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Is RRI a new R&I logic? A reflection from an integrated RRI project ☆,☆☆

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ABSTRACT

This article presents an analysis of a project in the field of assisted living technologies (ALT) for older adults where Responsible Research and Innovation (RRI) is used as an overall approach to the research and technology development work. Taking the project's three literature reviews - conducted in the fields of health science oriented towards occupational therapy, ICT research and development, and RRI - as starting points it applies perspectives from institutional logics to analyse the tension between RRI as an overall research and innovation (R&I) logic versus a disciplinary logic. This tension complicates the implementation of RRI, and we argue for giving this question more visibility. The article concludes that this project, from the funder's side and the project leader's side, was intended to be an example of research and technology development carried out within a new RRI R&I logic, but that it in large parts was conducted as a multidisciplinary project with RRI as a quasi-disciplinary logic in part in parallel with and in part in conflict with other logics in the project.

1. Introduction

Responsible Research and Innovation (RRI) is an approach to research and innovation that emphasises the importance of research and innovation contributing to social goods, not creating undesirable side effects and being developed in dialogue with society and in line with societal values. Projects that connect to the RRI agenda can have a more or less *integrated* character. Usually, RRI projects are not very ambitious with regard to integration. They are often natural science or technology projects with an RRI work package that may include organising one or more deliberative workshops, assessing ethical implications of the technology in question or conducting anticipatory activities (see Åm (2019)). These are usually funded by natural science or technology programs, where RRI is emphasised as a requirement in the funding topic descriptions. RRI projects can also be more or less social science and humanities projects studying RRI implementation (for instance the Horizon 2020 RRI-Practice project, www.rri-practice.eu).

In a more integrated approach, RRI is seen as a new logic of research and innovation, transforming research practices across disciplines into being more deliberative, inclusive, and anticipatory. This can be called an integration of research and innovation with the values, needs and concerns of society in a way that transforms the practices of the research and innovation itself. Accordingly, a deeply integrated RRI project would be a project where RRI perspectives integrate all research and innovation practices in the project and transform the practices of the involved disciplines. The ambitions of such deep integration are based on different ideas in the relations between science and society, and these different ideas are also a factor behind the investigations in this paper. One aspect underlying RRI and its integrative ideal is to open up and discuss the so-called division of moral labour between actors and stakeholders in the research and innovation process Rip (2014). Real time technology assessment (Guston & Sarewitz 2002) and Socio-Technical Integration (Fisher et al. 2015) are technology assessment (TA) approaches closely related to the ideas of integrated RRI. As Guston & Sarewitz (2002) describe: 'Such real-time TA can inform and support natural science and engineering research, and it can provide an explicit mechanism for observing, critiquing, and influencing social values as they become embedded in innovations (p. 94). A related effort is based on a sociological and philosophical attention to practices and

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conceptualisations of responsibility (Owen et al. 2013; Pellizzoni 2004; Richardson 1999)

Not all RRI approaches are related to integrating societal aspects into research and development practices. Instead some take a more policy oriented approach highlighting that research and innovation policy needs to realize macro-political goals, often in the terms of societal challenges (Saille 2015; von Schomberg 2013). Some operationalise RRI into specific policy areas within research and innovation, better known as RRI policy keys (Delaney & Iagher, 2020; European Commission 2012). Owen & Pansera (2019) highlight these differences in an analysis of RRI in the UK and in the European Commission.

This article discusses a project that aimed to be an integrated RRI project in close affinity with the approach outlined by Owen et al. (2013), and further developed by Wickson & Forsberg (2015). It analyses the tensions that appear with such an ambition through a reflection on the literature review phase of the project.

The perspective used in this article is that of institutional logics. Institutional logics is a variant of neo-institutionalism in organisation theory that focuses on systems of meaning and beliefs, and how institutions change beliefs and vice versa. Institutionalist perspectives describe how organisational structures and practices relate to their institutional contexts, i.e. 'common understandings of what is appropriate and, fundamentally, meaningful behaviour' (Zucker 1983, p. 5). Institutional logics was originally introduced by Alford and Friedland (1985) who used it to describe how change could result from tensions at the level of modern societal institutions, and then in 1991 applied the concept to the relation between individuals, organisations and society Friedland & Alford (1991).

In our analysis, we will be closer to what Berg Johansen & Waldorff (2017) call empirically identified logics ranging from field-level norms to specific local practices, which do not position the logics with reference to the higher-level societal institutions such as the market, the religious sphere or the state. In this approach, actors in organisations, professions, disciplines or other institutionalised collectives are immersed in logics, but shape these logics and can import them into new fields (see Berg Johansen & Waldorff (2017), and Greenwood, Raynard, Kodeih, Micelotta, & Lounsbury (2011)). In situations where there exist competing logics in the same field, an individual can to an extent choose what logic to mobilise for a certain purpose (Friedland & Alford 1991), but this choice can be constrained by structural or cultural barriers (Swan, Bresnen, Robertson, Newell, & Dopson 2010).

A new logic can emerge as a response to delegitimization of an existing logic. Swan et al. (2010), referring also to Robertson (2007), show that the appearance of the Mode 2 approach to knowledge production in genetics science was a response to "the failure of traditional science to realize improvements in health (and wealth) expected as a result of the so-called 'biotechnology revolution', and the need to protect public health" (p. 1319). This is relevant also for understanding the RRI logic which shares many elements with the Mode 2 approach. Still, this delegitimization need not be experienced as urgent by all stakeholders in the field and thus the attraction of the new logic may be contested. Both with regard to Mode 2 and RRI, the logic may be held to originate from policy makers and introduced to the research communities by funding programmes rather than being anchored in research communities' own perceptions and needs. A logic becomes institutionalised when it is taken for granted and has high legitimacy Scott (2001).

When interpreting institutional logics in academia, one might find interesting differences in logics. One can identify such logics at different levels; for instance at the discipline level (Barry, Born, & Weszkalnys 2008) or within a scientific field such as the life sciences Smith-Doerr (2005).

Rather than providing a detailed account and discussion of this perspective (extending the already extensive literature review parts of this article) we will use it in a rather simple way to shed light on the nature of RRI and challenges in integrated RRI projects, as illustrated by a comparison of three literature reviews. The methodological approach in the article (the comparison of the literature reviews) is a variants of the *pattern inducing* approach to qualitative studies of institutional logics, as outlined by Reay & Jones (2016). In this approach, text is analysed to capture different logics at play. As Reay and Jones explain, institutional logics 'are revealed through language, practices, and manifested in symbols and materials' (2009, p. 442). Here we focus on text but refer to institutionalised norms being expressed in both text and in context, for instance in practices for PhD evaluations.

The contribution of this article is to make explicit some of the implicit assumptions about the nature of RRI. This explication does not imply making a final judgement on what *should* be the nature of RRI, but shows that installing RRI as a an overall research and innovation (R&I) logic may not work while treating it at the same time as a competing (quasi-disciplinary) logic. We may formulate the main question of the article as 'Is RRI an intention of transforming current institutional logics of research and innovation or is it an additional logic to existing ones?'. The current project's original intention was the former, while we shall see that in reality it did not escape being the latter. This has certain consequences that might be generic for RRI projects that aim to be integrated.

The article has the following structure. This first section was an introduction to the article. The second section describes the project, its integrated RRI ambition, and the context and methodologies for the three literature reviews. Section three describes the results from the three reviews. Section four analyses and discusses the findings in light of the perspective of institutional logics. Section five critically discusses the assumptions in the analysis and section six provides some brief concluding reflections.

2. The assisted living project, its approach to RRI and the status of the reviews

The term *assisted living technologies* (ALT) denotes a range of ICT-based technologies for those who, based on an assessment carried out by themselves or others, are deemed to have a specific bodily and/or cognitive need for assistance in their everyday lives. A large uptake of such technologies in homes and home-based services has yet to take place, presumably because of a lack of technological maturity (Calvaresi et al. 2017; Lapierre et al. 2018), and because of limited integration into current health service delivery (Peek, Wouters, Luijkx, & Vrijhoef 2016; Wouters, Weijers, & Nieboer 2017).

The project discussed here, the Assisted Living (AL) project, concerns research and technology development on ALT for older adults with mild cognitive impairment/dementia (MCI/D). The project included researchers from the fields of the health sciences (nursing and occupational therapy), technology research and development, and responsible research and innovation. Two characteristics of the project stand out:

a) It was a large, multi-partner, multidisciplinary technology development project led by the RRI partner. Most often projects that include technology development is led by the technology partner, and the RRI partner (if included) is a work package or task leader only.
b) It had an integrated RRI design from the beginning using an AIRR inspired (see Owen et al. (2013)) RRI framework to organise the whole project in an integrated way. This integrated design meant for instance that there were no disciplinary work packages, but instead thematic work packages (mapping, developing, assessing, and creating outlooks) that included all the partners and aimed at integrated outcomes. The project also included a governance function called the Integrated Assessment group, and devoted dedicated time for common reflection in the whole consortium at every consortium meeting (twice a year over four years). The whole research and de-

velopment process was intended to be user led by conducting deliberative processes with older adults.[1]

The assumption in the AL project was that successful innovations in this field need to be technically robust, health promoting, dignity preserving and in line with societal and user values, and the project was thus designed to accommodate these concerns.

At the start of the project, three literature reviews were carried out by each of the three PhD students in the project. As will be presented in section three, the health review gave an overview of usability, acceptability and the types of ALT that have been evaluated in homes with older adults with MCI/D (Holthe, Halvorsrud, Karterud, Hoel, & Lund 2018). The review of technologies and solutions looked at the state of the art in emerging commercial technologies and at potential solutions based on machine learning and computer vision Casagrande (2017). The RRI review addressed the main procedural challenges in combining technological solutions with health problems and looked at a range of normative considerations that need to be taken into account in the field of ALT Thorstensen (2017).

During their PhD periods Torhild Holthe, Flávia Casagrande, and Erik Thorstensen produced the summaries of reviews that are the bases for this article.[2] These were conducted in accordance with the conventions in their respective disciplines and were thus not harmonised with each other.

Each review was individually presented and discussed at project working meetings, full consortium meetings and a sounding board meeting. In addition, these reviews, as a collective, constituted the basis for a two-hour workshop in the consortium for understanding relevant and central similarities and differences between the three different approaches to ALT. Furthermore, this workshop aimed at finding good practices for research and innovation in ALT in the different reviews that could be recommended used in the other disciplines/approaches or as general policy for ALT research and innovation (Thorstensen et al. 2020). This workshop was a part of the design for the internal learning process in the project (see also Forsberg & Thorstensen (2018).

2.1. The health science review

A systematic search was performed in the databases Medline, PsychINFO, Embase, Amed and Cinahl and resulted in 362 titles.[3] After the selection process according to PRISMA (Moher, Liberati, Tetzlaff, Altman, & Group 2009), 29 titles published within the last eight years were eligible for review (Holthe et al. 2018): 23 papers presented European studies (Finland 1, France 3, Germany 1, the Netherlands 5, Norway 1, Italy 3, Sweden 4, and the UK 5); two studies took place in the USA; Australia, Canada, Brazil and Taiwan were represented with one study each.

Study designs varied. Qualitative studies were the most frequent, with 17 titles. There were eight quantitative descriptive studies, two quantitative non-randomized studies, one quantitative randomized study and one mixed methods study. All the papers were appraised for quality with the mixed methods appraisal tool, MMAT (Pluye et al. 2011), and 17 of the 29 papers were of good or excellent quality, and none were excluded due to low quality.

2.2. ICT research and development

For research and development in ICT, the review started focusing on established research groups that have been working with assisted living technologies on one hand and recent literature surveys on the other hand (Alam, Reaz, & Mohd Ali 2012; Blackman et al. 2016; Rashidi & Mihailidis 2013).

Among the central research groups were the CASAS group (Cook, Crandall, Thomas, & Krishnan 2013), the DOMUS group (DOMotics at the Université de Sherbrook) (Bergeron, Bouchard, Gaboury, Giroux, & Bouchard, 2016; Bouchard, Giroux, & Bouzouane 2007; Giroux et al. 2015; Roy et al. 2011); and The Institute for Infocomm Research (Feki, Biswas, & Tolstikov 2009).

Some relevant projects include COACH (Cognitive Orthosis for Assisting aCtivities in the Home) (Mihailidis, R. Fernie, & C. Barbenel 2001); the COGKNOW project (F. J. M. Meiland et al. 2007; Mulvenna et al. 2010); the Rosetta Project (Hattink et al. 2014); the NOCTURNAL project (Night Optimised Care Technology for UseRs Needing Assisted Lifestyles) (Augusto et al. 2011; McCullagh et al. 2012); and the Dem@Care project (Dementia Ambient Care) (Meditskos & Kompatsiaris 2014).

These projects, research groups and literature surveys were starting points to collect several articles for review from a number of databases, including IEEE Xplore, ACM Digital Library, Science Direct and Google Scholar. The technology review focused on the state-of-the-art in assisted living technologies, as well as the methods and techniques for their implementation. A number of 202 entries from scientific literature, product descriptions and policy reports were covered.

2.3. Responsible research and innovation

The field of RRI is not a distinct discipline, but encompasses approaches from applied ethics, practical technology assessment, science and technology studies (STS) and related disciplines. This was reflected in the compilation of the literature.

Before the start of the Assisted Living project, two major literature reviews on the ethics of ALT had been published (Hofmann 2013; Novitzky et al. 2015) and they were the basis for the ethics dimension of the review. For the other aspects of RRI, a double search strategy was chosen, one on RRI and ICT in general and one to gather projects specific to RRI and ALT.[4] Both search strategies were used on EBSCO, Web of Science, and Science Direct. These searches yielded 51 papers. Searches were also conducted in the Directory of Open Access Journals and in Google Scholar (the latter includes grey literature, that is, project deliverables and reports). After comparing these to the first searches, 28 new studies were included. A reading of these 79 studies, revealed 13 new relevant studies through what is known as 'the snowball method' (Van Ham, Verhoeven, Groenier, Groothoff, & De Haan 2006). Together

[1] For more information about the project see Forsberg and Thorstensen (2018), Thorstensen (2020), Thorstensen et al. (2020) and Zouganeli et al. (2017).

[2] Holthe published this with four co-authors, as Holthe et al. (2018).

[3] The search terms were specific for each database, but included terms such as AAL, AI, aid,* alzheimer's disease, alzheimer,* ambient, ambient assisted living, artificial, artificial intelligence, assisted, assistive, assistive technology, automation, autonom,* autonomy, body, client participation, cognitive, cognitive impairment, daily, daily living, dement,* dementia, dementia friendly, dementia with lewy bodies, device,* digni,* dignity, diseas,* disorder,* everyday, friendly, health, health related quality of life, home, home automation, hrqol, human computer interaction, human machine systems, impair,* independence (personality), intelligence, involvement, lewy, lewy body diseas,* life, life satisfaction, living, mci, memory, memory disorder,* memory disorders, memory impair,* mild, mild cognitive impair,* of participat,* qol, quality, quality of life, related, respect, satisf,* satisfaction, self-help, sensor, sensor technology, sensor-based, sensor-based technology, smart-home, social behavior, technology, vascular dementia, welfare, well being, well-being, wellbeing – see Holthe et al. (2018) for the full search strategies.

[4] The general search was conducted through the string ('Responsible research and innovation' OR 'Responsible Innovation' OR 'Social studies of science' OR 'Science and technology studies') AND ('ICT' OR 'Sensor*'), and the specific search ('Responsible research and innovation' OR 'Responsible Innovation' OR 'Social studies of science' OR 'Science and technology studies') AND ('Ambient living' OR 'Ambient assisted living' OR 'Welfare technology' OR 'Welfare technologies'). The wide search gave 50 relevant entries, after controlling for duplicates, and the narrow search provided one additional reference. See Thorstensen (2017) for further details.

Table 1
ALT in the reviewed studies.

Higher order purposes	ALT evaluated in the reviewed studies
Safe walking indoor and outdoor	GPS, mobile safety alarm for emergency calls and locating the person; RFID indoor navigation, photos on wearable screen to facilitate navigation in a hospital area
Safe living	Monitoring technologies in apartment, bed and chair cushion; door monitoring; continuous monitoring of health status and daily activities
Independent living	Electronic calendars; time orientation aids and reminders; simplified dialling using videophone instead of mobile phone/land line
Entertainment and social communication	Tablet computers for creative art therapy; tablets for enhancing communication between staff and persons with MCI/D; tablets to assist in daily living and/or as a source of leisure activities and social networking.

with the two ethics reviews, 94 studies were included in this review. Specific attention was given to research projects on RRI and ICT and/or ALT. The most important came from the project Responsible Industry (Porcari, Borsella, & Mantovani 2015) and from a collection edited by René von Schomberg (2011) .

2.4. Methodological contrasts and overlaps

There are contrasts between the methods used for literature searches between the disciplines (i.e. differences in systematisation). Occupational therapy followed a quality assessment of papers based on MMAT (Pluye et al. 2011) aiming at integrating different research methods towards a holistic appraisal. The RRI review had searched widely to cover all insights in the field, whereas the engineering approach had searched more specifically into the state of the art in the intersection between home assistance and machine learning.

As for the overlap in sources, the health and engineering reviews had two common sources and the health and RRI reviews had two common sources. There was no direct overlap between the engineering and RRI review sources, even though some of the same authors appeared in these reviews.

3. Results of the reviews

3.1. The health science review

A great range of technologies were included in studies where technology was introduced to older adults with MCI/D and their family carers (FC).[5] The authors in Holthe et al. (2018) reviewed the studies and classified the different ALTs and types of ALT into Safe walking indoor and outdoor; Safe living; Independent living; and Entertainment and social communication based on the purposes or the goals of the ALTs (see Table 1).

The authors investigated the papers that reported on participants' opinions on usability of different ALT technologies after a trial at home. Usability was defined as user-friendliness, usefulness and effectiveness of the product/technology (Meiland et al. 2012), and the extent to which it could help a person achieve a desired goal (Lindqvist, Larsson, & Borell 2015). Technology that was easy to use and that enabled a person with cognitive impairment to cope with daily tasks, was perceived as being usable. The term 'acceptability' was not used in the reviewed papers, but the terms 'accept' and 'acceptance' appeared in a few studies. Boman, Nygard, & Rosenberg (2014) stated that acceptance of technology was associated with the ability to maintain a desired self-image of being competent. Usability is thus a measure for the utility of ALT, whereas acceptance relates to the self-image or self-understanding of the user. An ALT might be accepted without being very useful, and – likewise – a useful ALT might be unacceptable due to conflicts with the user's self-understanding. A good fit is consequently a usable and accepted ALT.

All 29 eligible papers emphasised user involvement during the pre-implementation and design phases, in particular for specifying user requirements and user needs. User involvement was also important during the trial phase to learn about the new technology in a real-life context and to evaluate its functionalities: robustness, reliability, user-friendliness, quality and acceptance of the installed device (Cavallo, Aquilano, & Arvati 2015; Hattink et al. 2016; F. J. M. Meiland et al. 2014). Some papers reported on how the opportunity to try the technology at home, in a real-life situation, allowed older adults with MCI/D and their FC to see for themselves how it could offer support (Faucounau et al. 2009; Leuty, Boger, Young, Hoey, & Mihailidis 2013).

One key finding was the versatility of some technologies, and the need to express a variety of uses. Gibson et al. (2016) suggest dividing technology into three types: those used 'by' a person; those used 'with' a person; and those used 'on' a person with dementia. Another distinction is between technology that requires active use by a person, and passive technology (Swarthmore College Computer Society n.d.). In the earlier stages of MCI/D a person can benefit from technology that compensates for lost skills or that simplifies tasks that the user still carries out (Lindqvist, Nygård, & Borell 2013). In later stages of MCI/D, passive technologies may be more useful and can support FCs in their caring obligations (Riikonen, Mäkelä, & Perälä 2010). Furthermore, equipping the apartment with alien objects can be perceived as negative, since it interferes with the familiar (Ravneberg & Söderström 2017).

The review showed that a wide range of technologies have been evaluated but that most papers describe the opinions of family caregivers and staff on the technology trials, which is also documented elsewhere by Topo (2008). No specific opinions from older adults with MCI/D on technologies tested at home are visible in the reviewed studies by Holthe et al. (2018). However, opinions of older adults are represented in the papers on pre-implementation, planning and design (Augusto et al. 2013; McCabe & Innes 2013; Robinson, Brittain, Lindsay, Jackson, & Olivier 2009), and are very much appreciated. Some authors even recommended user involvement as a prerequisite for trials at home with people with MCI/D (Franka J. M. Meiland et al. 2012). Given the orientation of the AL project, a significant finding by Holthe et al. (2018) was that none of the reviewed papers reported the consequences of technology use for preserving or achieving human dignity.

3.2. The ICT research and development review

The aim of the technology/engineering literature survey of ALT was to provide an overview of the current status on research in this field for older adults in general, and older adults with MCI/D in particular, and to focus on emerging solutions and the use of machine learning for such applications. Commercial technologies were also looked at briefly.

Most commercial smart-home technologies for the general public are stand-alone devices, aimed at better comfort, safety and energy efficiency. Automatic lights (e.g. Philips Hue) and thermostats (e.g. Nest), smart locks (e.g. Augustus smart lock) and smart speakers (e.g. Amazon Echo Alexa) are becoming more common every day. Such systems provide specific assistance with one type of challenge. An integrated system that includes a range of devices connected in a smart home (the aim of the technology development in the AL project) would provide

[5] See Holthe et al. (2018) for the full study and methodological aspects.

value added services far beyond the sum of each isolated system. Such systems are emerging in the market but with quite limited functionality added.

There were far fewer commercial ALT devices and systems for older adults and older adults with MCI/D, compared to the number for general purpose smart homes, and the maturity of the technology was considerably lower for the latter (Bygholm & Kanstrup, 2015). The most common devices and systems appropriate to the older adults market were medication dispensers (e.g. Philips medication dispenser) and fall detection with alarm activation (e.g. Philips *GoSafe Alert* and XCenter *RoomMate*). The number of rehabilitation systems using cameras (e.g. Philips *Fitness@home*) in the market has grown.

Some commercial systems for older adults, including those with MCI/D, claim they do some behaviour pattern monitoring (e.g. Intel *QuietCare*). More specifically for people with MCI/D, there were several object finder devices based on GPS-technology and RFID (radio frequency identification) (e.g. *Find One Find All®)*. There were also some solutions that addressed wandering (e.g. *Vivago* wandering detection alarm, *SmartSole* soles).

Fall detection was a major concern among older adults and there are several fall detection systems, both in the market and under development. The main challenge for them all is preventing false alarms, i.e. alerting for a fall when there has not been one (Redmond, Zhaonan, Narayanan, & Lovell 2014). Machine learning is being explored to reduce false alarms, and has been shown to improve results considerably in terms of both a reduced number of false alarms and applicability to different environments (Zhang, Su, & Yu 2014). Fall detection systems that use accelerometers were the most commonly implemented (Özdemir & Barshan 2014). From the review it appeared to be an advantage to achieve automatic fall detection, preferably without the need to wear technology since this depends upon people actually putting it on. Issues such as battery-life and charging increase the uncertainty around proper use. Therefore, systems that employ depth video cameras are widely investigated (Stone & Skubic 2014) as they avoid the challenges of being fixed in the environment and being plugged in. Outside the home, it may be difficult to eliminate the need for wearable devices, which do exist and new ones keep emerging in the market.

Behaviour pattern monitoring is a particularly important area for older adults with MCI/D as they have special needs in their daily life due to memory issues, passive behaviour and inactivity, or sometimes because of wandering behaviour. Behaviour analysis can shed light on causes, facilitate remedies, and assist with challenges as they emerge. Hence, it is useful for diagnosis, for activity prediction and for personalising the solution. Several research projects focused on smart homes to address safety and help with indoor orientation (e.g. via illumination), or to provide behaviour pattern monitoring as a support tool for caregivers, clinicians and family members. Examples are NOCTURNAL (Augusto et al. 2011; McCullagh et al. 2012), Dem@Care (Karakostas et al. 2015) and COGKNOW (Mulvenna et al. 2010).

ICT-based diagnostic tools for MCI/D, as well as Alzheimer's and Parkinson's disease, are heavily researched (Ashraf & Taati 2016; Hayes et al. 2008; Riboni, Bettini, Civitarese, Janjua, & Helaoui 2016). The use of machine learning makes it possible to observe relatively small changes in a person's daily patterns, to identify early onset of the disease and to monitor its progress. These are important to provide timely assistance. A number of studies have focused on identifying differences between healthy older adults, older adults with MCI and older adults with dementia. This can be done by using, for example, behaviour pattern analysis or execution or occupational performance of activities of daily life (ADLs). Such tasks require robust activity and prediction algorithms.

There has been considerable research on activity recognition, and impressive results have been achieved in smart-home environments (Chen, Das, & Cook 2010). Activity recognition has been realised using simple sensors on objects, and/or a large number of ambient sensors. This was not always sophisticated and usually looked at high-level activity recognition, such as watching TV, cooking and sleeping. Very few studies addressed low-level action recognition. The COACH system decomposed low-level hand washing activity into recognisable actions (e.g. put on soap, turn on tap and so on) (Mihailidis et al. 2001). Such decomposition facilitates the recognition and evaluation of an activity plan, which has high relevance for people with MCI/D. Activity recognition *per se* does not have a direct value for the users, but it is a prerequisite and a necessary tool for achieving a number of functions in intelligent systems to improve smart automation in the home, or to detect behaviour pattern changes, such as: prompting systems (Das, Cook, Schmitter-Edgecombe, & Seelye 2012; Holder & Cook 2013); diagnosis tools (Ohgi, Hunter, Pillus, & Rosenfeld 2015; Williams, Weakley, Cook, & Schmitter-edgecombe 2013); and predicting activities (Minor & Cook 2016; Nazerfard & Cook 2015). Most activity recognition and prediction studies have been carried out in laboratory environments and using scripted activities so there is a lack of data from real homes.[6]

3.3. The RRI review

Because RRI is not a distinct discipline, the topics identified in the review are heterogeneous and revolve around the relationship between science and society, and the value issues at stake.

With a strong connection to policy goals in the field of ALT comes what René von Schomberg (a key promotor of RRI) has called a *policy pull*, instances where 'politicians and policy makers have been eager to accept and promote the implementation of those technologies' (2012, p. 58). Some authors in the reviewed literature questioned the assumption that ALT could reduce health-related costs, and warned against the 'crisis framing' of demographic change and its automatic connection to ALT as an all-encompassing solution (Hofmann 2013; Mort, Roberts, & Milligan 2009). Vines et al. (2015) identified this approach as 'the discourse of health economics', which is one of four frames they found in debates on age-related research in HCI (human computer interface). Neven (2015) analysed how the term 'innovation' produces a forceful effect that trumps other value-based or practical concerns.

Von Schomberg also addressed a different force, *technology push*, which denotes how operators and producers of technologies aim to establish independence from societal or political spheres. Despite some notable efforts to include older adults or people with MCI/D to align users' interests, preferences and needs with technology developers (see Kennedy & Ter Meulen (2016)), an orientation towards end-user engagement and end-user needs was too often found lacking, which negatively affects technology uptake, user well-being and dignity (Barlow, Bayer, & Curry 2006; Bechtold & Sotoudeh 2013; Nickelsen 2013; Nijboer 2015; Topo 2008). Novitzky et al. (2015) warned that technology push is likely to be greater than demand. Frennert (2014) showed that participation in technology development is a forceful way of creating learning and ultimately increases uptake.

Various approaches to participatory design and development were outlined as preferable (Bailey & Sheehan 2009; Heidingsfelder, Kimpel, Best, & Schraudner 2015). But these approaches also carried some critical issues, such as: whether the selected participants represent older adults in general (Callén, Domènech, López, & Tirado 2009); the responsibility for keeping the process going (McLoughlin, Maniatopoulos, Wilson, & Martin 2012); the danger of 'cherry-picking' inputs (Lassen, Bønnelycke, & Otto 2015); and that participatory methods are typically orientated towards "discursive bargaining" rather than an exploration through experiences with objects and prototypes (Compagna & Kohlbacher 2015).

A central issue in the uptake, use and usefulness of ALT was how users might create novel affective bonds with the ALT (Pols & Moser 2009). A fusion between devices and people is possible to the ex-

[6] The SPHERE project has provided new insights since the literature review (Zhu et al. 2015).

tent that devices empower and provide feedback to the user (Frennert & Östlund 2014). A lack of empowerment might lead to inactivity and passivity, which can create novel vulnerabilities (Novitzky et al. 2015). End-user engagement was found to be lacking in the developments and implementation of ALT; and several authors pointed to a lack of including professional caregivers in the implementation phase, and said that inclusion could contribute to increased uptake (Frennert 2014; Hellesen & Bisgaard-Nøhr 2013; Nielsen, Andersen, & Sigh 2013; Porcari et al. 2015; Saborowski & Kollak 2015; Tinker, Kellaher, Ginn, & Montserrat 2013).

The remaining three discourses identified by Vines et al. were 'the discourse of sociality, discourse of homogeneity, and discourse of deficit' (2015, p. 9). The importance of unpacking the images of 'ageing' and 'home' and relating their framing effect to the development of ALT was also noticed (Aceros, Pols, & Domènech 2015; Ootes, Pols, Tonkens, & Willems 2013). Central points raised here were the investigation – individually and on a macro level – into whether older adults' homes actually are healthy and in healthy surroundings, and the exploration of social solutions in parallel and as an alternative to technological solutions (Tinker et al. 2013). A repeated concern in the literature was the issue of addressing older adults as individuals with technological competencies and who are as diverse as any other age category and with the same range of joys and sorrows, and the challenge of keeping the innovation process focused on this knowledge (Mort et al. 2009; Peine, Faulkner, Jæger, & Moors 2015; Torrington 2009)

Hofmann (2013) proposed that the main ethical issues with ALT can be analysed from five different perspectives. First, since they are installed in people's homes there can be an issue of alienation and people no longer feeling safe in their home because of the technology. Second, there is a range of stakeholders who might benefit from ALT, which requires more analysis of who will benefit from its use and who is responsible for the full ALT system. Third, there are issues of privacy and confidentiality given the large amounts of data involved. Fourth, is the issue of distributive justice and the digital divide, where it is not clear if the technologies are distributed in a fair manner that is consistent with considerations of justice. Fifth, ALT might be introducing an instrumental rationality into homes and people's lives in a manner that challenges fundamental values such as care, dignity and vulnerability. Added to this last point is the concern that both admitting the need for and using ALT might be stigmatising (Dahler, Rasmussen, & Andersen 2016; Novitzky et al. 2015; Östlund, Olander, Jonsson, & Frennert 2015)

A theme that was not often raised, but those who raised it did it forcefully, was the lack of structured testing of ALT (Boucher 2018; Hofmann 2013; Kearns 2017; Novitzky et al. 2015). These were very often just tested as consumer goods but employed in homes to provide increased safety. Connected to the issue of assessment are points related to sustainability, gender and privacy. Privacy was raised as a central concern by most authors (Novitzky et al. 2015; Porcari et al. 2015; Stahl 2011; Stahl, Eden, & Jirotka, 2013; Wright, Gellert, Gutwirth, & Friedewald 2011), and related to a trade-off with security (Peissl 2011). However, Rommetveit (2011) challenged this through the notion of a 'control imaginary', that is, that the relationship between security and privacy is stable and controllable. Neven (2015) strengthened this point through his analysis of how different stakeholders perceived the purpose of ALT. Wright et al. (2011) described the need for privacy impact assessments. Since ALT often relate to coping at home, it is necessary to investigate the situated experience of coping with loss. Some pointed to this experience as being gendered (Dahler et al. 2016; Roberts & Mort 2009). Furthermore, a transfer away from the physical presence of care staff (Oudshoorn 2009), mainly impacts the work situation of low-paid and low-educated females (Roberts & Mort 2009).

4. Analysis

The key topics from the three reviews are included in table 2.

4.1. Observations from an institutional logics perspective

The reviews of ALT in these three academic fields give a picture of quite different profiles of topics. We can expect that the results to a certain extent reflect the more specific research interests of the three PhD students and their supervisors, but it is still reasonable to assume that any literature review in these three fields would include many of the topics identified in the three specific examples presented here. Although the differences in profiles reflected in the columns of Table 2 is in a sense an unsurprising result, it opens up for some reflections.

A first observation is that ALT is clearly not the same phenomenon no matter your perspective. For the health science/occupational therapy researchers, it is about the users and their everyday lives. For the ICT engineering researchers, it is about technological solutions and their potential services. For the RRI researchers it is about two kinds of topics, science and technology studies (STS) topics centring around the nature of this kind of research and technology, and ethical and privacy issues. These three quite different perspectives were present even in a project that was supposed to be as integrated as the AL project. If we return to Zucker's point of 'common understandings of what is appropriate and, fundamentally, meaningful behaviour', then these three perspectives display competing views of how to *appropriately* understand ALT.

If we use the institutional logics approach, we can point out that ICT research and the occupational therapy focused health research have two different logics that are institutionalised beyond the project and beyond Oslo Metropolitan University (where the three PhDs were employed). The norms are established in international professional-academic networks and through conventions upheld in the central journals and conferences of the fields. While academic work within a field often takes various forms, PhD education is supposed to ensure that the candidate masters the fundamental conventions of the field. One might say that the successful PhD holder has proven that he/she is adequately familiar with the institutional logic of the field. Once she/he masters this logic she/he can proceed to challenge and further develop it. However, challenging the field's logic is a significant risk for a PhD student and is often avoided. Following a transformative approach to research and innovation such as integrative RRI would amount to a challenge and a risk, perhaps especially for the ICT PhD (see also discussion below). This is in line with Swan et al.'s (2010) observation regarding Mode 2 knowledge production in biotechnology that "even where those involved understand the benefits of working in a more transdisciplinary way, they may simultaneously be drawn towards reinforcing disciplinary boundaries by existing systems of peer review and evaluation" (p. 1336). Thus, even in a project with an integrated ambition such as the AL project, the PhD reviews ended up portraying ALT quite differently.

But what about the RRI review? The RRI review showed that RRI was treated as a quasi-discipline in the project. An important reason for this is that there was a PhD student also for this part of the project. However, RRI cannot really be claimed to be a discipline in itself, - thus the term 'quasi-discipline'. Barry et al. (2008) suggest that a discipline ensures 'that certain disciplinary methods and concepts are used rigorously and that undisciplined and undisciplinary objects, methods and concepts are ruled out' (p. 20-21). There is no acknowledged standard for RRI research and thus hard to define the characteristics of RRI as an academic discipline. It is rather a research topic that can be addressed in different more established disciplines. As Table 2 shows, the topics of the RRI literature review is a mixture of classic applied ethics topics (dignity, privacy, etc.) and STS topics (how the research positions itself through framing issues, technology push, etc.). In the end the RRI PhD amounted most of all to a Technology Assessment (TA) project (see for instance Decker and Ladikas (2004)). Though TA is in many European countries institutionalised, it is institutionalised as an advisory practice and not as an academic discipline (there are few, if any, TA programmes at universities). All in all, though there is a sufficiently established RRI research community for an RRI PhD to be assessed and successfully de-

Table 2
Key topics from the reviews.

Topic identified	Health science	ICT	RRI
Usability	x	x	
Acceptance	x		
Versatility	x		
User involvement in design	x		
User involvement in testing	x		x
Family and staff involvement in testing	x		
Stand alone versus integrated smart home systems		x	
Commercial ALTs for older adults/MCI/D		x	
Value added service	x	x	
Behaviour pattern monitoring		x	
Fall detection		x	
Machine learning		x	
Technical problem with wearables		x	
Video camera use		x	
Diagnostic tools		x	
Activity recognition		x	
Policy pull			x
Technology push			x
Framing of ALT 'problem'			x
Participatory design	x		x
Relation between man and machine			x
Acknowledging diversity			x
Ethical issues			x
Need for/Lack of testing			x
Privacy			x

fended, it would be difficult to point to institutionalising factors establishing an RRI disciplinary logic in the higher education system.

However, this successful ambition for a PhD in RRI in the project created a tension between integrative RRI as a logic of all the research and development work in the project and RRI as a separate discipline; a discipline that could be criticised (and indeed also was criticised) for imposing extra-disciplinary elements to the other two research fields in the project. Based on an institutionalist logic, this challenger position probably worked as a barrier for the overall integrative ambition in the project and could be an element in explaining how the AL project ended up with three quite specialised doctoral dissertations (Casagrande 2019; Holthe 2020; Thorstensen 2020).

The subsequent question then becomes to what extent such an integrative, transformative logic of research and innovation has the necessary institutionalisation to challenge the highly institutionalised disciplinary approaches.

As mentioned in the introductory section, the integrated ambition in the project was based on the AIRR dimensions expecting the research and development work to be anticipative, inclusive, reflexive and responsive. This new logic of research and technology development is an ambition of the Research Council of Norway's (RCN's) SAMANSVAR program, which funded the project (and other RRI projects). It is also an approach taken by the UK Engineering and Physical Sciences Research Council (EPSRC) and defended by a number of prominent RRI scholars (Owen et al. 2013; Stilgoe, Owen, & Macnaghten 2013). However, although the SAMANSVAR program's ambition amount to a certain institutionalisation (or at least a certain legitimacy) of this logic, this institutionalisation process is only in its very beginning. In order for this approach to be properly institutionalised in the academic system, the higher education organisations (typically, universities) must incorporate this logic into their PhD programs, reward systems, recruitment criteria, etc. The most prominent RRI related programs of the RCN (currently all found in the Portfolio board of Enabling technologies) collaborate with the universities about doctoral courses on RRI, but there is a long way to go before RRI perspectives are properly integrated into the different disciplines. This means that there is no institutionalised logic incorporating an integrated RRI approach which could support this ambition in the project – and especially not outcompete the strongly institutionalised existing disciplinary logics. This means that RRI as an integrative R&I logic is only very weakly institutionalised, while RRI as a quasi-disciplinary logic is hardly institutionalised at all, as RRI as a discipline in itself is not established.

It is not inevitable that there would be an RRI PhD in an RRI project, when RRI is seen as an overall R&I logic. Proceeding responsibly in AL does seem to require that there is ethics expertise involved, but this does not need to be framed in RRI terms. The is a potential dilemma here: Including an RRI PhD furthers the knowledge base for doing good integrative RRI. At the same time, it invites a potential confusion regarding whether STS or ethics research must have primacy in an inter- or trans-disciplinary project framed in RRI terms.

Another question is whether a transformative RRI logic needs to be operative at the project level at all; perhaps it rather belongs in the realm of research policy or research institutions? The institution of R&I can indeed embrace such a logic and one could well argue that this is the result of a decades long learning process on how to drive innovations towards socially desirable ends.[7] Though we have some sympathy with this view, we believe that responsibility perspectives must be pervasive. RRI is not only about driving innovations towards socially desirable ends, but also about conducting the research and innovation processes in a way that avoids undesirable side-effects and the creation of new uncertainties that will need to be tackled down the road (when path dependency and lock-in effects are setting in, as described in the Collingridge dilemma Collingridge (1980). Taking such responsibility must be done at the level of research or funding programmes, but also where the research takes place, namely in concrete research projects.

A final observation regarding the logics of the three reviews is that RRI as an academic endeavour, is clearly positioned in the social and human sciences, and as such closer to the care-oriented health science research than to the ICT research. Reflections on users and a critical stance is common in both the health science and RRI reviews. In the RRI review, one of the ways this critical stance is expressed is through the notion of 'technology push'. This notion is not prominent in the ICT review, but instead there is a corresponding, but inverted, concern about the lack of uptake of technology as it translates to technology immaturity or lack of acceptance.

[7] We thank one of the anonymous reviewers for making this point.

The position of RRI related research as distanced from the technology research can be seen as a dilemma when RRI is regarded as an integrative notion about a new logic for research and technology development (especially in enabling/emerging technology fields such as ICT, biotechnology and nanotechnology). There is a considerable difference in perspective that needs to be bridged when the RRI discourse is distanced from the fields with which RRI advocates seek to engage.

5. Discussion

The institutional logics perspective in this paper differs from its original use. The original use applied institutional logics to society's large and central institutions, such as the market, the state or religious institutions. According to this type of macro-institutional logics, the right unit of analysis would be "academia" or "research" with a connection to an overall logic of late-modern European society. However, in this article the integrative RRI approach and its possible relation to an overall societal logics has not been investigated, though one could claim that transformative RRI may be seen as an expression of tensions between the logic of the autonomous, assumedly simply truth-seeking academic sphere versus both a logic where research and innovation should be market driven, and where it should be government driven (for a similar analysis of universities see Shields & Watermeyer (2018)).

However, many scholars have, like us, taken the institutional logics perspective to a meso or micro level (see e.g. Bjerregaard (2010); Marquis and Lounsbury (2007); Shipilov, Greve, & Rowley (2010)). In their chapter on the state-of-the-art of institutional logics, Thornton & Ocasio (2008) recommend further studies on many levels. We have here analysed the level of different academic fields and disciplines. Our analyses complement the interesting analysis of Swan et al. (2010), addressing the dynamics between Mode 1 and Mode 2 research in genetics science, as well as Smith-Doerr (2005) on logics and narratives in biotechnology.

We have above discussed the status of RRI as a discipline. It should be noted that, similarly, describing health science and ICT as disciplines can raise questions. These fields are interdisciplinary, but interdisciplinary in a more narrow sense than the broad inter- or even trans-disciplinarity advocated in integrative RRI. Also, a discipline is not a static entity. As Barry et al. (2008) say 'what were once interdisciplines themselves become progressively established as distinct fields or disciplines' (p. 23).[8] Barry et al. refer to scholars showing the disciplines themselves as being remarkably heterogeneous or internally divided (p. 26). What is important from our point of view is to identify differences between the three 'disciplines'. Rather than giving an account of what a health science, ICT or RRI logic is, we are only concerned with showing their different approaches to the study of AL, and their few overlaps.

We believe that the institutional logics perspective at this level gives us a viewpoint that allows for interesting reflections. Though superficially treated in this article, we believe the institutional logics perspective opens up a fruitful way to understand dynamics in the project, here illustrated through the literature reviews in the early phases. A more comprehensive study should follow up on this study, which could in some respects be called a pilot study. This should analyse all phases of the project and engage more deeply with the comprehensive scholarship on institutional logics, in a way there was no space for in this article.

We could have been more specific and outlined how the different logics include different explanatory and conceptual models, what kind of data are relevant, the purpose of the research, validation approaches, the status of normativity, etc. However, it would be too much for this article to analyse in detail the institutional orders of the different academic fields and disciplines, and it would also make us stray too far from the central issue in this article: namely the relation between RRI as an integrated project and as an academic (quasi-) discipline.

Another objection that can be made to our approach in this article is to point out that a project is not an organisation and institutional theory is mostly about organisations. In a sense, we have here treated a project as a temporary organisation. This is not unwarranted in the literature, see for instance Turner and Müller (2003), and it in fact brings out important features of integrated RRI projects. If you want to institutionalise a new logic it is probably impossible to do this through relatively short projects (the AL project lasted for four years). You can see a project as a learning arena (see Egeland, Forsberg, & Maximova-Mentzoni (2019)), but if a project is to effect learning outside its own borders (which is necessary for institutionalising a logic), it has to be connected to potentially institutionalising structures (such as PhD programs or other educational actors, department management or professional organisations).[9] An externally funded project, such as the AL project, was not in this way structurally connected.

Creating organisational learning arenas that are more permanent than projects would thus be an important action for funders wanting to see RRI implemented more broadly in the research system. Here, RRI projects should have a place, but organisational structures that last beyond the projects' lifetimes are necessary. However, the challenge for the funders is that they do not have a direct link to such structures as they mainly fund individual projects. Still, some avenues are there. In the Digital Life Norway network, funded by the RCN, the RCN requires the project leaders' institutions to commit at an organisational level to enhance the institutionalising potential of the projects funded under the auspices of this centre. For more recent projects funded by the SAMANSVAR program, the RCN has similarly required the project leaders to have an organisational commitment to a 'hub' (see https://www.ntnu.edu/afino/). The funders themselves are, and should be, involved in such institutional structures, so that the funders also learn from the projects and the dilemmas the logic of integrative RRI raises vis-à-vis existing logics in academia. This might lead to transformative effects on research practices and structures also after the conclusion of individual projects.

An assumption in the discussion of the results above is that if the project was indeed entirely integrated there would be more overlap of topics in Table 2. Two questions can be asked about this assumption. Would all deeply integrated RRI projects need to make this assumption? This question invites to a reflection on how much inter- or transdisciplinarity is assumed to be necessary in integrated RRI. The other question would be: How much overlap is desirable? Is it not reasonable to have a division of labour? One might argue that disciplinary studies are completely acceptable even for complex, multifaceted and ethically sensitive topics like artificial intelligence in the homes of elderly; it is rather decision-makers that should take the broader transdisciplinary view. This last question involves a challenge of a central tenet of RRI, namely that the researchers and innovators themselves are co-responsible for the outcomes of their work. But if this involves a broadening of the disciplinary profiles to the extent that their individual logics disappear, this might have implications for quality and quality control. For instance, what would be assessment criteria in doctoral commissions?

Another interesting study would be to explore in more detail the status of apparently identical terms in the two logics of ICT and occupational therapy research. It became clear from the comparison of the reviews that there are important differences in language when it comes to terms such as 'behaviour', 'activity' and 'rehabilitation', and phenomena such as 'risk', 'safety' and 'vulnerability', between fields like engineering and occupational therapy (both of which share a commitment to trying out assisted living technologies). These could be investigated further to reveal whether and how their perspectives overlap and/or di-

[8] Barry et al. (2008) discuss three logics of interdisciplinarity itself; namely accountability, innovation and ontological change. This is an interesting analysis, but not essential to the discussion in the paper.

[9] See Wittrock, Forsberg, Pols, Macnaghten, and Ludwig (2020).

verge, enhancing the interprofessional mutual understanding that is a crucial success factor for inter- or trans-disciplinary ALT projects.

A final point to make in this discussion section is that we have in this article simplified the RRI concept. Here we have described the RRI R&I logic in terms of the AIRR dimensions where research and innovation is supposed to be anticipatory, reflexive, inclusive and responsive. This is in line with the RCN and the AL project's approach. However, in the European Commission (EC), and subsequently in a number of EC funded research and innovation projects, RRI is sometimes also described as five or six keys (Ethics, Gender, Open access/science, Societal engagement and Science education, and sometimes including Governance). This adds complexity to the RRI concept and makes institutionalisation of RRI more difficult.

6. Conclusion

In this article we have used resources from the institutional logics approach to analyse the status of RRI in an assisted living technology project with strong ambitions for integration. We discussed the differences between the logics that played out in the project, illustrated with the case of the initial literature reviews. We used this analysis to discuss important tensions or challenges related to RRI projects in general and identified further research needs.

We asked in the beginning of this article: 'Is RRI an intention of changing current institutional logics of research and innovation or is it an additional logic to existing ones?' Based on the analysis in this article we can conclude that RRI in the AL project from the funder's side and the project leader's side was intended to be an example of research and technology development carried out within a new RRI R&I logic, but that it in large parts was conducted as a multidisciplinary project with RRI as a quasi-disciplinary logic in part in parallel with and in part in conflict with other logics in the project.

Whereas there is a value in having an open approach to practices and approaches in RRI (Gerber et al. 2020), this openness needs to be analysed and well-understood in order to provide a non-ambiguous understanding of the scope, purpose and logics of RRI in the relevant settings. The tensions discussed in this article should thus be explicitly considered both by funders promoting RRI and researchers conducting RRI projects. Distinguishing more clearly between RRI as a new logic of research and innovation versus as a quasi-discipline might help facilitate broader implementation of RRI in research and innovation. One could speculate whether avoiding the suggestion that RRI is a discipline, implicit in for instance talking about an 'RRI PhD', could make RRI as an R&I logic more acceptable, as it might then not be seen as a competition between disciplines but as a common aim. This does not mean that the research conducted under the term 'RRI' is not important; but it could instead be conducted under the disciplinary terms of STS or applied ethics (or other relevant alternatives). We believe that this is a discussion that should be taken by researchers involved in work on RRI related topics.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Research ethics

After consulting with the regional ethics review board, we were advised that the project would not require ethical review. Following national guidelines, the project was registered with the Norwegian Centre for Research Data and carried out aligned with their guidelines and advice.

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Supplementary materials

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