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## Co-Design of a routine that implements an equity and quality checklist to vulnerable elders on primary care: a living lab approach

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### Abstract

The population structure is changing. The proportion of elderly who is at risk of functional decline or death in a period of two years, the vulnerable elders, is rising. In this way, primary health care must incorporate quality and equity instruments that favor a better care provision. This study aims at co-designing the content, functionality, and interface modalities of an Equity and Quality Checklist to support the management of vulnerable elder patients in primary health care. The living labs approach involved multiple stakeholders: physicians, nurses, managers, and information technology developers assuming different roles in the context of a real environment. The decision-making process and the rationality of the choices made during the co-design workshops for the mockups and prototype is explained. The routine developed can be added to existing clinical information systems, and according to the participants will have a high impact on the care of vulnerable elders.

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**Keywords:** Vulnerable elder, living lab, clinical information system, primary care, equity, quality indicators.

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## 1. Introduction

The population structure is changing, especially in developed countries [1]. The proportion of elders (i.e., individuals aged 65 or over) has risen mainly due to lower fertility rates and increased longevity (higher life expectancy) [2]. The World Health Organization (WHO) defines a vulnerable elder as an elderly individual who is at risk of functional decline or death in a period of two years. Equity contributes to the overall improvement of population health [3]. The WHO has called for routine monitoring of healthcare equity in all countries [4]. The existence of quality indicators is an essential prerequisite to monitor, compare and improve the level of effectiveness and efficiency of health systems [5]. In Portugal, the 365 existing quality indicators for primary health care [6] only include four indicators of the quality of health care processes for the elderly. [7] developed an equity and adapted quality indicators (EQI) checklist based on ACOVE-3 tailored to the primary care in the Portuguese national health system (comprise 139 quality indicators plus 31 equity indicators).

This study aimed at co-designing the content, functionality, and interface modalities of the EQI Checklist to support the management of vulnerable elder patients in primary health care, and then to assess the acceptance of the content of the routine.

The review of [8] emphasizes that: a) clinical information systems have an impact on: nursing practice, patient safety, quality of treatment, communication, treatment management, nursing tasks, and hospital resource management; and b) the ‘quality and design of clinical information systems’, such as ease of use and learning, flexibility and software speed, have an impact on nursing practice and satisfaction.

The living labs (LL) approach is suitable to develop and test technology in a physical or virtual real-life context where users are important informants and co-creators of the tests [9]. The concept of a LL refers to the involvement of multiple stakeholders, including users, in the exploration, co-design/co-creation, and evaluation of ICT-related innovations within a realistic setting [10], [11]. According to [12], there is an apparent lack of empirical studies on LL, and, according to [13], there is a general lack of studies that both show the design evolution of health IT systems and explain the rationale for the choices made.

We conducted 3 co-design workshops and a proof-of-concept implementation in a LL environment with users, decision-makers, and IT developers. Another workshop was conducted with other health professionals to assess the acceptability of the routine to be implemented in the existing clinical information system (SCLínico - CSP).

This study contributes to practice by enabling a new EQI Checklist in the clinical information system (CIS) with apparently a high impact on the vulnerable elders, and to the theory by adding an empirical example to living labs.

This article is structured as follows: a) section 2 presents a brief theoretical contextualization of the LL concept; b) section 3 characterizes the methodological options of the study; c) section 4 presents the description of the cycle of activities developed in the co-design workshops until the creation of the prototype.

## 2. Theoretical context

There have been numerous attempts to define what a LL is; nevertheless, there is still no consensual definition. In [14], the authors review different definitions of LL, and in [15] their key characteristics (real environment context; multiple stakeholders; activities; business models and networks; methods, tools, and approaches; challenges; outcomes; and sustainability). The European Network of LL ([openlivinglabs.eu/aboutus](http://openlivinglabs.eu/aboutus)) defines them as “*user-centred open innovation ecosystems based on a systematic user co-creation approach, integrating research and innovation processes in real-life communities and settings*”.

LL are experiential real-life environments where participants engage in a creative space to design and experience products and services [16]. The literature documents a diverse set of LL environments: a single isolated place, educational institutes, people's homes, and workplaces, a city or a part thereof, etc. [17]. Our LL took place in a mixed environment ranging from the workplace and the participants' homes to virtual meeting rooms. The Living Labs are suitable for developing, co-creating, validating, and testing technologies [18]. In our LL, cooperative design activities among stakeholders that assumed different roles to create the routine were encouraged. The activities of testing, validating and commercialization were out of the scope of this work. Stakeholder roles are very intertwined with living lab activities. The literature comprises different views on stakeholder roles, please see [15]. We followed the four key actors: enablers, providers, users, and utilizers of [19].

[10] present 4 Models of LL according to the type of actors (Utilizer-driven; Enabler-driven; Provider-driven, and User-driven). In this study we followed the last one. User-driven LL focus on specific challenges of the users benefitting other stakeholders either directly or indirectly. The main features of our model were: 1) the network was initiated by enablers and there were no formal coordination mechanisms; 2) information was collected informally and was built upon users' interests; 3) the knowledge generated by participants was utilized to help the users community; and 4) the outcome is a solution to users' everyday-life problems. Our LL somehow follows the perspective of [12]: actively involving users in innovation activities, both in public-private-people partnerships and in real-life environments, namely, participants from Academia, a software development company, and primary health care centers. Users' knowledge offers a valuable resource for innovation because it fosters understanding of real-life situations [20]. In our LL, users, academics, and software developers worked together iteratively. [14] state that getting users interested is easy, but involving them in a practical way is more difficult, because the benefits of collaborating with the LL are not always clear. The primary health care providers and the vulnerable elders will ultimately be the beneficiary of our routine.

### 3. Methodology

Living Labs aim at studying information systems usage in actual real-life habitats and promote active co-creation with users of digital products and services [21]. The different users, each one with his/her own needs and expectations, that interact with health information systems (implementing and organizing new routines, inserting data, consulting data, performing analyses, etc.) influence systems' success [22]. Table 1 shows the users/participants involved in this study.

Table 1. Participants.

Participants Co-design	Professional area	Experience (years)	Function	Job description	Living Lab Role
P1	Nursing	19	Family Nurse	Elderly health care	User
P2	Nursing	13	Nurse manager	Management / Clinical Governance	Utilizer
P3	Nursing	19	Family Nurse	Elderly health care / Clinical Governance	User
P4	Physician	4	Family doctor	Elderly health care	User
P5	Information Systems	8	Software developer	Information systems developer	Provider
P6	Nursing	15	Family Nurse	LL workshops coordination	Provider
P7	Information Systems	5	Software Quality Manager	Responsible for ensuring the quality of the developed software	Provider
P8	Academia	32	Researcher	Research and coordination activities	Enabler
P9	Academia	20	Researcher	Research and coordination activities	Enabler
Participants Prototype test					
P10, P11, P12, P13	Nursing	-	Family Nurse	Elderly health care / Clinical Governance	User
P14, P15	Physician	-	Family doctor	Elderly health care	User

The description of a LL comprises the definition of: purpose, inputs, environment, approach, activities (cycle), objectives, and outputs [21]. The purpose of this study was to design and implement a routine concerning an EQI Checklist instrument in the CIS. The inputs were the EQI Checklist, the users' requirements, and the level of IS knowledge of the users. The LL environment must favor products or services to be experienced within a context that closely resembles real use [23]. So, the environment should encourage the involvement of different types of stakeholders, the introduction of new technologies in realistic circumstances, the monitoring of their acceptance, usage and effects in a collaborative process [10].

In the design process, LL approaches typically include: user-centered design, participatory design, and interaction design. User-centered design involves multiple users in all the steps of the development process to avoid excessive influence of informatics researchers [24], and draws on cognitive science, psychology, and computer science to make information systems more useful and easier to use [25]. Selecting representative users for user-centered design is critical. Our LL approach followed a user-centered design and involved the active participation of health care

practitioners in design, group critical thinking, problem-setting, and problem-solving activities. Typically, living labs follow an iterative cycle of activities including requirement elicitation, co-design, prototyping, testing and monitoring, and implementation (commercialization) [11]. The scope of this study was: requirement elicitation, co-design, and prototyping. Fig. 1 shows the study design.

The objectives of the research were: a) enable users to influence design features more in line with their preferences and practices, b) understand and tackle inhibiting factors, c) discover unexpected uses, d) increase acceptance, and e) minimize failures. The output of the study was designing a contextualized and customized routine that will identify inequity and poor-quality situations across the health care of vulnerable elders.

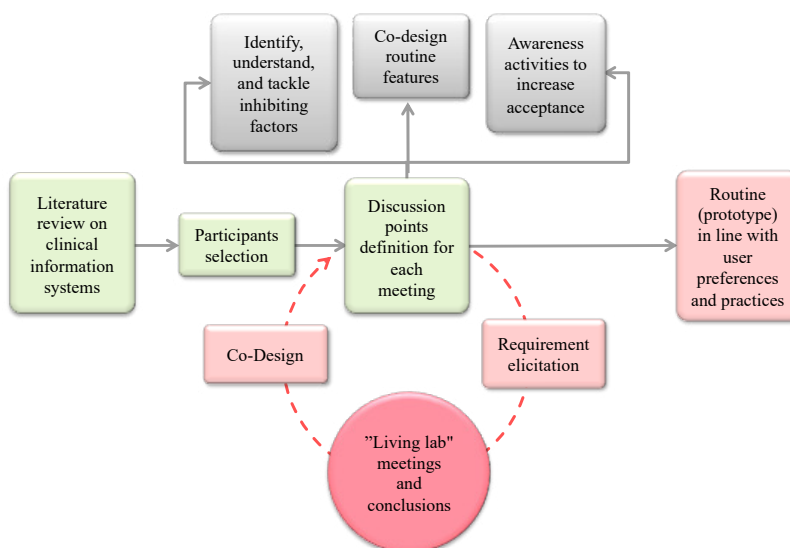


Fig. 1. Study design.

#### 4. Designing the EQI Checklist routine

The design of the EQI Checklist routine in the SClínico environment comprised 3 co-design workshops (Table 2, Table 3, and Table 4) and a proof-of-concept implementation (Table 5).

Table 2. Introductory activities.

Living lab #1	
Analyze the potential for adoption of the EQI Checklist on SClínico	
Inputs: EQI Checklist; Recall of SClínico capabilities and features	
Discussion points (objectives)	Activities
a) What is the advantage of using an instrument like the EQI Checklist? (identify the awareness of the participants about the subject)	1) Welcome, contextualization of the study with the presentation of the main objective (Co-design a routine to be implemented in SClínico), provide information on the functioning of the living lab meetings, and on the ethical considerations of this study.
b) Do you think it is worthy to incorporate it in the current clinical information system? (assess the utility of the Checklist)	
c) From the organization's point of view, who do you think will use it? (determine the scope of potential utilization)	2) Explain the EQI Checklist, definitions, scope, and purpose of the routine.
d) What do you imagine is the best way to operationalize it? (understand where to locate the Checklist inside SClínico)	

e) What do you think the vulnerable points associated with routine implementation can be? (obtain a first perception of difficulties)	3) Initial activities of identification of the users' requirements, expected difficulties, and the technological knowledge of the potential users.
d) What information from the Checklist is considered more important for health improvement? (given the dimension of the Checklist, understand which information is more valuable in order to emphasize it in SClínico)	
<b>Outputs:</b>	
<ul style="list-style-type: none"> <li>- The current state of SClínico on this subject from the health professionals' point of view was analyzed.</li> <li>- A consensus about the advantages of the EQI Checklist was obtained.</li> <li>- A reflection about existing data that could be export to the routine was done.</li> </ul>	

In the first workshop, the participants discussed the topics above, and a consensus about the advantages of the incorporation of the EQI checklist in the existing clinical information system was obtained. Therefore, it was decided to discuss which of the existing information should be used in the routine in the next workshops. *"Part of the data of the EQI Checklist is already in SClínico, but they are dispersed."*

Table 3. First sketches of the routine.

<b>Living lab #2</b>	
Discuss alternative design projects	
<b>Inputs:</b> Recall SClínico capabilities and features, a summary of the first workshop, paper, pencil.	
<b>Discussion points</b> (objectives)	<b>Activities</b>
a) Recall and synthesize the identification of the user requirements, expected difficulties, and the technological knowledge of the potential users.	1) Synthesize the advantages and barriers of implementing the routine, in order to sensitize the participants to the requirements of the operationalization of an effective routine.
b) For a specific clinical condition (as an example):	2) Design the menus and submenus that the routine should contain (for a specific clinical condition - the risk of falls).
- What information should be display?	3) Discuss the strengths and weaknesses of the suggested menus and submenus, i.e., create a SWOT analysis for the Mockups presented.
- What information should be migrated from SClínico to the clinical condition menu?	
- How many menus and submenus are needed?	
- How should they look like, which template?	
c) Discuss/elaborate the SWOT analysis of the Mockups presented.	
<b>Outputs:</b>	
<ul style="list-style-type: none"> <li>- First sketches of the menus and submenus.</li> <li>- A first draft that summarizes the information considered most important for monitoring vulnerable elderly people to create Mockups.</li> <li>- Swot analysis of the created structure.</li> </ul>	

In the second workshop, the rationality of the first sketches drawn by each participant relatively to the menus and submenus, templates, and the way information is inserted in the routine (buttons, boxes, scroll down, ...) was discussed. An initial set of mockups was obtained by a consensus. Nevertheless, some divergences still exist concerning the type of questions to be used to insert information, some defended the existence of free text fields to write personal comments about the patient. Despite that, everyone agreed that limiting their use will allow calculating indicators, and so the majority thought that that type of fields should be avoided. There was also unanimity in respect to the need to have a routine as lean as possible.



QPM

Escala de Tinetti (Tinetti Scale)

Data (Date)

29/01/2021

1. Equilíbrio Sentado (Seated balance)

Selecionar... (Select...)

2. Ao levantar (When getting up)

Selecionar... (Select...)

3. Tentativas de levantar (Attempts to get up)

Selecionar... (Select...)

4. Assim que levantar (As soon as you get up) (first 5 seconds)

Selecionar... (Select...)

5. Equilíbrio em pé (Standing balance)

Selecionar... (Select...)

6. Teste dos três tempos \* (Three stroke test \*)

\* Examinador empurra levemente o esterno do paciente, que deve ficar de pé junto.

\* The examiner gently pushes the patient's sternum, who should leave their feet together

Selecionar... (Select...)

7. Olhos fechados \* (Closed eyes \*)

\* Examinador pergunta levemente o esterno do paciente, que deve ficar de pé junto.

\* The examiner gently pushes the patient's sternum, who should leave their feet together

Selecionar... (Select...)

QPM

Mini-Exame do Estado Mental (Mini Mental State Examination)

Data (Date)

01/01/0001

1. Orientação (Orientation)

1.1 Em que ano estamos? (What year are we in?)

1.2 Em que mês estamos? (What month are we in?)

1.3 Em que dia do mês estamos? (What day of the month is it?)

1.4 Em que dia da semana estamos? (What day of the week are we in?)

1.5 Em que estação do ano estamos? (What season are we in?)

1.6 Em que país estamos? (What country are we in?)

1.7 Em que distrito vive? (In which district do you live?)

1.8 Em que terra vive? (In which location do you live?)

(Between parentheses a translation of the original to English for better understanding)

Fig. 2. Prototype Menus.

The last workshop aimed at verifying the utility and functionality of the prototype with the participation of 6 additional participants with the role of future users. The routine had a very good acceptance, the advantages were obvious to all participants and they shared the actual difficulties they face when using the current CIS to register and consult information about vulnerable elders, since some data are absent and many other are very disperse. They suggested the introduction of a customized patient history page that summarizes the problems associated with the patient. Such customization must be defined by the set of professionals of a given primary care center since care is provided by the team. Currently, some information is only displayed for the nurses or for the physicians. It is urgent to achieve a multidisciplinary crossover of the information among nurses and physicians, so this would be another requirement for the CIS. Other would be: free choice not to register all the fields, to decrease the use of scroll type fields, since, in the opinion of the participants, they may lead to errors and be excessive time consuming; allow the existence of free text fields to comment; introduce the possibility to create alerts for monitoring some indicators in the continuity of the care, and have easy access to the memory of recorded information. These requirements as well as extend it to other EQI clinical conditions will constitute additional features to be added in the future development of the routine.

#### 4. Conclusions and future research

This study describes the co-design of a routine that implements an EQI checklist for vulnerable elders on a primary health care CIS. For that, 3 co-design workshops and a proof-of-concept implementation in a LL environment with users, decision-makers, and IT developers were performed. This study contributes to 1) the theory by showing the design evolution of a routine to be implemented in the existing clinical information system (SCLínico) with explanations about the rationale for the choices made, and 2) to better care to the vulnerable elders in primary health care centers. The final prototype was validated by a group of health professionals. Future research will undergo a more comprehensive pilot test to obtain greater validation.

#### References

1. Eurostat, Population by Age Group. 2019, European Commission: Luxembourg .
2. European Commission, The 2015 Ageing Report. 2015, Publications Office of the European Union, European Economy series: Brussels, Belgium
3. Waters, H.R., Measuring equity in access to health care. Soc Sci Med, 2000. **51**(4): p. 599-612.

4. World Health Organization, WORLD HEALTH REPORT (The): Health Systems Financing: the path to universal Coverage (Arabic). 2010: World Health Organization.
5. Joling, K.J., et al., Quality indicators for community care for older people: A systematic review. PLoS One, 2018. **13**(1): p. e0190298.
6. ACSS, Bilhete de identidade dos indicadores dos cuidados de saúde primários para o ano de 2017. 2017, Ministério da Saúde | ACSS. © Abril 2017: Lisboa, 2017.
7. Taveira, A., Indicadores de qualidade nos processos assistenciais de saúde prestados à pessoa idosa vulnerável em Cuidados de Saúde Primários: Tradução e adaptação. 2020, University of Minho, Portugal.
8. Ferdousi, R., et al., Attitudes of nurses towards clinical information systems: a systematic review and meta-analysis. International Nursing Review, 2021. **68**(1): p. 59-66.
9. Kusiak, A., Innovation: The living laboratory perspective. Computer-Aided Design and Applications, 2007. **4**(6): p. 863-876.
10. Leminen, S., M. Westerlund, and A.-G. Nyström, Living Labs as open-innovation networks. 2012.
11. Ballon, P., M. Van Hoed, and D. Schuurman, The effectiveness of involving users in digital innovation: Measuring the impact of living labs. Telematics Informatics, 2018. **35**(5): p. 1201-1214.
12. Chris, M., et al., Editorial: Living Labs and User Innovation (January 2016). Technology Innovation Management Review, 2016. **6**(1).
13. Abugabah, A.J. and O. Alfarraj, Issues to consider in designing health care information systems: a user-centred design approach. electronic Journal of Health Informatics, 2015. **9**(1): p. 8.
14. Compagnucci, L., et al., Living Labs and user engagement for innovation and sustainability. Journal of Cleaner Production, 2021. **289**: p. 125721.
15. Hossain, M., S. Leminen, and M. Westerlund, A systematic review of living lab literature. Journal of Cleaner Production, 2019. **213**: p. 976-988.
16. Dvarioniene, J., et al., Stakeholders involvement for energy conscious communities: The Energy Labs experience in 10 European communities. Renewable Energy, 2015. **75**: p. 512-518.
17. Seppo, L., R. Mervi, and W. Mika, Towards Third-Generation Living Lab Networks in Cities. Technology Innovation Management Review, 2017. **7**(11).
18. Leminen, S. and M. Westerlund, A framework for understanding the different research avenues of living labs. International Journal of Technology Marketing, 2016. **11**(4): p. 399-420.
19. Mika, W. and L. Seppo, Managing the Challenges of Becoming an Open Innovation Company: Experiences from Living Labs. Technology Innovation Management Review, 2011. **1**(1).
20. Poetz, M.K. and M. Schreier, The Value of Crowdsourcing: Can Users Really Compete with Professionals in Generating New Product Ideas? Journal of Product Innovation Management, 2012. **29**(2): p. 245-256.
21. Ballon, P. and D. Schuurman, Living labs: concepts, tools and cases. info, 2015. **17**(4).
22. Calvillo-Arbizu, J., et al., User-centred design for developing e-Health system for renal patients at home (AppNephro). Int J Med Inform, 2019. **125**: p. 47-54.
23. Følstad, A., Living labs for innovation and development of information and communication technology: a literature review. 2008.
24. Brunner, J., et al., User-centered design to improve clinical decision support in primary care. Int J Med Inform, 2017. **104**: p. 56-64.
25. Johnson, C.M., T.R. Johnson, and J. Zhang, A user-centered framework for redesigning health care interfaces. J Biomed Inform, 2005. **38**(1): p. 75-87.