



## Consumer direction in the field of digital technologies and people with dementia: a literature review

Antonios Tsertsidis, Ella Kolkowska & Irene Rapado

To cite this article: Antonios Tsertsidis, Ella Kolkowska & Irene Rapado (2021): Consumer direction in the field of digital technologies and people with dementia: a literature review, Disability and Rehabilitation: Assistive Technology, DOI: [10.1080/17483107.2021.2008529](https://doi.org/10.1080/17483107.2021.2008529)

To link to this article: <https://doi.org/10.1080/17483107.2021.2008529>



© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



Published online: 20 Dec 2021.



[Submit your article to this journal](#)



[View related articles](#)



[View Crossmark data](#)

## Consumer direction in the field of digital technologies and people with dementia: a literature review

Antonios Tsertsidis<sup>a</sup>, Ella Kolkowska<sup>a</sup> and Irene Rapado<sup>b</sup>

<sup>a</sup>Department of Informatics, Örebro University, Örebro, Sweden; <sup>b</sup>Department of Philosophy, Linguistics and Theory of Science, Gothenburg University, Gothenburg, Sweden

### ABSTRACT

**Purpose:** Digital technologies have a great potential to improve the quality of life of people with dementia. However, this group is usually not involved in their development and dissemination. A consumer-directed role in the delivery of digital technologies could allow this group to regain autonomy and certain independence. This article aims to conceptualise the components of the Consumer Direction theory in the context of digital technologies and people with dementia.

**Method:** A literature review was conducted. We searched for studies within the aforementioned context in five relevant databases, covering the years 2012–2020. Identified studies were screened and assessed for inclusion. The data were categorised using two-stage qualitative content analysis.

**Results:** Forty articles were included. The results provide definitions of the four components of the Consumer Direction theory in the context of this study. Namely, what it means for people with dementia to be (1) in control of technology use, (2) offered a variety of technological options, (3) informed and supported regarding the use and training of digital technologies, and (4) actively participating in systems design. These can lead to the empowerment of people with dementia.

**Conclusion:** The four theoretical components of the Consumer Direction theory are conceptualised differently in the context of this study. By providing new definitions, this paper contributes to research and practice. We expect the definitions to be deployed by researchers, practitioners, and policymakers for the creation of a more consumer-directed delivery of digital technologies to people with dementia.

### ARTICLE HISTORY

Received 9 February 2021  
Revised 2 September 2021  
Accepted 12 November 2021

### KEYWORDS

Dementia; elderly; digital technologies; consumer direction; review

### ► IMPLICATIONS FOR REHABILITATION

- Digital technologies have a great potential to improve the quality of life of people with dementia.
- A consumer-directed role in the delivery of digital technologies could empower people with dementia and give them the opportunity to take control over the offered services as well as maintain a degree of independence.
- The Consumer Direction theory and its components should be conceptualised differently in the context of digital technologies and people with dementia than in previous contexts that used the theory.
- The new definitions can be utilised by researchers, practitioners and policymakers for the creation of a more consumer-directed delivery of digital technologies to people with dementia.

## Introduction

Worldwide, the number of people suffering from cognitive disabilities is steadily increasing, with predictions estimating 114 million people with dementia by 2050 [1,2]. Dementia is a disease that can alter an individual's personality and behaviour, causing impaired judgement that can eventually hinder decision-making ability [3,4]. Nowadays, dementia is treated as one of the largest global public health challenges as the main source of disability and dependence [5]. People with dementia are often stigmatised because of their frailty and vulnerability [6,7].

Numerous digital technologies have emerged to tackle the challenges associated with dementia. Researchers treat digital technologies as one possible means to improve the quality of life of people with dementia [8,9]. Digital technologies are used to (1)

enable the independence of disabled people, but also (2) to increase the ease and safety by which certain tasks are performed [10]. An additional goal of digital technologies is to help people age in place, which most older people strive for [11]. By definition, ageing in place entails 'the ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level' [12]. Digital technologies have been developed within the areas of (1) reminding notifications, (2) social contact, (3) safety, and (4) activities of daily living [13].

However, recent research shows a lack of involvement by people with dementia in the development, dissemination and adoption of digital technologies [14], potentially due to the stigma of frailty and vulnerability [6,7]. To the latter, other much wider factors add in such as difficulties in involving people with dementia in technology development, because of difficulties in receiving

consent [15] which can prevent researchers from targeting this group, or because of lack of competencies and methods in how to involve people with dementia actively and meaningfully [16]. Therefore, we argue that it is important for people with disabilities and dementia to maintain a consumer-directed role regarding digital technologies instead of being passive receivers of these technologies. A consumer-directed role means that people with disabilities (1) have control over offered services, (2) are offered a variety of services to choose from, (3) are informed, receive sufficient support, and (4) participate in policymaking and the design of services (See Figure 1). Maintaining a consumer-directed role usually leads to better community integration, empowerment, and increased quality of life [17,18]. Hence, a consumer-directed role in the delivery of digital technologies provides people with dementia the opportunity to take control of their lives and maintain a degree of independence.

Consumer direction has been used in different areas such as disease management, health and social care, tourism, business and economics [19–23]. In the aforementioned studies, consumer direction is usually described as something which helps empower clients, patients, and consumers to direct their respective services. Although previous research addressing digital technologies supporting ageing in place and people with dementia suggested person-centred approaches putting the user and his/her needs in focus for development and implementation of technology [24], very little [25] research examines consumer direction in this context. In a consumer-directed system, individual with disabilities (e.g., dementia) should not just be at the centre, but should be the ones that are in control of the provided services and the policies and practices that affect their lives [26]. The theory that guides the Consumer Direction, namely the Consumer Directed Theory of Empowerment is an attempt to assemble one simple theory on Consumer Direction that informs person-centred/person-directed approaches [27] and focuses on the empowerment of people with disabilities. Additionally, as Mirza and Hammel [28] mention, adapting a consumer-directed approach is not only possible but also effective among people with disabilities. They further argue that positive results cannot occur just by person-centred interventions. Consumer Direction is an open-ended construct and context-dependent [29], thus we argue that it is important to understand what consumer direction means in the context of the delivery of digital technologies to people with dementia. This study aims to conceptualise consumer direction in this new context. Accordingly, we conduct a review of the scientific literature (empirical studies) within the areas of digital technologies and people with dementia. This literature review aims to answer the following question which are linked to the four theoretical components of the Consumer Direction: What does it mean to (1) be in control, (2) have different options available, (3) receive sufficient information and support, and (4) participate in system design in the context of digital technologies for ageing in place and people with dementia?

### **Theoretical framework: consumer direction**

The concept of consumer direction derives from the Consumer-Directed Theory of Empowerment, which aims to promote the empowerment of people with disabilities [18] and is primarily used within disability policymaking and service delivery. While consumer approaches have been criticised for placing the end-user as a passive receiver of technology [30], this is not the case with the consumer direction as it emphasises the active involvement of the consumer (i.e., people with disabilities) in deciding

about their own care/treatment plans or technology design and use [18]. Span et al. [13] argue that such active involvement can lead to the empowerment of people with dementia. To avoid previous consumer approaches which portray the user as a passive receiver of services/technologies, Kosciulek [18] also presents three underlying assumptions for the Consumer Direction. These assumptions are: (1) consumers with disabilities know best what they need; (2) choice and control should be an integral part of care services and designed to provide the user with a variety of options; and (3) consumer direction should be available to all people with disabilities [18].

Furthermore, the Consumer-Directed Theory of Empowerment focuses on consumer direction since it can lead to better community integration, empowerment, and quality of life for people with disabilities. Consumer Direction also presumes that long-term care is mostly non-medical, putting its focus on technological devices that allow people with disabilities to maintain their independence [31]. The main theoretical assumption of consumer direction is that people with disabilities have control over the practices that affect their lives [17], which in this article is the delivery of digital technologies. Consumer direction includes four components [17,18], definitions of which are presented below (See Figure 1):

#### ***Control and direct services***

According to the definition provided by Kosciulek [18], the component of Control and Direct Services relates to the amount of control that consumers have over how, when, and by whom services are delivered. Additionally, it focuses on the degree to which an individual with disabilities can determine the type and influence the quality of the received services [32,33].

#### ***Variety of service options***

The second component of consumer direction relates to whether consumers have a choice from a range of service options [18]. This component also considers possible limitations, risks, or restrictions to consumer control. For example, if a consumer with a disability attempts to assert control over their rehabilitation program by designing and proposing an alternate service type not previously provided, do funding and program rules and regulations allow for such an option?

#### ***Information and support***

The third component refers to the amount of information and support available to consumers [18]. According to Holmes [34] and Kosciulek [35], the main criticisms of service systems by consumers with disabilities and their relatives regard: (a) lack of information and (b) lack of long-term support. Therefore, it is important to examine whether consumers receive appropriate information and support, which further enables them to take advantage of and receive the benefits of the services they are entitled to. In a consumer-directed system, consumers are informed about available service options as well as the legal, financial, and personal issues associated with each option [18].

#### ***Participate in policymaking/systems design***

The last component of consumer direction refers to the consumers' ability to participate in systems design and service allocation [18]. This component emphasises consumers' degree of participation at the policymaking level; for example, in policy formulation,

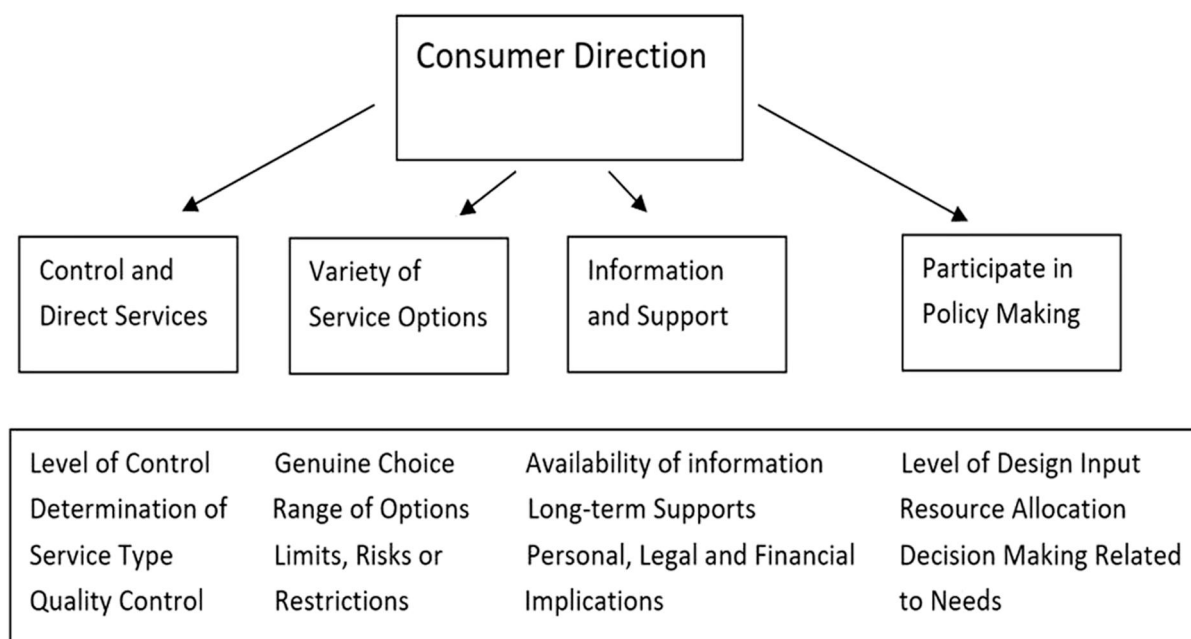


Figure 1. Conceptualisation of consumer direction [17].

design of rehabilitation services, and allocation of financial resources [18,32].

### Related research

To our knowledge, no previous review has tackled this article's topic. None of the reviews in this section focus explicitly on the components of consumer direction. However, we present an overview of existing literature reviews within the broader context of digital technologies and people with dementia by relating them to the four components of consumer direction.

Several literature reviews focus on the effectiveness of digital technologies for people with dementia [36,37], namely technologies concerned with safety and independence. Other reviews focus on the different types of technologies that exist for people with dementia [38–41], such as virtual environments, intelligent assistive technologies and more. All these reviews discuss different types of digital technologies, which could be interpreted as an existing *variety of technological solutions* for people with dementia. Furthermore, reviews focus on ethical concerns surrounding the use of technologies by people with dementia [41–43]. Such ethical issues regarding, for example, monitoring systems and how they can intrude on a person's privacy or who would be responsible for tracking.

Moreover, some reviews focus on the *participation of people with dementia in systems design* within different stages of technological development [13,44–47]. These reviews [13,43–46] focus on the participation of people with dementia in systems design, even though they do not apply consumer direction as an analytical lens. However, in their review, Dawson et al. [48] point out the lack of focus on the perspectives of people with dementia in the scientific literature. Along these lines, Daly Lynn et al. [38] report that people with dementia were often treated as passive participants in their reviewed studies. The review of Span et al. [13] similarly explains that included studies did not investigate the effect of participation on people with dementia. The same result was found in the review of Suijkerbuijk et al. [47], which states that most of the included studies did not describe how people with dementia experience their participation. This lack of

participation may have adverse effects on people with dementia since as Kosciulek [17] and Span et al. [13] state, the participation of people with dementia is crucial for their empowerment.

Other gaps identified in the reviews relate to the use of self-directed support by people with dementia and lack of support [48]. These findings are in line with reviews noting potential users' lack of awareness of options and the need for information and support from caregivers and professionals [44,46]. A review by Thordardottir et al. [49] on acceptance and use of assistive technologies among people with mild cognitive impairment and dementia found that more knowledge is needed about barriers and facilitators to using assistive technologies. These reviews' findings could fall under the consumer direction component of *Information and Support*. We argue that such knowledge can be obtained by pursuing an increase in consumer direction.

Finally, we could not find any literature reviews that would focus on the *Control and Direct* component in the context of digital technologies and people with dementia. This component focuses on the control that people with dementia have concerning when and if technology should be used (or not). Control is an important component; to achieve an increased consumer direction, a person with dementia must be in control, be offered options, have sufficient information and support, and be involved in systems design or policymaking. These factors are all crucial to empower people with dementia [25].

While the previous literature reviews summarised studies within the different areas that could be related to specific consumer direction components, this review focuses on understanding and defining the consumer direction components in the context of using digital technologies for ageing in place and people with dementia.

### Method

To determine how the four components of consumer direction can be defined, understood, and used in the context of digital technologies and people with dementia, we conducted a scoping review. Scoping reviews do not assess study quality [50]. Nevertheless, they can use a structured approach, which ensures

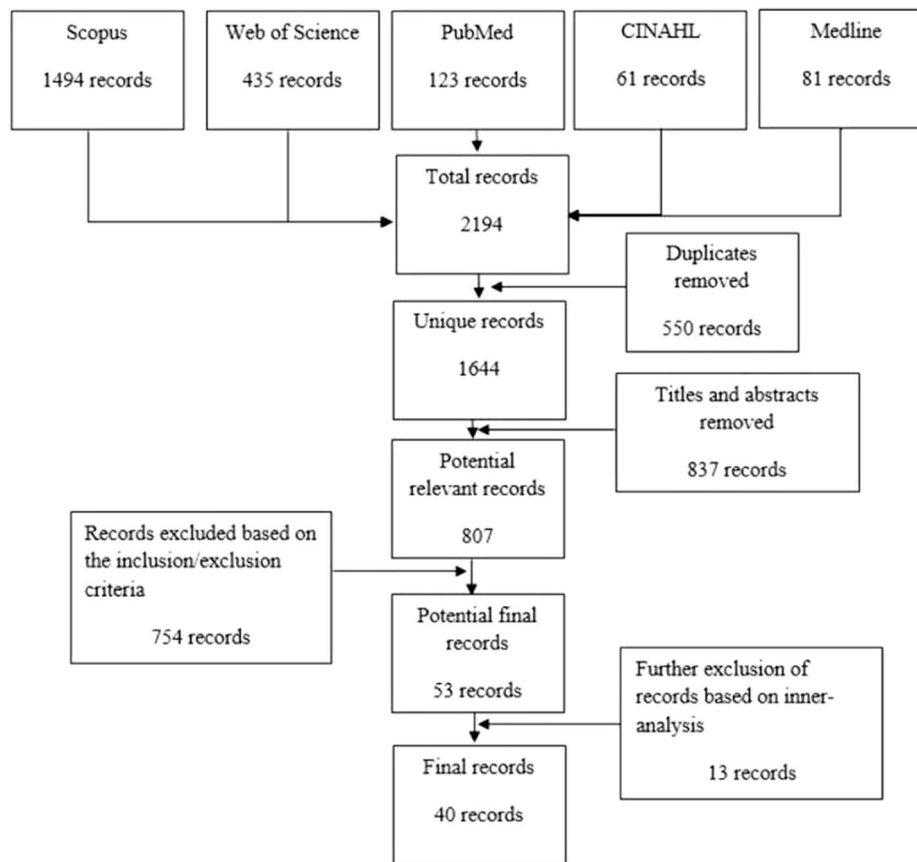


Figure 2. A flowchart about the search and selection process of the papers.

consistency [51]. This review was based on the following recommendations of Arksey and O'Malley [50]: (1) start by identifying the research question (found at the end of the introduction), (2) identify relevant studies from different sources, (3 and 4) encompass study selection and data charting, and, lastly, (5) analyse the data. Earlier reviews in the domain of digital technologies and people with dementia have been conducted following the same structure [see 40,52].

### Search strategy and selection of articles

Five electronic databases were searched by the first author (Scopus, Web of Science, PubMed, CINAHL, and Medline) using a combination of the following broad search terms: elderly, technologies, and dementia (and their synonyms) (See Appendix 1). The author has undergone training in conducting literature reviews through courses provided by librarians and received guidance in literature search within the area of technology supporting people with dementia. These databases were selected due to their different focus areas. Thus, each has records from different research areas (recommendation nr. 2). The search strategy was adapted to fit each database (See Appendix 2). Studies were limited to those published in English from 2012 to 2020 to keep the review contemporary. The search and selection process is shown in Figure 2. Screening of the abstracts and the articles was done mainly by the first author, applying the inclusion criteria appearing in Table 1 (recommendation nr. 3).

The first step was to remove duplicates. In the next stage, the remaining studies were screened by checking both their titles and abstracts. Papers that were deemed irrelevant based on the inclusion criteria, or had a completely different focus, were excluded.

In cases where it was difficult to decide if a paper did or did not fulfil the inclusion criteria, the paper was included to be further examined in the later stages. Once the stage of potentially relevant records was reached, the author excluded studies based on the following criteria: (1) medical-related, (2) hospital settings, (3) non-digital technologies, such as canes, and (4) focus on the effect of digital technologies on caregivers. To resolve ambiguity, the selection and exclusion were discussed with the other two authors. However, studies were not critically appraised since the goal of this review was to identify and review published, peer-reviewed, empirical studies on this topic [53]. A last round of exclusion was conducted because 13 articles within the 'potential final records' category could not be interpreted as one of our four main categories; this is discussed in the data collection section. The collection and screening of the studies took place in the reference manager software Zotero [54] (recommendation nr. 4). The searches resulted in 1644 records (after duplicate exclusion). After applying the inclusion and exclusion criteria, 40 articles remained eligible for this review (See Figure 2).

### Data analysis

Since the collection of the studies took place in Zotero, the studies were sorted alphabetically. Relevant data were extracted from each study, including country, sample size, stage of dementia, and technology type studied (recommendation nr. 5). These data are presented because this article's scope is the context of digital technologies (technology type) and people with dementia (number of participants, dementia stage), but also because such information was included in previous reviews (See Related Research). Additionally, where possible, we analysed the *level of technology*

**Table 1.** Inclusion criteria.

- Original and peer-reviewed research written in English
- Articles published 2012–2020
- Empirical research papers
- Research focus on people with dementia and digital technologies
- Studies reporting mixed populations (with MCI<sup>a</sup>–Alzheimer/dementia) were included
- Research conducted at home or in institutional settings (care homes)

<sup>a</sup>MCI: Mild Cognitive Impairment.

**Table 2.** Technology readiness scale.

Level of technology readiness (TRL)	Description
TRL 1	Basic principles of technology are observed and reported
TRL 2	Technology concept and/or application is formulated
TRL 3	Analytical and experimental critical functions and/or characteristic proof of concept
TRL 4	Component and/or system validation is conducted in a laboratory environment
TRL 5	Technology is developed and tested both in a laboratory and validated in relevant environments
TRL 6	Technology demonstrations, in which engineering, pilot-scale, and similar prototypical system validation in relevant environments is conducted
TRL 7	System commissioning I, a full-scale similar prototypical system is demonstrated in relevant environments
TRL 8	System commissioning II, the actual system is completed and qualified through test and demonstration in relevant environments
TRL 9	System operation, the actual system operates over the full range of expected mission conditions

readiness (TRL) using the 9-level readiness scale [55] (See Table 2). We performed this analysis since several earlier literature reviews [56–58] concluded that there is still little research on readily accessible technologies. We believe that understanding the definitions of the four components of consumer direction cannot be based solely on technologies with low TRL.

Once the study selection was concluded, the next step was to conduct a qualitative content analysis of the selected studies' results and conclusions sections. Qualitative content analysis (QCA) is a systematic and flexible method for describing in detail the meaning of qualitative data through coding [59]. More specifically, QCA helps reduce the amount of qualitative data by focusing on selected aspects of meaning related to the main research question, i.e., by assigning parts of the material to the categories and subcategories of a coding frame. In this study, the coding frame's main categories were created in a concept-driven way (i.e., deductively) based on the four theoretical components of consumer direction. These components and concept-driven categories were (1) control and direct services, (2) variety of options, (3) information and support, and (4) participation in policy-making/systems design.

Once the main categories were decided, the three authors individually read and coded the results and conclusions sections of three to five studies. To assess coding consistency (i.e., internal reliability), authors' individual analyses were shared and discussed until a consensus was reached about how to apply the coding categories consistently to all material. Next, the analysis of the entire sample of selected articles was carried out separately by the first and third authors. All relevant text passages in the selected articles' results and conclusions sections were coded into the four main categories. Using the qualitative data analysis software NVivo11, passages of the material were assigned to one of the four main categories (See Figure 3). NVivo formalises the coding process and creates an 'auditable footprint', thereby increasing reliability, transparency, and credibility [60, p.827; 61]. Once the first and third authors concluded their analysis of the entire selection of studies, their individual coding results were discussed when differences in coding were identified. Each of these cases

was discussed until reaching a consensus on the consistent application of the coding frame.

In the second stage, to ensure that the QCA provides a detailed description of the material, the subcategories were generated inductively, i.e., created in a data-driven way. This was done by carefully going through all the material coded under the main categories on NVivo and closely reading the coded passages. Once a relevant concept was encountered, it was checked whether a subcategory covering the found concept already existed and, if so, incorporated the material under the respective subcategory. If not, a new subcategory was created for the concept [59, p. 179]. This process of reading the coded passages and subcategorising relevant passages or creating new subcategories continued successively until no additional concepts were found. Last, the qualitative content analysis findings were structured in a concept matrix table (See Table 3) [102].

## Results

### Characteristics of included studies

The characteristics of the reviewed articles are presented in Table 4. Of the 40 selected studies, nine concerned commercially available technologies (TRL 9), six included actual system relevant environments (TRL 8), two considered whole-system prototypes in a real environment (TRL 7), three demonstrated and tested prototypes (TRL 6), two validated technologies in the laboratory and relevant environments (TRL 5), one validated a particular component of a system (TRL 4) and one concerned the formulation of technological concepts (TRL 2). The remaining 16 articles discussed technologies in general and did not have a particular focus on a specific technology, thus the TRL scale could not be used. The majority of the articles included tracking technologies (GPS), computer-based interventions, tablets (Android, iPad), and robots; two articles included virtual reality and smart sensors. The stage of dementia was not reported in 17 articles, but the majority included participants with mild to moderate stages of dementia. The majority of the articles did not include more than 30 participants, while three used proxies. Two articles were

Name	Files	References
Control and direct services	23	50
Information and support	29	89
Participate in systems design	30	81
Variety of options	5	9

Figure 3. Extract of the main categories created in NVivo.

Table 3. Consumer direction conceptualizations derived from reviewed articles.

Main categories	Sub-categories	References
Control and direct	Control over when technology should be used	[62–68]
	Loss of control – external factors	[69–72]
	Regain control as a result of technology use	[64–67,69–84]
Variety of options	Cost as a factor for technology use	[64,68]
	Ethical-legal restrictions	[65,85]
	Public authorities as providers of technologies	[68,70]
Information and support	Assistance by others	[63,64,69,71,74,75,82,85–92]
	Lack of information and support	[68,70,83,84,93–96]
	Provision of information and support	[63–68,70,71,78,82,85,86,89–91,94,97]
Participate in systems design/policymaking	Participation bias by others	[67,97,98]
	Positive effects of participation	[62,70,71,74,77,82,84,87,94,98,99]
	PwD <sup>a</sup> input in systems design	[62,65,67,70–73,76–80,83,86–88,92,93,95–101]

<sup>a</sup>PwD: People with Dementia.

Table 4. Characteristics of included articles.

Ref. Number	Authors	TRL	Object of study	Number of participants	Dementia stage	Country
[62]	Farina et al.	9	Wearable activity monitor	26	Mild	England
[73]	Hicks et al.	9	Wii / Kinect / iPad	22	No report	England
[74]	Jönsson et al.	9	Food reminder system	9	No report	Sweden
[75]	Imbeault et al.	9	Android tablet	1	No report	Canada
[63]	Laundau & Werner	9	GPS	Proxies	N/A	Israel
[76]	McCabe & Innes	9	GPS	12	No report	Scotland & England
[86]	Moyle et al.	9	Virtual reality	10	No report	Australia
[69]	Oderud et al.	9	GPS	208	Early	Norway
[77]	Subramaniam & Woods	9	Digital life storybooks	6	Mild to moderate	England
[100]	Boman et al.	8	Videophone – iMac based program	4	No report	Sweden
[87]	Khosla et al.	8	Robots	5	No report	Australia
[64]	Olsson et al.	8	GPS	11	Mild	Sweden
[97]	Span et al.	8	Web tool	23	Mild to moderate	Netherlands
[78]	Wang et al.	8	Robots	10	Mild to moderate	Canada
[88]	Wolters et al.	8	Cognitive assistant – iPad based program	6	No report	Scotland
[79]	Leuty et al.	7	Computer based intervention	6	Mild to moderate	Canada
[65]	Olsson et al.	7	GPS	5	Early to mild	Sweden
[99]	Dethlefs et al.	6	Computer-based cognitive intervention	10	Mild to moderate	Scotland
[93]	Kerkhof et al.	6	Memory aid	6	No report	Netherlands
[66]	Pot et al.	6	GPS	28	No report	Netherlands
[94]	Cavallo et al.	5	Smart sensors	14	Early to mild	Italy
[70]	Oksnebjerg et al.	5	Self-management application	28	No report	Denmark
[98]	Span et al.	4	Web tool	6	Mild to moderate	Netherlands
[67]	Boman et al.	2	Videophone – iMac-based program	6	No report	Sweden
[71]	Arntzen et al.	N/A <sup>a</sup>	Discussions about technology	12	No report	Norway
[80]	Asghar et al.	N/A	Discussions about technology	20	Mild	Pakistan
[81]	Ashgar et al.	N/A	Discussions about technology	327	Mild	Pakistan
[85]	Billis et al.	N/A	Discussions about technology	5	MCI	Greece
[82]	Cudd et al.	N/A	Discussions about technology	1	No report	Scotland
[95]	De Filippis et al.	N/A	Discussions about technology	Proxies	N/A	England
[68]	Gibson et al.	N/A	Discussions about technology	13	No report	England
[101]	Kort et al.	N/A	Discussions about technology	3	No report	Netherlands
[83]	Lindqvist et al.	N/A	Discussions about technology	10	Early	Sweden
[84]	Madjaroff & Mentis	N/A	Discussions about technology	5	MCI– Dementia	USA
[96]	Newton et al.	N/A	Discussions about technology	13	No report	England
[89]	Riikonen et al.	N/A	Discussions about technology	25	Mild, Moderate, and Severe	Finland
[90]	Rosenberg & Nygård	N/A	Discussions about technology	7	Mild to moderate	Sweden
[91]	Rosenberg & Nygård	N/A	Discussions about technology	20	MCI & AD <sup>b</sup>	Sweden
[92]	Rosenberg et al.	N/A	Discussions about technology	Proxies	N/A	Sweden
[72]	Zouganeli et al.	N/A	Discussions about technology	20	MCI – Early	Norway

<sup>a</sup>N/A: Not applicable; <sup>b</sup>AD: Alzheimer's Disease.

quantitative studies with more than 200 participants. Most studies were conducted in Western Europe (31), while the rest were in Canada (3), Australia (2), Pakistan (2), USA (1), and Israel (1).

### Categories derived from reviewed articles

In this section, we present the findings of our literature review. Based on the analysis, we describe the categories identified in the literature in relation to the four components of consumer direction. Table 3 summarises the identified categories. The categories are described in detail in the text below the table. Lastly, in this section, we summarise the results by providing new definitions of the four components of consumer direction applicable to the study of digital technologies and people with dementia.

#### Control and direct services

Out of 40 studies, 23 were coded under the main category of Control and Direct services. The results of this literature review showed that the first component of consumer direction regards the amount of control that people with dementia have over when and if technology should be used [62–68]. Particularly, in some studies, people with dementia expressed the need to provide consent over when technology is to be used (control over when technology should be used), for example in the use of tracking technologies such as GPS [67]. People with dementia and their relatives also want to control how technologies function, such as making their own adjustments [65] while using them. However, the studies also showed that people with dementia use technology while being treated by other people (e.g., caregivers) who do not have previous experiences with technologies, resulting in people with dementia having limited control over their technology use [68,69]. This literature review showed that people with dementia are susceptible to losing control over when technologies are to be used by their relatives and caregivers, who sometimes bypass consulting people with dementia or force these technologies on them without obtaining consent [63]. The last key finding of this literature review was that technologies brought back a level of control to the lives of people with dementia, meaning that they were able to achieve a degree of independence, safety, and empowerment through technology use [64–67,69–84].

#### Variety of options

Out of 40 studies, 5 were coded under the main category of Variety of Options. The second component of consumer direction was found in only a few studies. Many studies either tested a particular technology, discussed technologies in general, or addressed factors that would enable technology use. However, we identified three subcategories in the component of a variety of options. The first subcategory was cost as a factor for technology use, meaning that people with dementia and their relatives would first consider the price of a given technology and whether public authorities covered the costs [64,68]. The second subcategory identified in the included studies was ethical-legal restrictions, which limit the variety of technological options for people with dementia and their relatives [65,85]. Lastly, regarding who is responsible for providing such technologies to people with dementia and their relatives, it was found that, in most cases, the responsibility falls under public authorities [68,70]. An additional finding was that public authorities did not have the same practices for replacing damaged digital technology as for other traditional aids, such as walkers [70].

#### Information and support

Out of 40 studies, 29 were coded under the main category of Information and Support. The third component of consumer direction consisted of three subcategories. The first subcategory was assistance by others (such as family, carers, or friends) and how that support by others engaged people with dementia in technology use [63,64,69,71,74,75,82,85–92]. The results from this literature review showed that a social network is crucial to support technology use by people with dementia [89,91]. Information and support also concern the training that people with dementia and their relatives receive regarding technology use [70,85]. The results showed a number of incidents where there was a lack of information provided to people with dementia and their relatives, either about technology use or the variety of technologies [68,70,83,84,93–96]. Specifically, we found that people with dementia and their relatives did not always have a clear pathway regarding where to turn for information [96], did not receive sufficient instructions after the technology was installed [93], and complained about the lack of information provided by professionals [84]. On that point, it was also found that professionals reported issues regarding not receiving enough training [94] and that technologies were not seen as a core part of dementia care [84,96]. Finally, the review identified a debate regarding when to provide information about digital technologies, consisting of an argument between early introduction [63,64,89,92] or at the time of need [68,86].

#### Participate in systems design

Out of 40 studies, 30 were coded under the main category of Participate in systems design. According to the articles included in our review, the fourth and last component of consumer direction consisted of three subcategories. In the first subcategory, participation bias by others, we found that people with dementia were often treated as non-valuable sources of input by professionals [67,97,98]. This was attributed to professionals' biases associated with dementia [98]. Overall, it was reported that professionals, designers, and caregivers held biased views on people with dementia. Nevertheless, others' bias was overpowered in the second subcategory, PwD input in systems design, where many researchers stated that people with dementia offered invaluable and unique feedback [62,65,67,70–73,76–80,83,86–88,92,93,95–101]. Additionally, using proxies such as professionals and/or caregivers to provide feedback does not reflect reality and should not substitute the opinions of people with dementia [88,93]. This subcategory also showed that people with dementia preferred technologies made in a way so as not to be stigmatising [67,76,95]. Furthermore, people with dementia reported that technologies should be simple [92], individually determined [71], and adapted to their skills and experiences [65,70,87]. Lastly, results showed that participation in systems design has positive effects on people with dementia [62,70,71,74,77,82,84,87,94,98,99] and promotes enjoyment among people with dementia [74,77,87,98,99]. These positive effects relate to feeling heard by others and contributing to society and future people with dementia [62,82,84,97].

#### Summary of the results

Figure 4 shows a conceptualisation of the four components of consumer direction in the context of digital technologies and people with dementia. In the context of consumer direction in the use of digital technology by people with dementia, we provide the following new definitions:

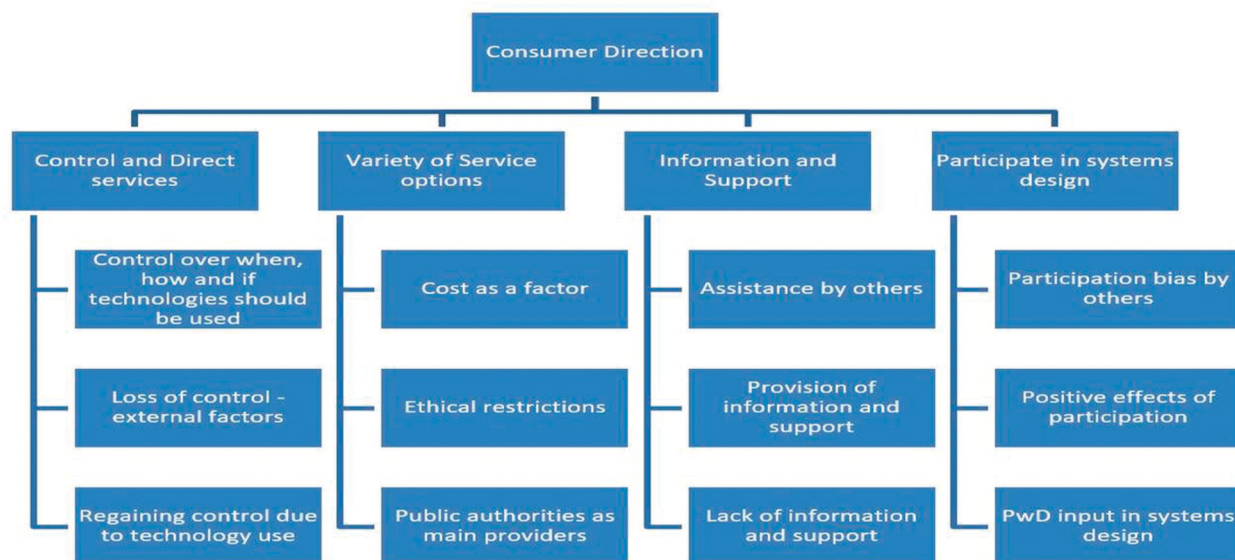


Figure 4. Consumer direction and its subcategories.

**Control and direct technology use.** Refers first to the amount of control that people with dementia have over when and if technologies are to be used. Second, it considers possible limitations to control by others and the effects thereof on people with dementia. Last, it relates to people with dementia regaining control over aspects of their daily life, such as independence and autonomy.

**Variety of technological options.** Relates to the variety of technological options available to people with dementia. It first considers the costs of technologies and if public authorities cover these costs. Second, it deals with ethical-legal restrictions that hinder the variety of technological options. Last, it highlights the importance of public authorities being the primary providers of technological options.

**Information and support.** Refers to the amount of information and support that people with dementia and their relatives receive about technological options and technology use. First, it considers the need for a social network of formal or informal support to engage and train people with dementia in technology use. Second, it relates to the timely provision of information and support, meaning that information should be provided at an early stage of the disease. Last, it deals with criticisms regarding (a) lack of information, (b) lack of clear pathways to information, and (c) professionals' lack of training.

**Participation in systems design.** Relates to the ability of people with dementia to participate in systems design. It emphasises the degree to which people with dementia participate in and are engaged in systems design and the positive effects of such participation. Last, it refers to the possible exclusion of people with dementia in systems design, which is linked to others' biased perceptions (e.g., professionals, caregivers, designers).

## Discussion and conclusion

The aim of this study was to review empirical studies to conceptualise the components of the consumer direction in the context of digital technologies and people with dementia. As shown in the previous section, the four theoretical components should be conceptualised differently than in previous contexts that used the

theory. This review provides new definitions for the four theoretical components. Namely, what it means for people with dementia to be (1) in control of technology use, (2) offered a variety of technological options, (3) informed and supported regarding the use and training of digital technologies, and (4) actively participating in systems design. This study has important implications for theory, research, and practice.

In regard to theoretical contributions, this literature review has attempted to re-conceptualise the components of consumer direction in the context of digital technologies and people with dementia. As discussed in the introduction, tenets of consumer direction have been used in different contexts [19–23], but not the one that this study investigated. We found that, in this context, the components should be conceptualised differently from the definitions provided by Kosciulek [18] (See Table 5).

Furthermore, it is important to highlight that the context where consumer direction is applied matters. Depending on the context, people with dementia may not embody the full definition of a consumer, as technology can be provided to them by the state and other public institutions. In such events, people with dementia do not have the same variety of options as the latter is regulated by a particular institution (or it may also be that the institution has a limited assortment). In another sense, the variety of options can also be limited if information about digital technologies is not provided [25]. Additionally, the control that people with dementia exert is also regulated by the institutions which provide the technologies. An example is that technologies are usually provided after a needs' assessment rather than based on personal preferences (meaning that a person cannot directly choose what he/she wants if the technological product is outside of the assortment). Hence, the practices of private and public organisations can also affect how consumer direction is shaped.

Regarding practical contributions, we believe that by considering our definitions, researchers, practitioners, and policymakers will be able to create a more consumer-directed delivery of digital technologies, which can empower people with dementia and possibly increase their quality of life. According to Kosciulek, increasing consumer direction leads to the empowerment of people with disabilities and increases the quality of life [18]; thus, we expect a similar result from increasing consumer direction for people with dementia.

Table 5. Consumer direction definitions by Kosciulek and this review.

Components	Kosciulek [18]	This review
Control and direct	Focuses on the degree to which an individual with disabilities can determine the type and influence the quality of the received services.	Considers possible limitations of control by others and the effects thereof on people with dementia. Relates to people with dementia regaining control over aspects of their daily life, such as independence and autonomy.
Variety of options	Considers possible limitations, risks, or restrictions to consumer control.	Considers the costs of technologies and if public authorities cover these costs. Deals with ethical–legal restrictions that hinder variety. Highlights the importance of public authorities being the primary providers.
Information and support	Main criticisms of service systems from consumers with disabilities and their relatives regard: (a) lack of information and (b) lack of long-term support.	Identifies the need for a social network of formal or informal support to engage and train people with dementia in technology use and timely provision of information and support. Considers criticisms regarding (a) lack of information, (b) lack of clear pathways to information, and (c) professionals' lack of training.
Participation in systems design	Emphasises consumers' degree of participation at the policymaking level; for example, policy formulation, design of rehabilitation services, and allocation of financial resources.	Considers the degree of participation to which people with dementia are engaged in systems design and the positive effects of participation. Links possible exclusion of people with dementia in systems design to others' biased perceptions.

This study contributes to previous research regarding digital technologies and people with dementia by considering various aspects related to consumer direction extending beyond the focus of previous reviews on the involvement of people with dementia in systems design [13,43–47]. This review also discusses the number of control people with dementia has over technologies, the variety of options and their potential limitations, and the information and support that people with dementia and their relatives receive regarding training and the use of digital technologies. All these components, not just participation in system design [13], are crucial for increasing consumer direction and empowering people with dementia [17,18] in this context.

After completing this review, we note that the majority of the included articles were conducted in Western Europe (31). Accordingly, we are unaware of how the components of consumer direction could be understood and defined in other countries and regions. In addition, many articles (17) in our review did not specify participants' stages of dementia. However, participants' most commonly reported stages ranged from mild to moderate dementia. Only one article (1) reported findings from participants with severe stages of dementia, indicating that people with severe dementia are not typically included in studies of digital technologies. Consequently, we do not know whether the components of consumer direction need to be understood and defined differently, for addressing people in different stages of dementia. Hence, future researchers must put more emphasis on how to collaborate with people with severe dementia in regard to digital technologies. This relates to the need for developing different methodologies to capture the needs of people with moderate to severe dementia, such for example cultural probes [103]. The use of such methodologies and the further involvement of people with moderate to severe dementia could help provide potentially new definitions for the four theoretical components of the Consumer Direction.

Previous reviews [58] regarding factors affecting the use of digital technologies identified a low maturity level of technologies in the scientific literature. On the contrary, our review shows that out of 24 studies that could be categorised with the TRL scale, 15 studies involved testing mature technologies (TRL 8–9). Having the possibility to analyse studies concerning mature technologies was important in the context of this review, which aimed at understanding and defining the components of consumer direction in relation to the delivery of digital technologies to people with dementia.

Lastly, this review provides answers to the effects of participation by people with dementia in systems design, which Suijkerbuijk et al. [47] found lacking. In contrast to the identified

studies in the Daly Lynn et al. [38] review, in which people with dementia were treated as passive participants, the studies in our review (aside from three studies that used proxies) actively involved people with dementia and showed that their feedback was unique and should not be disregarded. This review also pointed about gaps in information and lack of support for some claims by previous researchers [44,46,48,49]. Furthermore, ethical concerns regarding tracking technologies [41–43] were found in our review. These concerns were primarily found under the control and direct technology use component in which people with dementia wanted to maintain control over when tracking or monitoring would occur and by whom. Regarding the variety of technological options, most studies in our review focussed on tracking technologies, computer-based interventions, and other commercial technologies such as Wii, iPads, and others. These studies emphasised assistance in everyday life, which all the aforementioned reviews discussed [38,41–44,46–49].

### Limitations and future research

This review has some limitations. The identified studies were mostly within one geographic region and many studies used prototypes, which could affect the definitions of consumer direction. That itself may be a limitation for the formulated definitions, thus we suggest that researchers should apply and validate our definitions in similar contexts. Another limitation regards the low sample of people with severe dementia in the included studies. Having a potentially higher sample of people with severe dementia could provide different re-conceptualizations for the four theoretical components of the consumer direction. Based on this, we suggest an increased focus on how people with dementia can achieve the consumer role in service delivery systems. Additionally, researchers can examine the contingency between the four consumer direction components. Lastly, another interesting point for future research regards the technology readiness level and its potential impact on the components or the definitions of consumer direction.

### Disclosure statement

The authors declare that there are no conflicts of interest.

### Funding

The author(s) reported there is no funding associated with the work featured in this article.

## Author contributions

All authors certify that they have seen and approved the final version of the manuscript being submitted. The article is the authors' original work, hasn't received prior publication and isn't under consideration for publication elsewhere. All authors have made substantial contribution to this study. Antonios Tsertsidis: study concept and design, data collection and analysis, data interpretation and drafting of the manuscript. Ella Kolkowska: critical revision of the manuscript for important intellectual content. Irene Rapado: data analysis, critical revision of the manuscript for important intellectual content.

## References

- [1] Prince M, Bryce R, Ferri C. The benefits of early diagnosis and intervention. *World Alzheimer Report*. 2011.
- [2] Prince MJ. *World Alzheimer Report 2015: the global impact of dementia: an analysis of prevalence, incidence, cost and trends*. Alzheimer's Disease International; 2015.
- [3] Hubbard G, Cook A, Tester S, et al. Beyond words: older people with dementia using and interpreting nonverbal behaviour. *J Aging Stud*. 2002;16(2):155–167.
- [4] Scherer MJ. *Assistive technologies and other supports for people with brain impairment*. New York (NY): Springer Publishing Company; 2011.
- [5] Alzheimer's Disease International [Internet]. *World Alzheimer Report 2013. An analysis of long-term care for dementia*. Available from: <http://www.alz.co.uk/research/world-report-2013>
- [6] Dewing J. From ritual to relationship: a person-centred approach to consent in qualitative research with older people who have a dementia. *Dementia*. 2002;1(2):157–171.
- [7] Batsch NL, Mittelman MS. *World Alzheimer Report 2012. Overcoming the stigma of dementia*. Alzheimer's Disease International (ADI). 2015. p. 5.
- [8] Tchalla AE, Lachal F, Cardinaud N, et al. Efficacy of simple home-based technologies combined with a monitoring assistive center in decreasing falls in a frail elderly population (results of the esoppe study). *Arch Gerontol Geriatr*. 2012;55(3):683–689.
- [9] Fardoun HM, Mashat AA, Ramirez Castillo J. Recognition of familiar people with a mobile cloud architecture for alzheimer patients. *Disabil Rehabil*. 2017;39(4):398–402.
- [10] Van Hoof J, Kort HS, Rutten PG, et al. Ageing-in-place with the use of ambient intelligence technology: perspectives of older users. *Int J Med Inform*. 2011;80(5):310–331.
- [11] Boldy D, Grenade L, Lewin G, et al. Older people's decisions regarding 'ageing in place': a Western Australian case study. *Australas J Ageing*. 2011;30(3):136–142.
- [12] Center for Disease Control [Internet]. 2009. *Healthy Places Terminology*. Available from: <https://www.cdc.gov/healthy-places/terminology.htm>
- [13] Span M, Hettinga M, Vernooij-Dassen M, et al. Involving people with dementia in the development of supportive IT applications: a systematic review. *Ageing Res Rev*. 2013;12(2):535–551.
- [14] Øksnebjerg L, Janbek J, Woods B, et al. Assistive technology designed to support self-management of people with dementia: user involvement, dissemination, and adoption. A scoping review. *Int Psychogeriatr*. 2020;32(8):937–953.
- [15] Burrow S, Brooks D. ATDementia: an information resource on assistive technologies that help support the independence of people with dementia. *Dementia*. 2012;11(4):553–557.
- [16] Tsertsidis A. Identifying digital solutions for people with dementia (PwD): lessons learned from a Swedish dementia care residence. *Gerontechnology*. 2021;20(1):1–4.
- [17] Kosciulek JF. Consumer direction in disability policy formulation and rehabilitation service delivery. *J Rehabil*. 1999;65(2):4.
- [18] Kosciulek JF. The consumer-directed theory of empowerment. *Rehabil Couns Bull*. 1999;44:196–213.
- [19] Pranic L, Roehl WS. Rethinking service recovery: a customer empowerment (CE) perspective. *J Bus Econ Manag*. 2012;13(2):242–260.
- [20] Pranić L, Roehl WS. Development and validation of the customer empowerment scale in hotel service recovery. *Curr Issues Tour*. 2013;16(4):369–387.
- [21] Mazzone D, Cicognani E, Laghi M, et al. Patients' direction, empowerment and quality of life in haemodialysis. *Psychol Health Med*. 2014;19(5):552–558.
- [22] You E, Dunt D, Doyle C. How would case managers' practice change in a consumer-directed care environment in Australia? *Health Soc Care Community*. 2017;25(1):255–265.
- [23] Payne G, Fisher G. The service triangle and power: the role of frontline home support workers and consumer-directed care—an Australian context. *Industrial Relations J*. 2019;50(2):197–213.
- [24] Federici S, Corradi F, Meloni F, et al. A Person-Centered assistive technology service delivery model: a framework for device selection and assignment. *Life Span Disabil*. 2014;17(2):175–198.
- [25] Tsertsidis A. Challenges in the provision of digital technologies to elderly with dementia to support ageing in place: a case study of a Swedish municipality. *Disabil Rehabil Assist Technol*. 2021;16(7):758–68.
- [26] Kosciulek JF, Merz M. Structural analysis of the consumer-directed theory of empowerment. *Rehabil Couns Bull*. 2001;44(4):209–216.
- [27] Hooyman NR, Mahoney KJ, Sciegaj M, et al. Theories that guide consumer-directed/person-centered initiatives in policy and practice. *Handbook of theories on aging*. 3rd Edn. New York (NY): Springer; 2016. p. 427–442.
- [28] Mirza M, Hammel J. Consumer-directed goal planning in the delivery of assistive technology services for people who are ageing with intellectual disabilities. *J Appl Res Intellect Disabil*. 2009;22(5):445–457.
- [29] Kosciulek JF. Structural equation model of the consumer-directed theory of empowerment in a vocational rehabilitation context. *Rehabil Couns Bull*. 2005;49(1):40–49.
- [30] Schor JB. In defense of consumer critique: revisiting the consumption debates of the twentieth century. *Ann Am Acad Pol Soc Sci*. 2007;611(1):16–30.
- [31] Stone R. Introduction consumer direction in long-term care. *Generations*. 2000;24(3):5–9.
- [32] Kosciulek JF. Improving rehabilitation service delivery by enhancing consumer direction among persons with disabilities. Seoul: International Conference on Disability; 1997.
- [33] Wagner D, Nadash P, Friedman A, et al. Principles of consumer-directed home and community-based services.

- Washington DC: National Institute on Consumer-Directed Long-Term Services; 1996.
- [34] Holmes GE. The historical roots of the empowerment dilemma in vocational rehabilitation. *J Disabil Policy Stud.* 1993;4(1):1–20.
- [35] Kosciulek JF. Impact of head injury on families: an introduction for family counselors. *Family J.* 1995;3(2):116–125.
- [36] Fleming R, Sum S. Empirical studies on the effectiveness of assistive technology in the care of people with dementia: a systematic review. *J Assist Technol.* 2014;8(1):14–34.
- [37] Brims L, Oliver K. Effectiveness of assistive technology in improving the safety of people with dementia: a systematic review and meta-analysis. *Aging Mental Health.* 2019; 23(8):942–951.
- [38] Daly Lynn J, Rondón-Sulbarán J, Quinn E, et al. A systematic review of electronic assistive technology within supporting living environments for people with dementia. *Dementia.* 2019;18(7–8):2371–2435.
- [39] D’Cunha NM, Nguyen D, Naumovski N, et al. A mini-review of virtual reality-based interventions to promote well-being for people living with dementia and mild cognitive impairment. *Gerontology.* 2019;65(4):430–440.
- [40] Koo BM, Vizer LM. Examining mobile technologies to support older adults with dementia through the lens of personhood and human needs: scoping review. *JMIR Mhealth Uhealth.* 2019;7(11):e15122.
- [41] Vollmer Dahlke D, Ory MG. Emerging issues of intelligent assistive technology use among people with dementia and their caregivers: a US perspective. *Front Public Health.* 2020;8:191.
- [42] Novitzky P, Smeaton AF, Chen C, et al. A review of contemporary work on the ethics of ambient assisted living technologies for people with dementia. *Sci Eng Ethics.* 2015;21(3):707–765.
- [43] Ienca M, Wangmo T, Jotterand F, et al. Ethical design of intelligent assistive technologies for dementia: a descriptive review. *Sci Eng Ethics.* 2018;24(4):1035–1055.
- [44] Meiland F, Innes A, Mountain G, et al. Technologies to support community-dwelling persons with dementia: a position paper on issues regarding development, usability, effectiveness and cost-effectiveness, deployment, and ethics. *JMIR Rehabil Assist Technol.* 2017;4(1):e1.
- [45] Holthe T, Halvorsrud L, Karterud D, et al. Usability and acceptability of technology for community-dwelling older adults with mild cognitive impairment and dementia: a systematic literature review. *Clin Interv Aging.* 2018;13:863–886.
- [46] Lorenz K, Freddolino PP, Comas-Herrera A, et al. Technology-based tools and services for people with dementia and carers: mapping technology onto the dementia care pathway. *Dementia.* 2019;18(2):725–741.
- [47] Suijkerbuijk S, Nap HH, Cornelisse L, et al. Active involvement of people with dementia: a systematic review of studies developing supportive technologies. *J Alzheimers Dis.* 2019;69(4):1041–1065.
- [48] Dawson A, Bowes A, Kelly F, et al. Evidence of what works to support and sustain care at home for people with dementia: a literature review with a systematic approach. *BMC Geriatr.* 2015;15(1):59.
- [49] Thordardottir B, Malmgren Fänge A, Lethin C, et al. Acceptance and use of innovative assistive technologies among people with cognitive impairment and their caregivers: a systematic review. *Biomed Res Int.* 2019;2019: 9196729.
- [50] Arksey H, O’Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol.* 2005;8(1): 19–32.
- [51] McKinstry C, Brown T, Gustafsson L. Scoping reviews in occupational therapy: the what, why, and how to. *Aust Occup Ther J.* 2014;61(2):58–66.
- [52] Gagnon-Roy M, Bourget A, Stocco S, et al. Assistive technology addressing safety issues in dementia: a scoping review. *Am J Occup Ther.* 2017;71(5): 7105190020p1–7105190020p10.
- [53] Armstrong R, Hall BJ, Doyle J, et al. Cochrane update. ‘Scoping the scope’ of a Cochrane review. *J Public Health.* 2011;33(1):147–150.
- [54] Zotero (homepage). Available from: <http://www.zotero.org>.
- [55] DoE US. Department of energy: technology readiness assessment guide. Washington (DC): DOE G; 2011. p. 413–413.
- [56] Peek ST, Wouters EJ, Van Hoof J, et al. Factors influencing acceptance of technology for aging in place: a systematic review. *Int J Med Inform.* 2014;83(4):235–248.
- [57] Liu L, Stroulia E, Nikolaidis I, et al. Smart homes and home health monitoring technologies for older adults: a systematic review. *Int J Med Inform.* 2016;91:44–59.
- [58] Tsertsidis A, Kolkowska E, Hedström K. Factors influencing seniors’ acceptance of technology for ageing in place in the post-implementation stage: a literature review. *Int J Med Inform.* 2019;129:324–333.
- [59] Schreier M. Qualitative content analysis. In: Flick uwe. *The SAGE handbook of qualitative data analysis (digital version)*. London: Sage; 2013. p. 170–183.
- [60] Sinkovics RR, Alfoldi EA. Progressive focusing and trustworthiness in qualitative research. *Manag Int Rev.* 2012; 52(6):817–845.
- [61] Sinkovics RR, Penz E, Ghauri PN. Enhancing the trustworthiness of qualitative research in international business. *Manage Int Rev.* 2008;48(6):689–714.
- [62] Farina N, Sherlock G, Thomas S, et al. Acceptability and feasibility of wearing activity monitors in community-dwelling older adults with dementia. *Int J Geriatr Psychiatry.* 2019;34(4):617–624.
- [63] Landau R, Werner S. Ethical aspects of using GPS for tracking people with dementia: recommendations for practice. *Int Psychogeriatr.* 2012;24(3):358–366.
- [64] Olsson A, Skovdahl K, Engström M. Using diffusion of innovation theory to describe perceptions of a passive positioning alarm among persons with mild dementia: a repeated interview study. *BMC Geriatr.* 2016;16(1):3–6.
- [65] Olsson A, Engström M, Lampic C, et al. A passive positioning alarm used by persons with dementia and their spouses—a qualitative intervention study. *BMC Geriatr.* 2013; 13(1):11–19.
- [66] Pot AM, Willemse BM, Horjus S. A pilot study on the use of tracking technology: feasibility, acceptability, and benefits for people in early stages of dementia and their informal caregivers. *Aging Ment Health.* 2012;16(1):127–134.
- [67] Boman IL, Nygård L, Rosenberg L. Users’ and professionals’ contributions in the process of designing an easy-to-use videophone for people with dementia. *Disabil Rehabil Assist Technol.* 2014;9(2):164–172.
- [68] Gibson G, Dickinson C, Brittain K, et al. The everyday use of assistive technology by people with dementia and their family carers: a qualitative study. *BMC Geriatr.* 2015;15(1): 1–10.

- [69] Øderud T, Landmark B, Eriksen S, et al. Persons with dementia and their caregivers using GPS. In: *AAATE Conf.* 2015;217:212–221.
- [70] Øksnebjerg L, Woods B, Waldemar G. Designing the ReACT app to support self-management of people with dementia: an iterative user-involving process. *Gerontology.* 2019; 65(6):673–685.
- [71] Arntzen C, Holthe T, Jentoft R. Tracing the successful incorporation of assistive technology into everyday life for younger people with dementia and family carers. *Dementia.* 2016;15(4):646–662.
- [72] Zouganelli E, Casagrande FD, Holthe T, et al. Responsible development of self-learning assisted living technology for older adults with mild cognitive impairment or dementia. In: *ICT4AgeingWell.* 2017;204–209. DOI:10.5220/0006367702040209
- [73] Hicks B, Innes A, Nyman A. Exploring the ‘active mechanisms’ for engaging rural-dwelling older men with dementia in a community technological initiative. *Ageing & Society.* 2020;40(9):1906–1938.
- [74] Jönsson KE, Ornstein K, Christensen J, et al. A reminder system for independence in dementia care: a case study in an assisted living facility. In: *Proceedings of the 12th ACM international conference on pervasive technologies related to assistive environments;* 2019. p. 176–185.
- [75] Imbeault H, Langlois F, Bocti C, et al. Can people with Alzheimer’s disease improve their day-to-day functioning with a tablet computer? *Neuropsychol Rehabil.* 2018;28(5):779–796.
- [76] McCabe L, Innes A. Supporting safe walking for people with dementia: user participation in the development of new technology. *Gerontechnology.* 2013;12(1):4–15.
- [77] Subramaniam P, Woods B. Digital life storybooks for people with dementia living in care homes: an evaluation. *Clin Interv Aging.* 2016;11:1263–1276.
- [78] Wang RH, Sudhama A, Begum M, et al. Robots to assist daily activities: views of older adults with Alzheimer’s disease and their caregivers. *Int Psychogeriatr.* 2017;29(1):67–79.
- [79] Leuty V, Boger J, Young L, et al. Engaging older adults with dementia in creative occupations using artificially intelligent assistive technology. *Assist Technol.* 2013;25(2):72–79.
- [80] Asghar I, Cang S, Yu H. Usability evaluation of assistive technologies through qualitative research focusing on people with mild dementia. *Comp Hum Behav.* 2018;79:192–201.
- [81] Asghar I, Cang S, Yu H. Impact evaluation of assistive technology support for the people with dementia. *Assist Technol.* 2019;31(4):180–192.
- [82] Cudd P, Mountain G, Astell AJ, et al. Leveraging everyday technology for people living with dementia: a case study. *J Assistive Technol.* 2014;8(4):164–176.
- [83] Lindqvist E, Larsson TJ, Borell L. Experienced usability of assistive technology for cognitive support with respect to user goals. *NeuroRehabilitation.* 2015;36(1):135–149.
- [84] Madjaroff G, Mentis H. Narratives of older adults with mild cognitive impairment and their caregivers. In: *Proceedings of the 19th international ACM SIGACCESS conference on computers and accessibility;* 2017. p. 140–149.
- [85] Billis A, Mantziari D, Zilidou VI, et al. Co-Creation of an innovative vocational training platform to improve autonomy in the context of Alzheimer’s disease. In: *CIMTH.* 2018; 251:309–312.
- [86] Moyle W, Jones C, Dwan T, et al. Effectiveness of a virtual reality forest on people with dementia: a mixed methods pilot study. *Gerontologist.* 2018;58(3):478–487.
- [87] Khosla R, Chu MT, Khaksar SM, et al. Engagement and experience of older people with socially assistive robots in home care. *Assistive Technol.* 2021;33(2):55–57.
- [88] Wolters MK, Kelly F, Kilgour J. Designing a spoken dialogue interface to an intelligent cognitive assistant for people with dementia. *Health Informatics J.* 2016;22(4):854–866.
- [89] Riikonen M, Paavilainen E, Salo H. Factors supporting the use of technology in daily life of home-living people with dementia. *TAD.* 2013;25(4):233–243.
- [90] Rosenberg L, Nygård L. Learning and knowing technology as lived experience in people with Alzheimer’s disease: a phenomenological study. *Aging Ment Health.* 2017;21(12): 1272–1279.
- [91] Rosenberg L, Nygård L. Learning and using technology in intertwined processes: a study of people with mild cognitive impairment or Alzheimer’s disease. *Dementia.* 2014; 13(5):662–677.
- [92] Rosenberg L, Kottorp A, Nygård L. Readiness for technology use with people with dementia: the perspectives of significant others. *J Appl Gerontol.* 2012;31(4):510–530.
- [93] Kerkhof YJ, Rabiee F, Willems CG. Experiences of using a memory aid to structure and support daily activities in a small-scale group accommodation for people with dementia. *Dementia.* 2015;14(5):633–649.
- [94] Cavallo F, Aquilano M, Arvati M. An ambient assisted living approach in designing domiciliary services combined with innovative technologies for patients with Alzheimer’s disease: a case study. *Am J Alzheimers Dis Other Demen.* 2015;30(1):69–77.
- [95] De Filippis ML, Craven MP, Denning T. Informal carer role in the personalisation of assistive solutions connected to aspirations of people with dementia. In: *International Workshop on Ambient Assisted Living.* Cham: Springer; 2014. p. 236–243.
- [96] Newton L, Dickinson C, Gibson G, et al. Exploring the views of GPs, people with dementia and their carers on assistive technology: a qualitative study. *BMJ Open.* 2016;6(5):e011132.
- [97] Span M, Hettinga M, Groen-van de Ven L, et al. Involving people with dementia in developing an interactive web tool for shared decision-making: experiences with a participatory design approach. *Disabil Rehabil.* 2018;40(12):1410–1420.
- [98] Span M, Smits C, Groen-Van De Ven LM, et al. Towards an interactive web tool that supports shared decision making in dementia: identifying user requirements. *Int J Adv Life Sci.* 2014;6:338–349.
- [99] Dethlefs N, Milders M, Cuayáhuitl H, et al. A natural language-based presentation of cognitive stimulation to people with dementia in assistive technology: a pilot study. *Inform Health Soc Care.* 2017;42(4):349–360.
- [100] Boman IL, Lundberg S, Starkhammar S, et al. Exploring the usability of a videophone mock-up for persons with dementia and their significant others. *BMC Geriatr.* 2014;14(1):41–49.
- [101] Kort HS, Steunenbergh B, Van Hoof J. Methods for involving people living with dementia and their informal carers as co-developers of technological solutions. *Dement Geriatr Cogn Disord.* 2019;47(3):149–156.
- [102] Webster J, Watson RT. Analyzing the past to prepare for the future: writing a literature review. *MIS Quarterly.* 2002; 26(2):xiii-xiii.
- [103] Brown M, Tsai A, Baurley S, et al. Using cultural probes to inform the design of assistive technologies. In: *International Conference on Human-Computer Interaction.* Cham: Springer; 2014. p. 35–46.

## Appendices

### Appendix 1

Keywords	Synonyms
Elderly	Aged Old Senior Older adult
Technologies	Assistive technologies Welfare technologies Ambient assisted living Technological aid
Dementia	Alzheimer Mental illness Mental decay Mental deterioration

### Appendix 2

SCOPUS	CRITERIA
"elderly" OR "aged" OR "old" OR "senior" OR "older adult" AND "technologies" OR "assistive technologies" OR "welfare technologies" OR "ambient assisted living" OR "technological aids" AND "dementia" OR "Alzheimer"	2012–2020 Articles/conference papers/reviews English language
WEB OF SCIENCE Elderly AND technologies AND dementia Elderly AND assistive technologies AND dementia Seniors AND assistive technologies AND dementia Seniors AND assistive technologies AND Alzheimer Elderly AND assistive technologies AND alzheimer	CRITERIA 2012–2020 Language: English Search by: Topic
PUBMED Elderly AND technologies AND dementia Dementia AND assistive technologies AND seniors Elderly AND assistive technologies AND dementia Aged AND technologies AND dementia Elderly AND technologies AND alzheimer	CRITERIA 2012–2020 Title-abstract English
CINAHL Aged AND assistive technologies AND dementia Elderly AND technologies AND dementia Seniors AND technologies AND dementia Elderly AND assistive technologies AND Alzheimer Elderly AND technologies AND alzheimer	CRITERIA 2012–2020 AB ABSTRACT Peer-reviewed English
MEDLINE Elderly AND technologies AND dementia Elderly AND assistive technologies AND dementia Seniors AND assistive technologies AND dementia Aged AND assistive technologies AND dementia Elderly AND assistive technologies AND alzheimer	CRITERIA 2012–2020 AB Abstract Peer-reviewed English

All authors certify that they have seen and approved the final version of the manuscript being submitted. The article is the authors' original work, hasn't received prior publication and isn't under consideration for publication elsewhere.

All authors have made substantial contribution to this study. Author 1: study concept and design, data collection and analysis, data interpretation and drafting of the manuscript. Author 2: critical revision of the manuscript for important intellectual content. Author 3: data analysis, critical revision of the manuscript for important intellectual content.