical activities.

Study context

In order to create the expected PSS, the designers and design researchers within the REACH⁹ consortium created and facilitated four co-creation workshops based on Method A¹⁰ in four different fields of application at the four solution providers including a clinical environment, a rehabilitation/care home center, a home care provider, and a home care/care home at a municipality level in four different EU countries within the project consortium¹¹. The co-creation workshop consists of three processes¹¹: the end user value creation process, the stakeholder value creation process and the encounter process (Figure 1). These workshops resulted in a number of PSS concepts that the consortium is working on at the moment.

Figure 2 depicts a service design blueprint template that was used in the workshops. In this service blueprint template, the locations of the services taking place are defined first, followed by the user actions in order to experience the service and interact with the products. Actions of the stakeholders who directly interact with the users are identified in relation to the user actions, as are those who indirectly interact with the users. Eventually the supporting processes including databases and other tools are identified to show how the user actions can be realized.

This paper analyses the three processes of the co-creation process (Figure 1) in the early ideation process on their contribution to the technology adoption process, more specifically, the domestication adoption process from Silverstone and Haddon¹⁴.

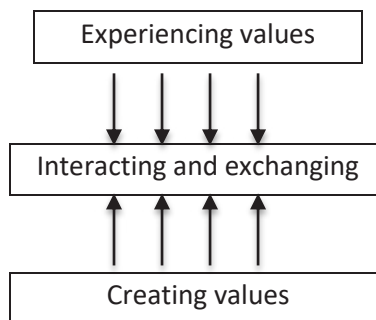
RESULTS AND ANALYSIS

In this section we will first describe the workshop co-creation process with some examples and then

The end user value-creating processes

The encounter processes

The stakeholder value-creating processes



discuss to what extent the three processes in the co-creation process in the early ideation process of the REACH project contribute to the different processes of the domestication adoption process.

The applied co-creation process¹⁰ combines the design solution space, the collaboration space (the stakeholders and their motivation and contribution in the resulting PSS) and the business space (the activities and resources that are required from the stakeholder to realize the PSS) (Figure 3). It started with a warming up activity through which a trusting and collaborative atmosphere for better acquaintance in multidisciplinary teams was created and the motivation of the stakeholders in participating in such network innovations was understood. Based on the earlier created experience maps and personas, and feedback from the targeted users, a common ground was created for the stakeholder network to ideate. The resulting ideas were visualized using the user experience map to demonstrate the activities of the targeted older adults. Furthermore, service blueprints were created to visualize the necessary front and back stage activities of the stakeholders in order to realize the intended user experiences. Eventually a number of concepts were chosen for next stage development based on preferences of the individual stakeholder.

Three processes could be identified.

- The stakeholder value-creation process. During this process, the stakeholders collaborated and created values not only for themselves (motivation) but also for the end users based on a common ground. The results were a number of PSS concepts visualized in service blueprint templates. The stakeholders' contribution to the PSS and the intended user experiences was clearly demonstrated.
- The end user value-creation process. During this process, the end users were able to provide information and feedback to the stakeholders so that the desired functions and features could be identified and co-created.
- The encounter process. During this process, the stakeholders actively defined their resources and activities that are needed to realize the created PSS concepts. The results were reflected in the filled in service blueprint templates.

In this section the results of the three processes will be discussed and analyzed on their contribution to the domestication adoption process.

Results of the co-creation process
To illustrate this process and make the discussion clear, an example is given below and used to sup-

Figure 1. Three different processes in the co-creation process¹¹

SERVICE BLUEPRINT

co - creation

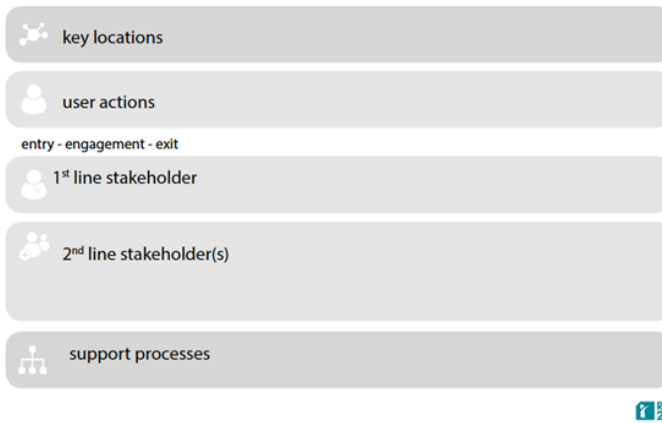


Figure 2. Service Blueprint Template¹¹

port the analysis. The Health Coach concept was one of the PSS concepts created in one of the workshops. It concerns a system that is able to capture health information including physical activity from the body (for example FitBit) and the environment continuously and provide information from older adult users, caregivers, GP and family members to take necessary actions and provide useful services to promote an active lifestyle of older adults. Important patterns are to be recognized based on the aggregated information to understand the daily life of older adults in order to predict and prevent acute events, identify abnormal patterns and introduce necessary interventions by suggesting different activities. This information will be shared with caregivers and General Practitioner (GP) in real time so that they can provide necessary services and solutions. Older adults can receive rewards if they meet their individual goals. This concept was created for the home care context.

End user value creation process

During the end user value-creation process of all four workshops, older adult participants were actively involved in the process to provide related user insights at the early phase and later to provide feedback from their perspectives. Specifically in the Health Coach concept, they mentioned that they were not aware of their own physical activity level, and that they would like to do more, but did not know how and what to do. They liked the Health Coach concept and shared their insights, which allowed the multi-stakeholder to understand the pain points that older adults currently experience and to identify the opportunities for innovation.

Stakeholder value-creation process

At the beginning of the workshops, an icebreaking activity was organized to create professional

empathy²⁸ among the stakeholders for better understanding of each other¹¹. This was also where the motivation for participating in the collaboration and desired values for the stakeholders were identified. For example, in the Health Coach concept, the target older adults were eager to learn about their daily activity status and be in control of their own lives; the caregivers on the other hand experienced a lot of workload and emotional stress in their work due to increase number of ageing clients and increasing reduction in human care resources; the GP also experiences an increase in older patient visits that potentially could be handled more effi-

ciently or even could be avoided if specific information about older adults was made available before the visits were planned; family members expressed that they found it stressful if the acute situation with their older adult family members happened without their awareness and did not allow them to prevent it from happening. The industrial partners with the sensing and monitoring technologies and the data analytics specialists from the academic partners aimed to apply their technologies to provide self-awareness to the older adults about their daily activities and promote and support more physical activities involved in the Health Coach concept. Therefore these stakeholders are looking for ways to make their work more efficient and effective and to support the target older adults to be more physically active. These values were then taken into account in the ideation process and visualized in the service blueprint template (Figure 4).

Encounter process

During the encounter process, the stakeholders interacted with each other and co-created the PSS ideas for the targeted older adults using a number of generic design research tools such as user experience map¹¹. The main results were illustrated using the service blueprint template. The filled in service blueprint template for the Health Coach concept is listed below for illustration. In this concept, the older adult users will use FitBit for example to monitor their daily physical activities. Through the system they can set their own goals on daily or weekly basis and receive reward when completing their goals; if their goals are not met, intervention will be suggested by the concept and activities will be planned for older adults in order to meet their goals.

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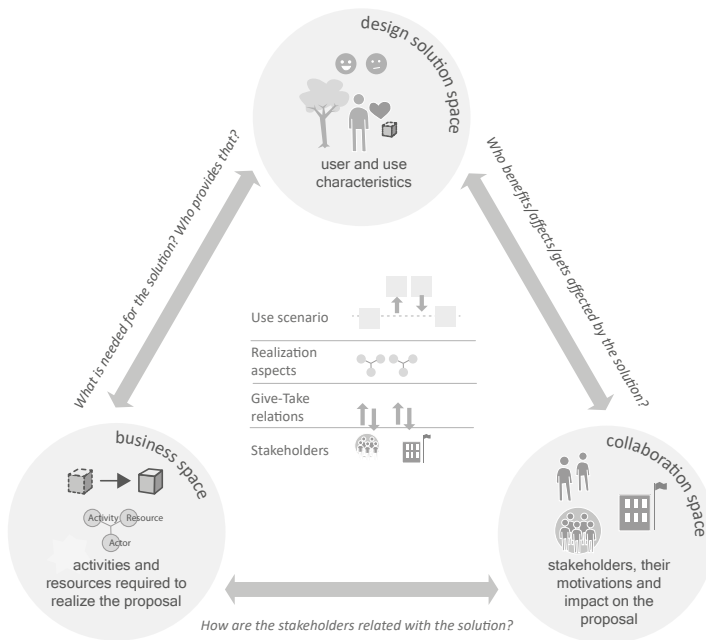


Figure 3. The Value Design Method supports pairwise comparison between the design considerations, stakeholder considerations and business considerations based on evolving use scenarios, as shown in the diagram¹⁰

To facilitate the activities of older adults, the stakeholders need to collaborate and facilitate the interactions between the older adult users and the system. The industrial experts with smart sensing and monitoring technologies will provide the required technologies to help older adult users record their daily physical activities. The healthcare system integrator will create a dashboard to, on the one hand, host the collected daily activities, on the other hand, to allow the users to set their own goals and provide direct feedback and suggestions. The data analytics' specialists will analyze the collected daily activities and identify the expected and unexpected patterns. These patterns will be then communicated through the dashboard to caregivers, GP and family members to enable them to take coordinated actions to support these older adult users to meet their goals and prevent acute events.

Through the different touchpoints: the sensing and monitoring device, the dashboard interfaces for older adult users, caregivers, GP and family members, the industrial partners will be able to support the continuous sensing and monitoring of the daily physical activities and real time care advice and support to the older adult users.

Analysis with regard to the domestic adoption process

It is interesting to mention that the ideation activities discussed in these three processes mainly re-

lated to the functions and features that older adults would experience with the intended PSS but did not focus on the motivation to purchase the PSS and the route and experience from acquiring information till purchasing the PSS. Thus they had no contribution to the appropriation process.

Through these three processes, it was very clearly understood what meaning the technologies should create for the end users, however, it was not yet specified how the older adults would use these technologies. In the Health Coach concept, the sensing, monitoring technologies and data analytics will be used to make the end users aware of their own status and know how to react, with or without external interventions when necessary. How these technologies will be placed in the older adults' life and where they will be placed remain unanswered yet. Therefore, they all contributed partly to the objectification process.

Furthermore, the resulting concepts from these three processes were very much on the interaction at the system level between the system and the end user. The stakeholders could define on the system level how the end users could interact with the system and what support could be necessary. Although the resulting PSS propositions were visualized using the service blueprint template in which the interactions through a series of touchpoints between older adults and the PSS concepts was defined, it was not clearly defined how the interaction/service would take place at individual touchpoint level enabled by the related technologies. For example, the stakeholders did not define how older adults would interact with sensing technologies in the Health Coach concept and whether it would be difficult for them to interact with the technologies. They were not able to define and agree on which resources were needed to realize these interactions using their technologies either. The data analytics would like to have as many measurements as possible to identify patterns and make necessary predictions. However, from the sensing and monitoring technology provider's perspective, this demands a much higher battery power as well as strong Internet connection and large database capacity and is not cost effective. The dashboard developers could be able to provide very

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SERVICE BLUEPRINT ▶ Health Level co - creation

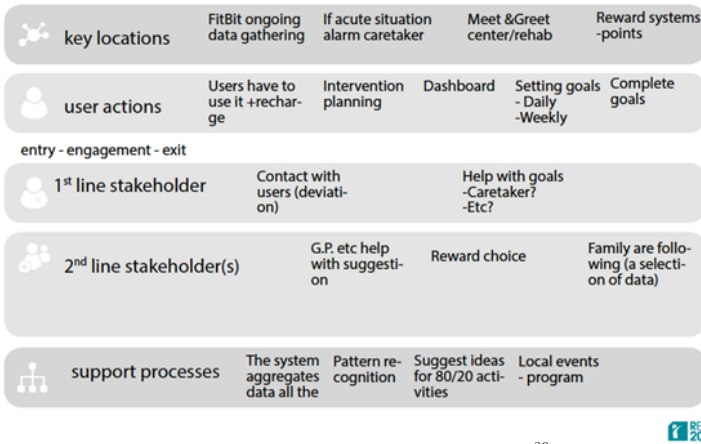


Figure 4. Service blueprint of the Health Coach concept²⁹

frequent feedback to the older adult users and formal and informal caregivers because of the availability of the large volume of data, however the required frequency of feedback may vary very much from users to users. It could be then concluded that the stakeholder value-creation process and encounter process could not support the incorporation and conversion process at the touchpoint level but only at the system level of the PSS concept at this stage. Consequently, the older adults could not comment on whether they would have difficulties in using these technologies and how easy it would be for them to learn and could not demonstrate any unexpected use of these technologies or unintended ways of interaction. Therefore, the end user value-creation process has no contribution to the incorporation and the conversion process at all (Table 1).

CONCLUSION

From the discussion and analysis above it can be learned that given the characteristics of the early ideation process, the co-creation process contributes largely to the objectification process of the domestication adoption process as the meaning of the technologies and values of the proposition towards the end users must be defined when ideating. It touches only a little on the incorporation process by specifying the system level interaction,

Table 1. How the three processes of co-creation ideation process supports the domestication adoption process

	Appropriation	Objectification	Incorporation	Conversion
End user value creation	No	Yes, partly	no	no
Stakeholder value creation	No	Yes, partly	Only on system level interaction	Only on system level interaction
Encounter	No	Yes, partly	Only on system level interaction	Only on system level interaction

but does not focus on individual technologies at the touchpoint level. Because the project was still in the earlier ideation process and no prototypes were made, it was not possible for the stakeholders to clearly address the process of interaction and the process of creating the interaction using the related technologies at the touchpoint as well as system level with a balanced considering of values for all stakeholders. The older adults were then not able to experience and to comment on how the interaction with the system and individual technologies was and what

the unintended usage would be. Although there was the business consideration in the co-creation process, the main focus of the workshops was to promote physical activities and no attention was paid to create channels that could make the created PSS available to the older -adults. The applied co-creation method at the earlier ideation stage is apparently insufficient to support the creation of technology adoption for older adults.

As known, proactively managing uncertainties in the early product development can prevent many problems in the downstream³⁰. If uncertainties related to technology adoption by older adults are not proactively dealt with in the co-creation process, it is highly possible that the PSS developed later may not be adopted and accepted by the older adults. Therefore, the co-creation ideation process needs to be reapplied when the project moves towards from system level design to touchpoint level design and service design. It should be improved for later stage of use to explicitly address the technology adoption challenge. Specifically, the following two future research directions need to be included:

(i) User testing with experience prototypes³¹ related to the individual touchpoint and their technologies in the concept development phase is of great importance to proactively manage uncertainties

related to technology adoption process by older adults, especially the incorporation and conversion process. This urges for explorative testing activities

and prototyping activities already taking place in the co-creation ideation phase.

(ii) Questions related to facilitating purchasing and covering the information acquisition to purchasing channel need to be raised already when creating the actions for older adults in the service blueprint template. In this way, the uncertainties related to the appropriation process of the technology adoption process can be covered. This urges for integrating marketing research into the

co-creation process when dealing with technology adoption of older adults.

The REACH project team is at the moment busy with early testing using already commercially available sensors to imitate the sensing behavior of the future PSS. This is certainly a responding act to the identified improvement action towards the better technology adoption by the older adults.

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