

Rehabilitation and User-driven development: a systematic literature review

IMT4134-Specialisation in software engineering report

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Abstract—Context: It is challenging to develop rehabilitation systems due to the particular end-user needs. The usage of traditional development and design frameworks seems to fall short when designing for marginalised end-users. Literature indicates that user-driven frameworks can greatly assist in the development process of systems targeting disabled individuals. **Objective:** My objective was to present various answers from literature to various research questions in regards to the effectiveness, usability and effectiveness of user-driven frameworks. **Methods:** For my exploration process, I performed a systematic literature review, using guidelines from various texts and guidance from my teacher Deepti Mishra. **Result:** 2072 research papers, from the years 2011 - 2021, were initially investigated in regards to their research on the user-driven framework. Of these 2072 papers, 212 papers were further analysed regarding the various research questions. **Conclusions:** My results indicate that the usage of user-driven frameworks in the development of rehabilitation increases the odds that the end product is of high quality, and suits the end user well. This paper also highlights common issues while using user-driven frameworks and how to mitigate some of them while discussing the different strategies researchers have applied to their development projects.

Index Terms—Systematic literature study, Participatory Design, User-driven development, User-driven design, rehabilitation, software engineering, system design

I. INTRODUCTION

As a developer, you are often tasked with the creation of applications you will not use, but you will need to rely on your own your team experience when designing, developing and testing, said applications, but, how do you design applications for users who have so vastly different ability and needs as yourself?

During my IMT4307- Introduction to Research in Serious Games and Gamification research project, I researched and documented the effect that serious games have on the physical rehabilitation of patients, focusing mainly on the research for a potential rehabilitation platform that would be able to assist in the treatment of every disability. I analysed many papers during this research, documenting their research questions, work methodology, and results. While analysing my results, I observed that papers that followed a framework called "User driven development" during research and development of their

systems seemingly had more conclusive results than counterparts that followed more traditional development methods. However, it was also observed that some development teams that did not follow the user-driven development method during their initial development had to redo parts of their project following the user-driven development framework to produce desired results.

This paper aims to systematically research and document the effectiveness of following a user-driven framework during the research and development of rehabilitation systems. In addition, the paper will cover the observed effect of following this methodology in developing rehabilitation systems and other systems where the target audience are disabled individuals.

The phrases "user-centered design" and "user-driven development" are as far as I observed used interchangeably in the literature. Therefore, I will not differentiate between the phrases in this text. Furthermore, the participatory design framework will also be discussed in this paper due to its close relationship to the user-centred design framework. Note: various terms will be used as synonyms. The terms user-driven development, Co-production,, requiements engineering, Participatory Design and the likes will be used at random to mean the same. The terminology will change based on the literature that is currently being discussed.

II. SCOPE

The focal point of this paper will be to look into research papers that focus on following the user-driven development framework during the development of systems where the core users are disabled individuals. I will mainly look at papers performing system development following user driven framework guidelines. I will not differ between physical and mental disabilities in this paper. I will also analyse research that focuses on elderly users.

III. LIMITATIONS

This paper attempted to cover as much literature as possible regarding the user-driven development field. As highlighted in the later sections, the user-driven development field is enormous and lack standardisation across disciplines. This

paper attempted to cover as much literature as possible but do not claim to be complete coverage of the field. This paper has a single author, with a limited time frame, so prioritisation had to be performed.

I will not do comparison between different engineering frameworks, even if I believe this would allow me to draw a better conclusion. I believe this is outside the scope of this paper.

IV. STRUCTURE

The paper will follow this structure:

- Ch. 1: Introduction
- Ch. 2: Research questions Ch. 3: Scope
- Ch. 4: Structure
- Ch. 5: Motivation
- Ch. 6: Related works
- Ch. 7: Methodology
- Ch. 8: Results
- Ch. 9: Discussion
- Ch. 10: Flaws
- Ch. 11: Conclusion
- Ch. 12: Future work

V. MOTIVATION

While I performed a systematic literature review as part of my IMT4307 research project, I observed that papers that followed the user-driven development framework could seemingly produce better results than their peers when testing their systems on disabled users. On the other hand, some of the systems that followed more traditional frameworks had to redesign parts of their system after testing it on its intended user base.

My master thesis will be conducted in collaboration with Vikersund Kurbad. Vikersund Kurbad is a place that specialises in the physical rehabilitation of patients. As part of their new initiative, they are planning on looking into the usage of serious games to assist in the rehabilitation of their patients. When this literature review was conducted, my project goal and scope were unknown, making it difficult to make concrete research goals. With that in mind, I strongly assumed that I would be tasked to research and develop a serious game system to rehabilitate users, making me inclined to research frameworks and methods that could assist me in developing such a system. Based on the results from my Serious games and rehabilitation: a literature review paper, I decided to research the effectiveness of using the user-driven development framework as a base to develop rehabilitation systems.

VI. RELATED WORKS

This collection of related work papers is further detailed documented in the methodology section. The collection of related works papers was done in two parts. First, the initial search was performed in a non-structured or systematic manner to get a broad overview of the current state of the art, synonyms and complete the first draft of research questions.

Then, the second part was structured and systematic, utilising the collected keywords to collect systematic review papers that covered these fields.

First iteration

The initial iteration of this literature study, was done very unstructured. As the goal was to get an overview of the literature, I used Google Scholar and Google to locate papers I felt looked good and analysed their research methodology and findings.

Systematic literature review on user-centred design and participatory design with older people: [1] In 2019, a team of researchers conducted a systematic literature review covering user-centred Design and Participatory Design usage with older people. The paper goes in-depth on the importance of proper design when targeting marginalised groups, highlighting how traditional system development methods might overlook sensitive user requirements in the design process. The paper highlights how well frameworks that involve users improve the final results and states that adoptions should be done to traditional frameworks to suit disabled users better.

Co-designing with a community of older learners for over ten years by moving user-driven participation from the margin to the centre: [2]

This paper conducted a longitudinal study of user-driven system development involving the elderly. The paper extensively covers how they performed system design and development while involving their primary user base during development. A long term study like this is rare since it is possible to judge the long term effect of their study. In addition, the paper discusses interesting elements of involving users, many of whom should be considered in every project that would base itself on user-driven design frameworks.

The paper mainly focuses on Participatory Design, but it contains valuable information about their experience using user-driven design frameworks.

Digitising the Hand Rehabilitation Using Serious Games Methodology with User-Centered Design Approach: [3] This paper discusses some of the essential elements User-Centered Design approaches can provide developers with regarding design limitations. Designing for marginalised groups can be challenging, and poor design choices can have a high probability of user injury. The paper discusses how to involve caretakers, healthcare professionals, and end-users in the design process. The paper claims that their user-centred design approach allowed them to push out a prototype that satisfies user requirements quickly; it discusses problems with taking user feedback at face value, concluding the need for active and passive ways to observe users. The paper also comments how "Other approaches like the waterfall or agile, might not satisfy the user requirement as the user-centered design can do in health related product." supporting my theory.

The paper "User-centered virtual environment design for virtual rehabilitation" [4] draws many conclusions, stating how important it is to find normal user range and ability. Using user-centred design methods also allows developers to find

hardware and human limitations quickly. It also concludes that: "...a user-centered design cycle that includes bench marking for the different sensory modalities is recommended for accurate interpretation of the efficacy of the virtual environment based rehabilitation programs."

Understanding the Human Motor Control for User-Centered Design of Custom Wearable Systems: Case Studies in Sports, Industry, Rehabilitation: [5]

Like the paper "Digitising the Hand Rehabilitation Using Serious Games Methodology with User-Centered Design Approach" [6] also claims that observation of non-verbal communication when getting user feedback is super important. Furthermore, the paper also states the importance of standardisation when collecting user feedback in a quantitatively matter.

Development of a robotic device for upper limb stroke rehabilitation: User-centered design approach: [7] This paper developed a robotic device for upper limb stroke rehabilitation. Even though their system is not a software system, I believe their concrete systematic User-Centered Design Process is of high quality, with excellent findings. The findings in this paper do match up with some of the previous papers, but this paper had more factual findings from their User-Centered Design Process. Examples are related to several iterations needed to get proper user feedback and the need for interdisciplinary teams while developing rehabilitation systems. Note that this paper states that some of their concluded results might not apply to the development of software systems.

Second iteration

After a review of the first iteration, I expected that the first iteration would not be able to give me a good enough structured overview of the current state of the art, which is why I redid my search for related literature systematically. The findings from iteration one gave me the terms "user-driven development" and "user-driven design" to work with. Using this, I created the query "((user-driven development) OR (user-driven design)) literature review," which gave me 17,400 results in google scholar. To narrow it down, I decided to only look at systematic literature reviews. My final google scholar search query ended up being: "((user-driven development) OR (user-driven design)) intitle:(systematic literature review)". I opted not to use match-case on the terms "user-driven development" and "user-driven design", which would allow Google to provide me with synonyms. This query resulted in 273 papers. After a quick manual analysis of titles, abstracts and conclusions in relevance to the research topic, I discarded 235 papers, leaving 38 of relevance. The 38 papers were analysed, focusing on my initial research questions to avoid research overlap, resulting in the removal of two research questions. See methodology for more details.

A complete list of accepted studies can be located in the appendix. In addition, some of the more relevant studies are discussed here.

A systematic approach to prioritising RD projects based on customer-perceived value using opinion mining: [8] This paper discussed the research and development of systems while

relying heavily on user input and the value they can provide for the end product. The paper presents a structured methodology that allows user feedback and increases "customer-perceived value" about the end product. This paper's methodology and experiments do not overlap enough with my research question RQ1 and RQ8 to warrant the removal of these, but I still believe this paper provides valuable input on how to better utilise end-user feedback during the design and development phases of products. The paper also relies on using big data to make statistical decisions, something I do not believe would be the case in many user-driven development projects.

Generative Participatory Design Methodology to Develop Electronic Health Interventions: Systematic Literature Review:

[9] This is one of the synonym papers I located with my search query. This paper performs a systematic study of using Participatory Design Methods during the research and development of healthcare-related systems. The paper states in its abstract that "PD is characterised by the involvement of all stakeholders in creative activities." This phrase can be applied to user-driven design and user-driven development. The paper also states that PD, compared to user-driven development, involves more users in decision-making. The paper does conclude that "Studies that have used a PD research methodology to develop eHealth primarily substantiate the choice of tools made and much less the use of stakeholders and outcome measures.", making this paper worth highlighting with regards to RQ1. Note that the way the paper views user-centred design frameworks differs from other papers, stating that PD has more user involvement than user-centred design frameworks.

Investigating User Participation in the Design Process via a Social-media based Tool – a Systematic Mapping Study: [10]

This paper highlights some attractive unexplored opportunities and challenges in user engagement when providing design feedback. This highly fit under RQ2, and I believe this paper provides a good starting point in exploring challenges and opportunities in terms of gathering user feedback.

Co-production of Digital Services: Definitions, User involvement in social work innovation: [11] Regarding RQ4, this paper explores the relation between developers, designers and the users providing feedback. The paper provides a typology related to users' involvement in the design process that focuses on the user's involvement in the innovation process, their roles, and how they can influence the design system's innovation. Since the paper covers innovation within the social work field, I do not know if their findings are directly applicable to rehabilitation or can be generalised, but I believe this paper gives a good starting point regarding RQ4. The paper does state some critical issues with various frameworks that rely on user involvement that should be considered during the acquisition of any user feedback.

Co-production of Digital Services: Definitions, Frameworks, Cases and Evaluation Initiatives - Findings from a Systematic Literature Review: [12]

This paper studies user-assisted design/development from 1998 to 2016, detailing different framework changes that allow for the production of better systems; even so, the paper also documents the missing parts

of the current state of co-production frameworks. One of the core findings of this paper is the presented frameworks that would allow users to partake more in the design and development phases, focusing on user engagement, stating that "From the articles, it seems clear that users need to be involved, supported and convinced of their power to change the proposed situation. Among the techniques employed, gamification seemed promising, even if conducted on non-digital platforms."

User involvement in the development of patient decision aids: A systematic review: [13] This paper discusses some of the challenges and opportunities user-driven design frameworks can provide designers when designing for a disabled user base. It discusses user involvement in great detail, highlighting the importance of user understanding, goals, strengths, limitations, etc. The paper also highlights the importance of feedback gathering systematically, concluding with the importance of involving various stakeholders like patients, clinicians and other users for a complete design process. Interestingly, this paper also notes that it might be beneficial primarily to include users as co-designers or partners during the research and development of systems.

The Importance of User Involvement: A Systematic Review of Involving Older Users in Technology Design: [14] This paper documents how to design around a specific group of individuals that share some traits. It presents methods to alleviate some of the more common issues they found regarding user participation in elderly groups. The paper also presents some interesting findings regarding RQ1, RQ3, RQ5 and RQ7. From the paper: "The authors find that the two teams that collaborated with older adults at the highest level were the most successful, and their proposed mobile applications won the competition far ahead of the other teams."

VII. RESEARCH QUESTIONS

Based on the related works papers, the consensus seems to be that using "user-centered design" and "user-driven development" is a superior design framework compared to traditional frameworks. (e.g. Scrum, waterfall) when designing and developing rehabilitation systems. With that in mind, I developed the research questions below. With these questions, I aim to answer more specific questions on how "user-centered design" and "user-driven development" impact the design process and what should be done to accommodate the usage of these frameworks in the development process of rehabilitation questions.

My research questions:

RQ1: What tangible impacts does user-driven design have on the final product?

RQ2: What are some challenges and opportunities with user-driven development, and what was done to alleviate the challenges?

RQ3: Can user input during the design phase make it, so the project deviates too much from final specifications?

RQ4: How have different researchers changed the traditional user-centred design framework to work with rehabilitation development?

RQ5: Does project scope need to be changed to accommodate the framework?

RQ6: How early should users be brought into the design process?

RQ7: How does different disability types affect the User-driven development framework?

RQ8: What are the different methods/metrics used to evaluate the product developed using user-driven development?

RQ9: What are some observed trends in user-driven development?

VIII. METHODOLOGY

A. Related work

First iteration: As stated in the related work section, my first look at related work was highly unstructured. Realising the fault in my methods, I used terms from the papers I located (As seen in the First iteration section in related work) to conduct a structured, systematic review of literature related to my research questions.

Preliminary research questions (PRQ) was created; these were:

- PRQ1: How have different researchers changed the traditional user-centred design to work with rehabilitation development?
- PRQ2: What tangible impacts does user-driven design have on the final product?
- PRQ3: What are some challenges and opportunities with user-driven development, and what has been done to alleviate the challenges?
- PRQ4: How do different disability types affect the User-driven development framework?
- PRQ5: How early should users be brought into the design process?
- PRQ6: Does the project scope need to be changed to accommodate the framework?
- PRQ7: Can user input during the design phase make it so the project deviates too much from final specifications?
- PRQ8: How should the design process be changed to accommodate users?
- PRQ9: How should user feedback be collected and evaluated?
- PRQ9: What are the different methods/metrics used to evaluate the product developed using user-driven development?
- PRQ10: What are some observed trends in user-driven development?

Second iteration: The time frame of the query was from 2011 to now, and only English articles.

Unless specified, the symbols " " are used to mark search queries and was not used in the actual query. During the research phases, these queries were explored:

- User-driven design systematic literature review - 14 000 results
- User-driven design literature review - 17 800 results
- User-driven design rehabilitation systematic literature review - 3 770 results
- User-driven design rehabilitation literature review - 7 000 results
- User-driven development systematic literature review - 14 500 results
- User-driven development literature review - 17 100 results
- User-driven development rehabilitation systematic literature review - 3 880 results
- User-driven development rehabilitation literature review - 7 300 results

Note that adding a dash is required, "user driven design literature review" gives 1 310 000 results, whereas "user-driven design literature review" gives 17 800 results.

To narrow down the number of papers, and to avoid duplicates, Boolean operators was applied to the queries.

- ((user-driven development) OR (user-driven design)) literature review - 17,400
- ((user-driven development) OR (user-driven design)) systematic literature review - 13,500

Still, to narrow the scope even more, I forced google scholar to look for a systematic literature review in the title, with the query: ((user-driven development) OR (user-driven design)) intitle:(systematic literature review). This query gave me 272 results.

Most of the resulting papers did not match the focal point of this paper, and exclusion criteria were applied to all 272 papers manually by analysing the papers titles, abstracts, conclusions and research questions with relevance to this paper RQs.

The exclusion criteria:

- Papers that had no reference to proper user-driven system development or engineering was discarded.
- Papers discussing business model innovation was discarded.
- Papers that was not readily available was discarded, e.g. Paywall, 404 etc.
- Papers that covered or used any user-driven design or development were discarded.
- Papers that studied the usage of "live labs" was discarded
- Papers that studied the usage of user-driven design in marketing campaigns were discarded
- Studies that have used user during design but had extremely specific RQs were discarded
- Books were ignored due to scope

After applying these criteria to the 272 papers, 235 were discarded, and 37 were saved for future analysis. One paper was discovered in the references to one of the papers analysed and was added to the list of relevant papers, now totalling 38.

The papers research questions and focus were analysed in regards to my PRQs to avoid overlapping research.

Agile Requirements Engineering: A systematic literature review covers question PRQ8. PR8 was discarded.

Citizen participation as a systematic development tool in renewing social and healthcare services covers and Crowdsourcing: A taxonomy and systematic mapping study vocal point overlap with PRQ9. R9 was discarded.

The papers are then analysed to expand this papers research questions, focusing on the future work found in the 38 papers. No new questions were added, leaving this paper with the research questions found in VII.

An analysis of the research questions was done to get a feeling of how much existing research existed in the related work papers that could apply to my questions.

- RQ1: There seems to be information relevant to this question in various papers, but I feel it systematically lacks proper exploration.
- RQ2: Same as RQ1
- RQ3: Unexplored
- RQ4: Same as RQ1, but covered a bit in the paper: Co-production of Digital Services: Definitions, User involvement in social work innovation,
- RQ5: Unexplored
- RQ6: Same as RQ1 but slightly discussed in: Participatory Design in Gerontechnology
- RQ7: Unexplored
- RQ8: Seemingly unexplored, papers state that this is a question that needs to be researched more
- RQ9: Heavily discussed but not in any systematic manner

Analysing the various papers' terms to reference user participation in the design or development process left me with many different terms and synonyms. There seems to be no clear standardisation of terms. In the synonyms list below, "... " indicate the removal of words I deem irrelevant for future search. An example is: "On the Systematic Development of Domain-Specific Mashup Tools for End Users" becoming "Development...for End Users". Terms found:

- Active Involvement...
- Agile Requirements Engineering
- Citizen participation
- Citizen-driven innovation
- Co-design
- Co-production
- Crowdsourced requirements engineering
- Development ... for End Users
- End-user involvement
- End-user development
- End-user programming
- End-user software engineering
- Engaging patients ...
- Human-centred design
- Human-centered development
- Involving people ... in development
- Involving.. Users... in development OR design
- Opinion mining
- Participatory design
- Patient and public involvement (PPI)
- Patient involvement

- Public involvement
- Requirements Engineering
- Stakeholders' Engagement
- User Involvement
- User Participation .. in design/development
- User-driven design
- User-driven development
- User innovation
- User involvement .. in design/development/i
- User-driven innovation

Due to the apparent vast list of synonyms, I can't guarantee that I managed to find all relevant related works articles, but due to a short time frame, I did not prioritise the expansion of this section, and instead dedicated more time into the systematic literature review.

Synonym filtering and grouping: Due to the lengthy list of synonyms, I had to perform grouping and filtering to be able to perform any sort of search query. I deemed it unfeasible to perform proper systematic searches on every 30 synonyms for each research question. Instead, an analysis of what domains the various papers fell into was performed. I analysed what type of journals the papers were published in, and if it was difficult to get a clear answer regarding journal type, I looked into the background of the authors, even so, three papers were put under "computer science and healthcare" as they were all published in the journal jmir. A journal that mixes computer science and healthcare. The results are shown here:

Domain:	Count
Healthcare	12
Computer science	12
Design	4
Sustainability	4
Computer science and healthcare	3
Social work	1
Climate science	1
Psychology	1

Healthcare and computer science were clearly dominant out of the paper I analysed. I cross-referenced the synonym table with the titles of the papers, counting each instance of the synonym lists located in the paper titles. The findings are shown in the table below:

Word:	Count
Co-design	3
participatory design	3
User Involvement	3
crowd sourced requirements engineering	2
End-user development	2
patient and public involvement	2
User Participation .. in design/development	2
Active Involvement...	1
Agile Requirements Engineering	1
Citizen participation	1
Co-production	1
end-user programming	1
end-user software engineering	1
Engaging patients ...	1
patient involvement	1
Stakeholder's Engagement	1
user innovation	1
User-driven innovation	1

Eleven synonym words were not found in the titles of the papers and have been removed from this table. The term "User Participation .. in design/development", "Active involvement", and "Engaging patients" was removed due to vagueness and overlap with different terms. The words: "user", "patients", "citizen" and "public", was grouped, removing 3 terms, leaving the terms: "User/Patient/Citizen/public innovation", "User/Patient/Citizen/public Involvement", "User/Patient/Citizen/public participation". Co-design and Co-production were grouped. End-user programming and end-user software engineering were also grouped. "User driven development" and "User driven design" was added to the list as they were the initial search terms used. Terms targeting groups of people were grouped for easier queries.

The remaining search terms are:

Agile Requirements Engineering
Co-design
Co-production
Crowd sourced requirements engineering
End-user development
End-user programming
End-user software engineering
Participatory design
Stakeholders' Engagement
User/Patient/Citizen/public Involvement
User/Patient/Citizen/public driven design
User/Patient/Citizen/public driven development
User/Patient/Citizen/public innovation
User/Patient/Citizen/public participation

The final google scholar search terms are:

- Q1: (Agile) OR (Crowd sourced) AND Requirements Engineering
- Q2: (Co-design) OR (Co-production)
- Q3: End-user (programming) OR (development) OR (software engineering)
- Q4: Participatory design
- Q5: Stakeholders Engagement
- Q6: ((User) OR (Patient) OR (Citizen) OR (public)) AND ("driven development") OR ("driven design")

The terms "Participation", "innovation", and "Involvement" was removed from Q6 due to the extremely high number of results these would return (4 million +).

Generalisation of research questions

To perform proper Google Scholar searches, generalisation of the research had to be performed. These were the final search terms used for each of the different research questions. The results were found via Google Scholar at November 28, looking at papers from 2011 to now published in English.

An identifier, e.g. Q1.1, is added to each query for identification purposes.

RQ1: What concrete impacts does user-driven design have on the final product?:

- Q1.1 Impact final product (Agile) OR (Crowd sourced) AND Requirements Engineering - 19,300 results
- Q1.2 Impact final product (Co-design) OR (Co-production) - 16,700 results

- Q1.3 Impact final product End-user (programming) OR (development) OR (software engineering) - 22,800 results
- Q1.4 Impact final product Participatory design - 30,000 results
- Q1.5 Impact final product Stakeholders Engagement - 39,200 results
- Q1.6 Impact final product ((User) OR (Patient) OR (Citizen) OR (public)) AND (("driven development") OR ("driven design")) - 17,400 results

RQ2: What are some challenges and opportunities with user-driven development, and what was done to alleviate the challenges?:

- Q2.1 Challenges opportunities (Agile) OR (Crowd sourced) AND Requirements Engineering - 18,700 results
- Q2.2 Challenges opportunities (Co-design) OR (Co-production) - 17,200 results
- Q2.3 Challenges opportunities End-user (programming) OR (development) OR (software engineering) - 17,800 results
- Q2.4 Challenges opportunities Participatory design - 87,700 results
- Q2.5 Challenges opportunities Stakeholders Engagement - 115,000 results
- Q2.6 Challenges opportunities ((User) OR (Patient) OR (Citizen) OR (public)) AND (("driven development") OR ("driven design")) - 16,900 results

RQ4: How have different researchers changed the traditional user-centred design to work with for rehabilitation development?:

- Q4.1 adjustment OR change OR adaptation (Agile) OR (Crowd sourced) AND Requirements Engineering - 18,900 results
- Q4.2 adjustment OR change OR adaptation (Co-design) OR (Co-production) - 16,600 results
- Q4.3 adjustment OR change OR adaptation End-user (programming) OR (development) OR (software engineering) - 163,000 results
- Q4.4 adjustment OR change OR adaptation Participatory design - 659,000 results
- Q4.5 adjustment OR change OR adaptation Stakeholders Engagement - 459,000 results
- Q4.6 adjustment OR change OR adaptation ((User) OR (Patient) OR (Citizen) OR (public)) AND (("driven development") OR ("driven design")) - 16,900 results

RQ5: Does project scope need to be changed to accommodate the framework?:

- Q5.1 Scope (Agile) OR (Crowd sourced) AND Requirements Engineering - 18,100 results
- Q5.2 Scope (Co-design) OR (Co-production) - 16,800 results
- Q5.3 Scope End-user (programming) OR (development) OR (software engineering) - 34,400 results
- Q5.4 Scope Participatory design - 246,000 results
- Q5.5 Scope Stakeholders Engagement - 228,000 results

- Q5.6 Scope ((User) OR (Patient) OR (Citizen) OR (public)) AND (("driven development") OR ("driven design")) - 17,300 results

RQ7: How do different disability types affect the User-driven development framework?:

- Q7.1 disability account effect (Agile) OR (Crowd sourced) AND Requirements Engineering - 17,400 results
- Q7.2 disability account effect (Co-design) OR (Co-production) - 17,100 results
- Q7.3 disability account effect End-user (programming) OR (development) OR (software engineering) - 17,000 results
- Q7.4 disability account effect Participatory design - 17,000 results
- Q7.5 disability account effect Stakeholders Engagement - 17,300 results
- Q7.6 disability account effect ((User) OR (Patient) OR (Citizen) OR (public)) AND (("driven development") OR ("driven design")) - 7,390 results

RQ8: What are the different methods/metrics used to evaluate the product developed using user-driven development?:

- evaluation (Agile) OR (Crowd sourced) AND Requirements Engineering - 18,600 results
- evaluation (Co-design) OR (Co-production) - 16,900 results
- evaluation End-user (programming) OR (development) OR (software engineering) - 41,300 results
- evaluation Participatory design - 446,000 results
- evaluation Stakeholders Engagement - 326,000 results
- evaluation ((User) OR (Patient) OR (Citizen) OR (public)) AND (("driven development") OR ("driven design")) - 16,900 results

RQ3, RQ6, RQ9: I did not create specific queries for research question 1,3,9, as I feel they are too unspecific to create queries. Instead, I tried to answer these questions by analysing the material I read as part of my effort to answer the research mentioned above questions.

As the resulting number of results were in the millions, I opted to rely on Google's Scholars relevant search result algorithm. For each of the 36 queries, I will analyse the first five pages of Google Scholar results. The searches were performed in Norway in the timeframe, December 1 - December 7, 2021. The inclusion and exclusion criteria were the same as the ones used in the related works section. The result filters were: papers from 2011 to today and papers in English.VIII-A

IX. RESULTS

1800 papers were looked at, and 1545 were excluded following the exclusion criteria. By removing duplicated papers, the resulting number of papers ended in 174. The different results from each query can be found here:

Note: Example, "RQ1.4" means the results for the query "Impact final product Participatory design", while "Total for query 4" means the total number of results from all queries

using the terms "Participatory design". This is to indicate the effectiveness of the various terms.

RQ1.1	10
RQ1.2	7
RQ1.3	11
RQ1.4	20
RQ1.5	8
RQ1.6	3
R1 total	59
RQ2.1	10
RQ2.2	4
RQ2.3	9
RQ2.4	10
RQ2.5	2
RQ2.6	1
R2 total	36
RQ4.1	8
RQ4.2	8
RQ4.3	6
RQ4.4	8
RQ4.5	2
RQ4.6	3
R4 total	35
RQ5.1	12
RQ5.2	9
RQ5.3	4
RQ5.4	16
RQ5.5	8
RQ5.6	3
R5 total	52
RQ7.1	4
RQ7.2	8
RQ7.3	7
RQ7.4	17
RQ7.5	1
RQ7.6	5
R7 total	42
RQ8.1	3
RQ8.2	8
RQ8.3	3
RQ8.4	12
RQ8.5	4
RQ8.6	1
R8 total	31
Total	255
Unique only	174
Total for query 1	47
Total for query 2	44
Total for query 3	40
Total for query 4	83
Total for query 5	25
Total for query 6	16

See appendix for complete literature list.

174 papers were chosen for further analysis, but due to the high number of relevant papers, only papers that contained information relevant to the different research questions are directly quoted and discussed here.

Research question 1

"REfine: A gamified platform for participatory requirements engineering" [15], state that user involvement increases product quality, broadens market and customer loyalty, indicating great success in using user-driven design. Stating, "User involvement also contributes to requirements quality by

increasing the chance of project success and lowering the costs of RE."

"Evaluating the level of stakeholder involvement during the project planning processes of building projects" [16] states that early inclusion of stakeholders is good since the earlier they are involved, the more tangible impact they can have on the design. This translates to improved economic sustainability and quality of the project; the paper states that it lacks quantitative research.

"In pursuit of rigour and accountability in participatory design" [17] states that the impact of PD is complicated to measure in an explicit manner as much of the PD impact can happen implicitly.

The paper "User Involvement in Software Development and System Success: A Systematic Literature Review [18]" performed a study of 2776 papers trying to answer the same research question like this one, concluding that user involvement had an overwhelmingly positive effect on system engineering. They also state that there is ambiguity in what user involvement entails. Its also highly difficult to measure the impact in concrete terms.

The paper "Co-Design to Support the Development of Inclusive eHealth Tools for Caregivers of Functionally Dependent Older Persons: Social Justice Design" [19], states that "The use of co-design involving participants at risk of SHIs does not guarantee innovation, but it does guarantee that the tool developed will comply with their process of help-seeking and their literacy level."

Research question 2

Oppertunities: Many papers refer to new opportunities related to new technology and new interfaces in terms of user interaction, the paper "Engaging Older People using Participatory Design" state that the usage of Participatory Design increased insight within the problem space.

Challenges: The paper "Designing technology for children with special needs" [20] discusses how the usage of participatory design can have significant benefits in terms of value, but it can put too much weight on the shoulders of the users.

"Collaboration and Co-Production of Knowledge in Healthcare" [21], "Stakeholder engagement in the design of scenarios of technology-enhanced tourism services " [22], and "In pursuit of rigour and accountability in participatory design " [17], state that the challenges they faced are related to stakeholder engagement, governance arrangements, and capacity and capability for working in a co-productive way, highlighting how difficult it is to get proper feedback from designers. The paper "Agile Requirements Engineering: A systematic literature review " [23] concludes that "The reported challenges are: lack of allocated time for upfront activities, difficulty of modularisation, optimising the work between developers and UCD practitioners, performing usability testing and lack of documentation."

Several papers state that there is a risk of too much of a difference in power between the users and the designers; this can skew the design and development phase.

Research question 3

"In pursuit of rigour and accountability in participatory design" [17] states that user design input can affect the project enough that the final design can deviate a lot from the initial design plan.

"Empathy, participatory design and people with dementia" [24] state that they have had issues where the designers and users vision is very different, they state that effort needs to be put in to find a middle ground between the designers and users.

Research question 4

"Academic engagement as knowledge co-production and implications for impact: Evidence from Knowledge Transfer Partnerships" [25] state that non-academic impact requires sustained knowledge in co-producing interactions, also stating that user participation needs to be done at different time intervals.

"The Promise of Empathy: Design, Disability, and Knowing the "Other" [26] and "Negotiating Gender and Disability Identities in Participatory Design" [27] state that relating to the users is very beneficial, as it increases product quality. Concluding that activities that bridge users and designers should be prioritised.

"Designing eHealth that Matters via a Multidisciplinary Requirements Development Approach" [28] state that "the requirements development approach presented in this article enables eHealth developers to apply a systematic and multidisciplinary approach towards the creation of requirements." claiming there are developed methodologies out there to try to standardise the framework. The paper strongly recommends relying on a multidisciplinary team for design and development reasons.

Research question 5

"Moving Toward the Promise of Participatory Engagement of Older Adults in Gerotechnology" [29] States that Participatory Design projects are often narrow in scope, saying that, "In restricting the scope and focus of PD research in the development of new technologies to solve a predetermined problem associated with aging, researchers and designers also largely direct meanings and interpretations that are possible. In particular, they do not allow for a reflexive and continuous process of discovery between the researchers and the participants, as well as between the participants themselves."

"Infrastructuring and the formation of publics in participatory design" [30] states that the reverse is true. They claim that an increase in scope, increases the effort dedicated to the Participatory Design process.

"On participatory design of home-based healthcare" [31] claim that participatory design is often used for learning, not pure development projects, making complete scope hard to estimate. This is supported by "Co-production and collaboration in planning" [32], which states that co-production broadens the possible domains, meaning project scope is increased, but this is often indicated early in the design phase.

"Requirements Engineering Challenges in Large-Scale Agile System Development" [33] state that scope can vary when using Participatory Design elements and recommend having shared holistic views before starting the design phase.

"A Mapping Study on Requirements Engineering in Agile Software Development" [34] states that Participatory Design often increases the scope of the project, but scope management methods can be applied, just like it can be applied to other agile frameworks.

Research question 6

"Evaluating the level of stakeholder involvement" [35] states that users should be involved early during the project planning processes of projects, as early inclusion makes user input more impact. This can extend to improved practicality, economic sustainability and quality of the project.

In general, I found most papers that evaluated their usage of Participatory Design, and the likes could not stress enough how beneficial it was to include users as early as possible. In the reflection section, several of the development papers stated that they wished they would include users earlier in the process or improve the involvement process.

Papers like "User-driven development with scientific and applied research" [36] state the importance of early prototyping for improved user involvement.

Research question 7

"STS-inspired design to meet the challenges of modern aging. Welfare technology as a tool to promote user driven innovations or another way to keep older users hostage?" argues the use of scientific methods during the design and development of systems targeting disabled users. [37]

As different disabilities require different adjustments and care, it is challenging to design frameworks that work with all disabilities. This is especially difficult in rehabilitation systems where patients vary in disabilities, both mental and physical. With that said, "User-Sensitive Inclusive Design" [38], state that a user-centred paradigm can be formed for generalising user design with many disabilities.

Research question 8

"Research co-design in health: a rapid overview of reviews" [39] state that research on co-design appears to be widely used but seldom described or evaluated in detail. Also, stating that quantifying the potential of co-design, may require the development of more precise and more consistent terminology, improved reporting of the activities involved and better evaluation.

"Co-Designing Technology for Aging in Place: A Systematic Review" [40] state that "evaluation of the impact of co-designed technologies is needed and standardisation of the definition of co-design would be helpful to researchers and designers".

One notable mention is the book: "Evaluating Co-production" [41], the book seems to cover this research question, but the book is pay walled.

Research question 9

Few observed trends; it was mentioned in a few papers that adaptability in systems is now more prevalent than before.

X. DISCUSSION

General Discussion

It was surprising how different search terms returned vastly different number of relevant papers. It is clear that the most appropriate term for this paper was the one relating to Participatory design. Other domains were using the other terms more. As seen in question Q7.5, only one relevant paper was worth noting down for that specific search term.

I find it highly interesting how varying the literature on the different research questions is. The papers I found mainly focused on specific user-driven design applications and were rarely studied in applications within generalised software engineering projects.

As documented in the table of literature findings, there is a significant difference in the number of papers within different terminology. This was also documented in the generalisation section. Another observation is the lack of clarifications when the different development papers use user-driven frameworks. For example, there is no clear definition between user-driven development, user-driven design, Participatory Design etc. I believe this might indicate that other researchers might have used a form of user-driven development for their projects, but used generic terminology, e.g. terms like "Engaging patients". This would make it impossible to locate their research papers while researching user-driven frameworks.

Research question 1

There seems to be a general lack of quantitative research on how user-driven development frameworks impact the final product. As mentioned, it was generally assumed that user-driven frameworks not only impact the quality of the end product but also impact the design and development framework in ways that are hard to measure. However, overall, almost all of the papers that discuss the usage of user-driven development overwhelmingly discuss it positively, stating that the usage of user-driven frameworks was often critical to the quality of the developed system.

Research question 2

It was difficult to find papers that concretely discussed the opportunities for user-driven frameworks. The opportunities were often non explicitly discussed in the improved system, increase in ease of use, economic improvements, etc. Nevertheless, it was clear that most of the papers that I analysed in this paper viewed the usage of user-driven frameworks in a positive light, with many opportunities.

On the opposite side, the various papers were very explicit when discussing various challenges with the current user-driven frameworks, with most of them relating to how to work and listen to users.

Research question 3

I found that this question was rarely discussed in the various papers. The main points I observed was how some papers brought up how too much deviation in regards to expectations between users and designers could lead to poor project design; highlighting the importance of proper communication guidelines between the users and designers.

Some other papers also stated that deviation might happen in cases where users are given too broad of design tasks, making it so that their feedback might differ too much from the end product.

There seems to be a lack of proper reflection on deviation from the initial system design in the papers analysed; it is often mentioned in papers but rarely evaluated.

Research question 4

Designers and developers seem to have adapted user-driven frameworks to their projects. As working with marginalised groups is a challenging task, this is understandable, but I find the lack of standardisation concerning.

The most interesting observation is how most researchers expanded on the frameworks regarding an emotional connection to humans. The consensus seems to be that the better connection between the users and designers, the better the resulting product will be.

Research question 5

The research was somewhat divided and inconclusive regarding how the project scope changes in regards to the usage of user-driven frameworks. Most researchers were optimistic that user-driven frameworks changed the project scope, but how the scope is affected was unclear. Since the point of using user-driven frameworks is to understand the problem better, it is arguable counterproductive to perform proper scoping of the project before initial user-driven design sessions have been performed.

The better the understanding between the users and the designers are, the more accurate the project scope can be set.

Research question 6

I could not find any concrete research on when users should be brought into the design process. A majority of the studies that discussed the usage of users in a development project mainly reflected on their usage in retrospective evaluations. Almost all papers I read that discussed the usage of users concluded that the usage of these individuals was vital for the development of their system, often indicating that they wish they brought them into the process more accessible in the design process or increased the process to involve them better. This indicates that users cannot be brought in fast enough.

Research question 7

I was unable to find papers that discussed disabilities in a general manner. A majority of them covered the usage of user-driven development regarding specific disabilities, indicating the disabilities were known before the design phase

was conducted. A few papers highlighted the possibility of changing the framework to more straightforward create a general framework that can be applied to varying groups of disabled individuals.

Research question 8

I was unable to find any suitable open publications that documented the evaluation of the end product of systems developed using user-driven development, as the analysed papers mainly referenced qualitative measures regarding the evaluation of the system. However, the consensus does seem that systems developed relying on user-driven development are superior in many ways, highlighting economic, user benefits, scope benefits etc., as pros.

Research question 9

I found it difficult to find any trends by observing the papers. However, I observed trends in using new technology, like utilising social media in user-driven development and other new technology. By observing the publication years, I did not see an increase or decrease in the number of publications.

I found it interesting that there seemed to be a lack of studies that tried to analyse trends in user-driven development systematically, but this question was not explored explicitly.

FLAWS

This study had some flaws due to time constraints and other unexpected issues; some of these are mentioned here:

Google Scholar: Google scholar returned poor results, both during my related work search and during my literature review study. I tried to adjust the search queries to increase the number of relevant papers, and decrease irrelevant papers, that appeared but to no avail.

Synonyms: There is a high likely hood that I missed one or several synonyms while doing a literature study. My list ended up being 40+ in terms of related terms, making it highly likely that I missed some. The odds of this happening is increased due to my unfamiliarity with many of the domains.

Few Google scholar pages: I only looked at the five first pages of the search results. This was 150 pages, but it might not have covered enough of the relevant papers in some domains.

Not verified: As a single author conducted the study on a single machine, the results were not verified. This could mean that the relevant papers in my Google scholar results could have been biased, based on my prior search history, location etc.

Paywalls: There was a good chunk of literature that was paywalled. The study was conducted using the school research paper access, but this was insufficient. It is unknown how relevant these papers were for this paper.

Poorly formulated RQs: Some of the RQs were poorly and vaguely formulated, making it somewhat difficult to perform proper research.

Extreme number of results: As the resulting number of papers were in 1800+, I had to quickly exclude papers where the abstract or title did not match the RQ's. There is a chance that some relevant papers were accidentally excluded during this part.

Research question 9: My plan in regards to RQ9 was to write down any potential observed trends I would find by performing my literature review. Unfortunately, I was unable to observe any tangible trends during my study. I do believe this is because I did not perform any detailed research to try to document any trends in the field. For future work, I recommend explicitly trying to analyse, and document observed trends in the field by using statistical analysis etc.

XI. CONCLUSION

This paper conducted a systematic literature review of the current state of user-driven development, intending to answer several questions on how and why user-driven frameworks are used in research and development projects, mainly targeting disabled individuals as end-users. The paper documents clear findings regarding some of the questions while demonstrating how some of the nine research questions are potentially lacking in studies.

In general, the paper demonstrated how the usage of users in the development of systems targeting disabled individuals is a good framework, by most conventional metrics. The paper highlights some of the issues of evaluating this kind of system. Finally, the paper documents some of the practical issues when using this framework and how different researchers have tried to minimise these issues.

Ultimately, this paper proves that the more you utilise and listen to your users in the design phase, the higher the chance of a successful development project is. However, with that said, the research seems to agree that relying on user-driven frameworks can end up in a "faster horses" situation, decreasing the odds of great innovative solutions. "If I had asked people what they wanted, they would have said faster horses." - Henry Ford.

Here is a summary of the main findings of this paper:

- Traditional discrete design methods are limiting.
- User involvement in the design process increases the happiness and motivation of both the users and developers.
- To avoid confusion, clear guidelines in how to listen to users need to be made, in regards to their feedback,
- Fostering of intergroup communication can yield unexpectedly good results.
- Rapid prototyping seems to be the superior way of testing the system,
- User-driven frameworks guarantees that the finalised system will be usable by the end-users. This is super important when targeting end-users with special needs.
- The user-driven framework domain is in dire need of standardisation.

One of the main contributions of this paper is how it highlights the lack of standardisation in the domain of user-driven design. There is no shared glossary or terminology in

the user-driven development domain, as documented in the preliminary, related work, and literature study sections. A clear example of this is how on Wikipedia, the phrase "user driven development" and "user driven design" are synonyms without any clear indication on what either means.

I will not make the assumption that this paper managed to document the entire field of user-driven development, but I believe that the paper managed to capture enough of the current state of the field that any reader could use this paper to argue for or against the usage of user-driven development, I also believe that any potential researcher can use this a springboard for future research,

XII. FUTURE WORK

I would recommend redoing the analysis of the papers with a better time frame. However, as time was of the essence, I can not guarantee that all the papers were correctly analysed. Therefore, further research on the research questions with more literature is also recommended.

Performing a systematic literature review with a team from multiple disciplines could also be beneficial, as there is a lack of standardisation in this field, meaning that there is a chance that I can have missed terminology or not been able to synthesise the information with the research questions and I lack multidisciplinary knowledge.

I do also recommend performing the grouping of the various relevant papers. Due to time constraints, this was not performed during the literature analysis, but by doing so, it could be possible to spot patterns between the papers.

As discussed in the flaws section, I was unable to document trends in user-driven design. In the future, I strongly recommend revisiting this question more explicitly.

XIII. BIAS

The author is highly interested in rehabilitation, engineering and the healthcare applications of user-driven design. This might have affected the selection process when going through the papers.

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LITERATURE FOUND DURING RELATED WORK STUDY			
title	URL	authors	Domain
Understanding the Role of User Needs and Perceptions Related to Sub-Seasonal and Seasonal Forecasts on Farmers' Decisions in Kenya: A Systematic Review	https://eprints.whiterose.ac.uk/173017/1/Muita%20et%20al_2021.pdf	Richard Muita et al.	climate science
The Systematic Discovery of Services in Early Stages of Agile Developments: A Systematic Literature Review	https://www.scirp.org/journal/paperinformation.aspx?paperid=93616	J Sedeño et al.	computer science
End-user development, end-user programming and end-user software engineering: A systematic mapping study	https://www.sciencedirect.com/science/article/pii/S0164121218302577	Barbara Rita Barricellia, Fabio Cassanob , Daniela Foglic, Antonio Piccinnob	computer science
Co-design in mHealth Systems Development: Insights From a Systematic Literature Review	https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1152&context=thci	Tyler J. Noorbergen , Marc T.P. Adam, Mark Roxburgh , Timm Teubner	computer science
Systematic mapping of the literature: social innovation laboratories for the collaborative construction of knowledge from the perspective of open innovation	https://dl.acm.org/doi/pdf/10.1145/3012430.3012609	José Antonio Yañez-Figueroa et al	computer science
A systematic literature review of evaluation methods for health collaborative systems	https://ieeexplore.ieee.org/abstract/document/6846871	Luciana Pereira de Araujo et al	computer science
Crowdsourcing: A taxonomy and systematic mapping study	https://www.sciencedirect.com/science/article/pii/S1574013715000052#s000105	M Hosseini et al.	computer science
Co-production of Digital Services: Definitions, Frameworks, Cases and Evaluation Initiatives - Findings from a Systematic Literature Review	https://link.springer.com/chapter/10.1007/978-3-319-98349-3_1#Sec7	G Almeida et al	computer science
Investigating User Participation in the Design Process via a Social-media based Tool – a Systematic Mapping Study	https://lutpub.lut.fi/bitstream/handle/10024/125586/thesis%20-%20Investigating%20User%20Participation%20in%20the%20Design%20Process%20via%20a%20Social-media%20based%20Tool%20-%20a%20Systematic%20Mapping%20Study.pdf?sequence=2	M Maldar et al.	computer science
A systematic mapping study on crowdsourced requirements engineering using user feedback	https://onlinelibrary.wiley.com/doi/full/10.1002/smr.2199	C Wang et al.	computer science
Agile Requirements Engineering: A systematic literature review	https://www.sciencedirect.com/science/article/pii/S0920548916300708?casa_token=oe1PSBHteXsAAAAA:rtEzUzDd7Ervi0Z8zLLF-MJmjLnT-SjuTP50OpegQW_vBIXPuyAcT8hHK6a9jmfibeXizC9zfg#s0195	EM Schön et al.	computer science
A Systematic Review of Personalized Collaborative Systems	https://www.frontiersin.org/articles/10.3389/fcomp.2020.562679/full	Thomas Neumayr et al.	computer science
On the Systematic Development of Domain-Specific Mashup Tools for End Users	https://link.springer.com/chapter/10.1007/978-3-642-31753-8_22	Muhammad Imran et al.	computer science
Applying the Electronic Health Literacy Lens: Systematic Review of Electronic Health Interventions Targeted at Socially Disadvantaged Groups	https://www.jmir.org/2020/8/e18476/	Christina Cheng et al	computer science and healthcare
Participatory Methods to Engage Health Service Users in the Development of Electronic Health Resources: Systematic Review	https://jopm.jmir.org/2019/1/e11474	G Moore et al	computer science and healthcare

Generative Participatory Design Methodology to Develop Electronic Health Interventions: Systematic Literature Review	https://www.jmir.org/2020/4/e13780/?utm_source=TrendMD&utm_medium=feed&utm_campaign=Feed%3A%20JMedInternetRes%20%28Journal%20of%20Medical%20Internet%20Research%20%28atom%29%29&utm_medium=cpc&utm_campaign=JMIR_TrendMD_1	Pieter Vandekerckhove et al.	computer science and healthcare
Co-designing with Senior Citizens: A Systematic Literature Review	https://link.springer.com/chapter/10.1007/978-3-030-78108-8_5#Sec8	Sónia Machado, Liliana Vale Costa, Oscar Mealha	design
Involving people with dementia in the development of supportive IT applications: A systematic review	https://www.sciencedirect.com/science/article/pii/S1568163713000032#sec0115	Marijke Span et al.	design
Citizen participation as a systematic development tool in renewing social and healthcare services	https://www.theseus.fi/bitstream/handle/10024/87102/Ja...pdf?sequence=1	T. Jäppinen	design
Creative Arts Interventions to Address Depression in Older Adults: A Systematic Review of Outcomes, Processes, and Mechanisms	https://www.frontiersin.org/articles/10.3389/fpsyg.2018.02655/full?utm_source=Email_to_authors&utm_medium=Email&utm_content=T1_11_5e1_author&utm_campaign=Email_publication&field&journalName=Frontiers_in_Psychology&id=409305&fbclid=IwAR07cEcd43A5OAoJTNt9Jhq5ZwHSLuh4OxOEqsLCulcnBECXp9cpwNvxXXc#h3	Kim Dunphy et al	design
Active Involvement of People with Dementia: A Systematic Review of Studies Developing Supportive Technologies	https://content.iospress.com/articles/journal-of-alzheimers-disease/jad190050	Suijkerbuijk, Sandra et al.	healthcare
Engaging patients to improve quality of care: a systematic review	https://link.springer.com/article/10.1186/s13012-018-0784-z#Sec21	Yvonne Bombard et al	healthcare
A Systematic Review of Design Workshops for Health Information Technologies	https://www.mdpi.com/2227-9709/8/2/34/htm	Mustafa Ozkaynak	healthcare
Current trends in patient and public involvement in cancer research: A systematic review	https://onlinelibrary.wiley.com/doi/full/10.1111/hex.12841	KH Pii et al.	healthcare
Use and reporting of experience-based codesign studies in the healthcare setting: a systematic review	https://qualitysafety.bmj.com/content/qhc/29/1/64.full.pdf	T Green et al.	healthcare
The use of systematic approaches to patient involvement in the development and evaluation of a patient reported outcomes tool for use in routine diabetes care	https://vbn.aau.dk/ws/portalfiles/portal/432703122/PD_SES_E_pdf.pdf	Skovlund, Soren	healthcare
User involvement in the development of patient decision aids: A systematic review	https://osf.io/qyfkp	G Vaisson et al.	healthcare
Participatory Design in Gerontechnology: A Systematic Literature Review	https://academic.oup.com/gerontologist/article/59/1/e16/4999719?login=true#129701803	Sebastian Merkel, Alexander Kucharski	healthcare
User-driven innovation and technology-use in public health and social care: A systematic review of existing evidence	https://journals.ojs3.fe.up.pt/index.php/jim/article/view/2183-0606_006_002_0008/313	Hong Zhu et al.	healthcare
Usability and acceptability of technology for community-dwelling older adults with mild cognitive impairment and dementia: a systematic literature review	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5942395/	T Holthe et al.	healthcare
The Importance of User Involvement: A Systematic Review of Involving Older Users in Technology Design	https://academic.oup.com/gerontologist/article/60/7/e513/5644100?login=true#207436398	Björn Fischer et al.	healthcare

Mapping the impact of patient and public involvement on health and social care research: a systematic review	https://onlinelibrary.wiley.com/doi/full/10.1111/j.1369-7625.2012.00795.x	Jo brett et al.	healthcare
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