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Embedding care robots into society and practice: Socio-technical considerations

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ABSTRACT

Robots are not yet typical in daily use in elder care services, but recent studies suggest that they will soon be mainstream. In this study, we focus on the future of elder care, affected by the emergence of care robotics. We tackle the socio-technical transition—a multi-level change with a re-configuration of social and technological elements of the system—of elder care. The transition in the elder care system and the conditions of the embedding the robots in welfare services and society in three European countries, Germany, Sweden and Finland, are examined. Our qualitative study focuses on current situation in the use of robots in elder care as well as advancing and hindering elements in embedding robots into society and elder care practices. According to the results, there is a shift towards using robots in care, but remarkable inertia exists in both technological development and socio-institutional adaptation. Advancing and hindering elements in transition are both technical and social – and increasingly interrelated, which needs to be considered in management and policy measures to promote successful future transition pathways. The change of attitudes and embedding robots into society is promoted, for instance, by raising relevant knowledge on robots at different levels.

1. Introduction

Digitalisation and disruptive technological advances can affect any societal practice, including elder care. It is estimated that artificial intelligence revolution will come into full force within the next twenty years (Makridakis, 2017). In particular, service robots are likely to change the field or the current 'regime' of care. Providing care for an ageing population with a shrinking workforce are often presented as one of the greatest challenges of our time. The solution is often sought from developing technologies. In this paper, we tackle the socio-technical transition—a multi-level change with a re-configuration of social and technological elements of the system—of elder care, affected by the emergence and early implementation of robotic technology. Wicked problems, including consequences for care services of the ageing population, typically cannot be tackled within only one policy sector (Auping et al., 2015) or resolved with individual innovations. Instead, the solution involves systemic change in the technological, social and institutional spheres and requires skilful change management.

As robots are not typical in the elder care services, they can still be seen as niche-type solutions in present-day care practices. However, recent studies (Hennala et al., 2017; O'Brolcháin, 2019) suggest that robots could soon be mainstream. Several age-friendly

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technology innovations already exist, but making them 'business as usual' presents several challenges related to organisational culture, practice and structure (Arentshorst & Peine, 2018). These challenges include, for instance, lack of shared vision and common language, boundaries between disciplines and sectors, lack of markets and lack of structuring elements for practical action, monitoring and evaluation (Arentshorst & Peine, 2018). Related to robots in care contexts in particular, we are in the middle of a wider breakthrough, but also face the same obstacles as with the introduction of any new technology in elder care. Many arguments revolve around controversies and fears such as ethical issues (e.g., Sharkey & Sharkey, 2012; Vandemeulebroucke, de Casterlé, & Gastmans, 2018). How the robots are embedded in the society and (care) practice (underlying mechanisms) are relevant questions when studying a regime change in care (see Pekkarinen & Melkas, 2019). In terms of socio-technical transitions, we consider embedding an interaction between robots as niches and the current elder care regime, that is, the readiness of the elder care regime to implement care robots, as well as the advancing and slowing elements in the implementation of robots.

This paper analyses the transition in the elder care system and the conditions of the embedding the care robots in welfare services and society in three European countries—Germany, Sweden and Finland. Our study focused on socio-technical analysis of regime change in terms of:

1 the current readiness and actual implementation of robots in elder care and
2 the advancing and hindering elements in embedding robots into society and elder care practices.

We study similarities and differences between these three countries. By means of these, we also consider the perspective of socio-technical scenarios (e.g. Geels, McMeekin, & Pfluger, 2020). While directly addressing long-term futures by constructing comprehensive scenarios is beyond the scope of this study, we understand scenarios as 'learning machines' (Berkhout, Hertin, & Jordan, 2002) that can enable reflection on the realism or implications of widely held views, and on how stakeholders understand and relate to different possibilities. Rather than provide evidence to inform concrete decisions, they foster learning by providing new insights, perspectives and ideas on policy issues (Hertin et al., 2009).

2. Theoretical framework: socio-technical transitions and multi-level perspective in the context of elder care

In this study, the change going on in the elder care services and the introduction of robotics in the field, was examined in terms of the multi-level perspective on transitions (e.g., Geels, 2002b, 2004, 2005, 2011; Geels & Kemp, 2007; Geels & Schot, 2007; see also Pekkarinen & Melkas, 2019; Pekkarinen, Melkas & Hyypiä, 2019), which is one of the frameworks where socio-technical transitions have been studied. Because this approach highlights the interdependence and mutual adjustments between technological, social, political and cultural dimensions (Bugge, Coenen, Marques, & Morgan, 2017; Smith, Voss, & Grin, 2010), it is a fruitful approach in studying processes taking place in the digitalising elder care sector.

Socio-technical transitions differ from technological transitions in that they include changes in user practices and institutional structures (e.g., regulatory and cultural) in addition to the emergence of new technologies (Markard, Raven, & Truffer, 2012). This is a crucial point of view to take into account, particularly in a sector like elder care, which traditionally is seen as based essentially on human work and human values. The introduction of technologies into society and the development of technological innovations require a deep transition that entails the simultaneous development (co-evolution) of technologies, service operations and individual practices and mindsets (e.g., Geels, 2002b, 2005; Truffer & Coenen, 2012).

A multi-level perspective tackles transitions as co-evolutionary processes on three interrelated conceptual levels: the socio-technical landscape, the socio-technical regime and bottom-level niches. Established socio-technical systems are resistant to change due to a high degree of structuration, close relationships among incumbent actors and vested interests (Markard et al., 2012). Transitions take place when changes at the landscape level exert pressure on the regime and make it unstable (Geels & Schot, 2007). Destabilisation of the regime creates windows of opportunity for niche innovations, which are emerging social or technical innovations that differ radically from the products and practices in the prevailing sociotechnical system and regime (Kemp et al., 1998; Geels, 2018).

The multi-level perspective, with its three interrelated conceptual levels, is illustrated in Fig. 1.

The ageing of the population and economic pressures in the public sector are among the landscape-level changes that have contributed to the destabilisation of the regime of elder care, acting as triggers for innovative technologies and practices (Pekkarinen, 2011; Bugge et al., 2017; Pekkarinen & Melkas, 2019); these factors need to be viewed as co-contributors to the socio-technical transition related to elder care.

Applied to the context of elder care, the socio-technical regime can be seen as the way services are currently organised regarding infrastructures, service structures and products (using both high and low technology). It also includes mindset-related issues, such as people's preferences about the products and services that they use and consume, and the market, public sector and policy views and the responses of such actors to people's wishes and requirements.

Examples of niches in social and health care and elder care, in turn, include service robots, various monitoring devices, technology for self-diagnosis and novel service configurations or care-work practices. These novel service configurations and practices may include empowering and activating methods for the older people, and promising examples exist of a remarkably decreased need for long-term inpatient care and medication based on them (Finne-Soveri, Pohjola, Keränen, & Raivio, 2014).

The role of niches is important in sociotechnical transitions, but in addition to actual niche development, niche-regime interaction is a key process in a transition because new rules and practices are integrated into the regime through it (Bui, Cardona, Laminen, & Cerf, 2016). That is why our interest is on studying these processes when care robots are adopted in the elder care context. However,

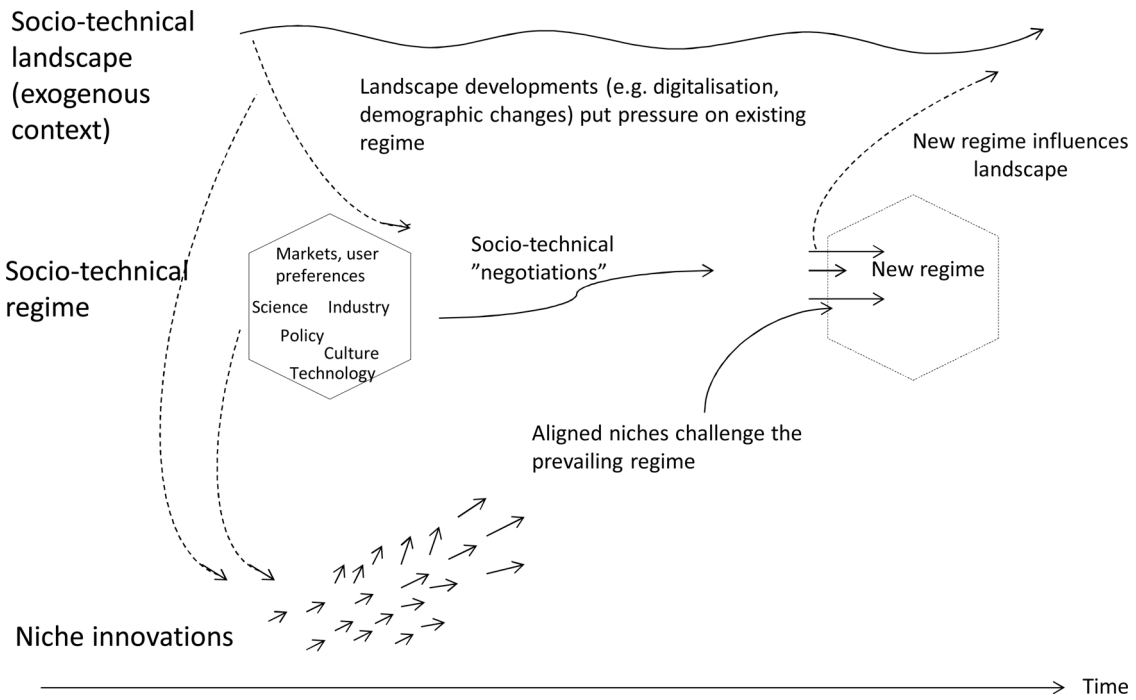

Fig. 1. Multi-level perspective on transitions (Pekkarinen, Melkas & Hyypiä, 2019; modified from Geels, 2002b; Geels & Schot, 2007).

the selection of new technologies and innovative practices is more than mere adoption. Users also must integrate novelties into their practices, organisations and routines (Geels, 2002b), and niches frequently collide with the regime because of existing practices' inertia and lock-ins. More than 'singular disruption' of niches, the question is about 'system reconfiguration' (Markard & Truffer, 2006; Geels, 2018).

System reconfiguration is strongly related to futures perspectives, which brings us back to the concept of scenarios. The idea of socio-technical scenarios was developed in the early 2000s (Elzen, Geels, Hofman, & Green, 2004; Geels, 2002a; Hofman, Elzen, & Geels, 2004; see also Bennett, 2012; McDowall, 2014) in response to limitations of model-based scenarios, which were seen to focus too little on wider socio-technical systems and too much on technologies. Attention was not given to actors, their decisions, interactions and learning processes, and to the ways in which these shape transition pathways (Hofman et al., 2004). Socio-technical scenarios were developed to advance (1) addressing the co-evolution of multiple dimensions (both techno-economic and socio-political), and (2) focusing on the 'endogenous enactment logic'; change of attitudes and behaviour of actors in the course of new developments (Hofman & Elzen, 2010: 656). In this study, we concentrate on the present niche and regime trajectories, but also seek to contribute to creating bridges between those and transition pathways towards future goals, an aim recently called for by Geels, McMeekin and Pfluger (2020).

3. The case context: care robots and welfare services

In this study, we focus on the embedding of care robotics as a sub-category of service robotics. Service robots are used by service providers or individual consumers. Care robots are service robots that are (mainly) utilised in welfare services, and in this way, they can be separated from the service robots in different fields, although, their tasks are quite similar to other service robots (Okamura, Mataric, & Christensen, 2010). The service robots utilised in care services may be categorised as follows: monitoring robots (helping to observe health behaviours), assistive robots (offering support for older people and their caregivers in daily tasks), and socially assistive robots (providing companionship) (Wu, Fassert, & Rigaud, 2012).

Care robots are not yet commonly used by healthcare professionals (Turja, van Aerschot, Särkikoski, & Oksanen, 2018), and the availability of robots is in the development phase. For instance, in a systematic review, conducted by Bedaf, Gelderblom, and de Witte (2015) identified 107 robots for older people. Out of those, six robots were still in a concept phase, 95 in a development phase, and only six were commercially available. For example, in Sweden only a robot pet is in use (JustoCat), but there are testing projects underway (Swedish National Board of Health & Welfare, 2019).

There are some differences in how social and health care services are organised in the three countries of this study (see Johansson-Pajala et al., 2019). In Finland and Sweden, social and healthcare services and elder care services are the public sector's responsibility, mainly that of municipalities. The services are mainly funded by municipal taxes and complementary patient fees. In Germany, elder care is funded by care insurance, and in some cases, completed by relatives or municipalities. These financing, provision and regulation-related differences between the so-called Beveridge and Bismarck systems (on ways to compare healthcare system types,

Table 1
Background data on the interviewees.

	Germany	Sweden	Finland
Age range	33–56	40–79	47–62
Gender	5 Female, 5 Male	6 Female, 5 Male	12 Female
Number of participants/group:			
Public sector organising services	2	3	2
Robot companies	2	2	2
Interest organisations of social and healthcare professionals	2	2	3
Interest organisations of end-users	2	2	3
Educational organisations	2	2	2

see, e.g., Wendt, Frisina, & Rothgang, 2009) may well impact the perception of new technologies and constitutes the foundational differences in the socio-technical landscape.

4. Methods

4.1. Participants

The data for this study was gathered with the help of 33 interviews conducted Germany, Sweden and Finland. The interviewees represented key persons in public sector organising services, robot companies, interest organisations (trade unions) of social and healthcare professionals, interest organisations of end-users, as well as educational organisations. There were two to three participants per aforementioned group in each country (see Table 1). These groups were chosen due to their position in the regime level; they are acting as intermediaries on the interface between, for instance, end-users and decision-makers, but also between the niche-level actors and landscape level changes. They were in contact with the practice, but also active in networking and operating in the context of broader societal issues.

The interviewees all had degrees from a university or a university of applied sciences, and almost 80 per cent of them had at least some experience of care robots. Their occupations included, for example, nurses, engineers, managers, teachers, principals of educational organisations, senior advisors, lawyers, developers and strategists.

4.2. Interviews

Related to this research, we asked the interviewees to describe freely the current situation in the field of care robotics in their country and to describe the information and knowledge level of the field actors. We asked their view about the readiness and competences of older people, their family members and professional caregivers to take robots into use. We also asked the interviewees about the hindering and advancing elements that they consider the most important in the increasing use of robots in elder care in the future. The interviewees' own interpretations solicited; hindering and advancing elements were not predefined by the interviewers. There were also other questions, but in this study, these were handled only if the interviewees mentioned something about the abovementioned topics. The interviews lasted about one to one a half hours; they were audio-recorded and transcribed. To ensure the consistency of the study in the three countries, an interview guide with common questions and general instructions was prepared, as well as instructions for analysis for initial coding. The interviews were conducted in the participant's original language and were translated to English after initial coding phase.

4.3. Data analysis

The data was analysed with the principles of qualitative content analysis (see e.g., Krippendorff, 2018) in three phases: preparation, organising and reporting (see Elo & Kyngas, 2008). In the preparation phase, meaning units were selected for the analysis and coding, and the data was reduced in the way that only the relevant contents considering the research questions (current situation concerning care robotics as well as hindering and advancing elements in their introduction) were included in the analysis. Otherwise, the grounded theory approach was used in the analysis. The data was organised using open coding, and after this initial coding phase, the categories (upper-level codes) for these initial codes were formed and data was abstracted for reporting the findings. With the help of this procedure, the characteristics of current readiness and actual implementation of care robotics (Section 5.1) as well as advancing and hindering elements were identified (Sections 5.2 and 5.3).

The findings will be presented according to these upper-level codes (categorisations), such as implementation phase, readiness for use and acceptance, level of knowledge and knowledge needs (Section 5.1), to describe the current situation. After examining the current situation, we present the analysis concerning the elements that are advancing and hindering the embedding of robots in society and care practice (Sections 5.2 and 5.3), where a similar procedure for analysis was conducted: first lower-level codes and then categorisations, which are presented as 'elements' in the Sections 5.2 and 5.3. The analysis follows with a particular focus on socio-technical considerations in the discussion section.

5. Results

This section presents the empirical results under three themes: 1) the current description of the regime of elder care from the point of view of robot implementation: in terms of readiness and implementation; 2) elements that advance the use of robots in care; and 3) elements that hinder the use of robots in care. These three themes help create a picture of the transition dynamics in regime change in elder care.

5.1. Characteristics of the regime and the niche- and landscape-level influences: current situation related to robotics in care in Germany, Sweden and Finland

The 'current situation' refers here to the analysis categories of interviewees' general view on present robot implementation in care services, the maturity of technology and the readiness of users (i.e., caregivers, older customers and family members) as well as the knowledge level related to the topic.

In Germany, the level of interest in the robotics topic in the care sector is very high, and the topic is often described as 'dynamic'. Robots have not been widely used up to now, but much is expected to happen in the next few years. Despite some reservations and resistance among care workers, robotic technology is regarded as a solution for the future and the need for assistive technologies is high. However, the current use of care robotics in the care sector is in an early stage. At present, there are some test homes and pilot projects, but few care robots are actually used in the care of older people. There are some assistance systems related to safety in households, but care robotics is not in widespread use. Research seems to be more advanced than actual usage among clients or patients. One participant from the public sector organising services in Germany said:

> So, I believe, that the research there [regarding care robotics] is essentially further along than we see in all the different points. Therefore, in my estimation, we have very few care robotics actually on site with policy holders, with residents or in nursing homes, etc. But I think that science is significantly further on in this regard, but it has not actually arrived yet. At least my subjective perception of what I see on-site with people.

Care robotics is considered the market of the future, and it remains to be seen to what extent care workers can be supported and the shortage of specialist staff resolved by it. The care institutions are under huge financial pressure, and they need to find a balance between technology and care staff.

The level of information and knowledge of caregivers needs improvement in Germany. The managers gather and receive information through their networks, and various types of literature and exhibitions and they are good sources of information, but not many practical experiences are brought up in those. As one participant from the education sector in Germany said:

> I believe that it [the level of knowledge of those involved] is certainly in need of improvement. There is not even a marginal level of knowledge of technical details, for example, right?

In robotics companies, the information and knowledge level is naturally good, but for 'outsiders', it is difficult to clearly understand what today's robots are capable of doing. The term 'care robotics' may even lead to rejection if there is not enough information. Seeing the benefits—for instance, if the robot can increase the autonomy and independence as well as delay the entry into a nursing home—is important for the acceptance.

Acceptance is thought to be increased if the systems and their functions were reliable and easy to use, and if they were introduced in an understandable way. A participant from an educational organisation in Germany said:

> If the robots are introduced well (transparently with a lot information) and care givers can see the benefits rather than obstacles, challenges, and limitations [they will be accepted]. So if they recognise the benefits of the technology, how it might relieve them, and that it comes with few or no risks, and, if there are risks, how to handle them, all with as much transparency as possible, then I can well imagine that acceptance will be great.

It was considered probable that the readiness to use will be higher in the future, but there were also opposite views. There is still significant ignorance and many false assumptions, such as worries about robots actually caring for older people alone. The acceptance of robots is related to how familiar the person is with technology and automation in general. In the future, technology is perceived to be more natural, and it is expected that people will even develop relationships with the robotic devices.

In Sweden, too, there are many testing activities and openings, but extending the use of robots is found to be difficult. Some applications are ready for implementation, while others are still in their infancy. A public sector participant from Sweden said:

> Often it ends in that it is just some single product or…it is not so often we have seen that it gets out in a bigger scale, and it is a challenge…

So far, robots have mainly been found in health care facilities such as hospitals. The interviewees said that there is potential and even a huge 'hype' and overly optimistic beliefs, but 'there is more talk than actual use' of many potential solutions (like shower robots and exoskeletons). One participant stated that the companies show an exaggerated picture of what technology is capable of, and therefore politicians and decision makers see care robots as a great opportunity and some even have an exaggerated belief in them and think that 'the aging population problem' is solved with the help of robots and other kinds of welfare technology. At

present, however, robots are not yet flexible enough to operate in different environments and do what users wish. A participant from a robot company in Sweden said:

> We who are working on robotics know that if we are to develop a robot that picks up glasses … and it should cope with all kinds of glasses; it should cope with all kinds of surfaces it falls on; it should cope with all kinds of lighting conditions, then we talk an apparatus for one and a half, two million today. So, there is not a possibility that we can have, and then we talk about one function, robots are not good at being flexible in an environment and we are far from there…

A bottom-up perspective (the actual needs of the staff and older people as well as trade unions) seems to be lacking in the product development, even though it is considered very important. Current products and solutions are perceived as technology-driven and not matching the needs and priorities in health care. There also appears to be an underestimation of older people's capabilities to know what is best for them. A Swedish robotic company participant said:

> In some ways older individuals are considered as having dementia or something, that they have a cognitive impairment, that they do not understand their own situation, like 'I know better, I give you this because then you will feel good'. I mean I know myself and what I feel good about, regardless of whether I am 75 or 95. So it is in some way like some kind of dummification, you think you lose your intelligence when you get older.

Regarding readiness in Sweden, many older people are curious and competent, and they want to be involved in technology development including the dissemination of knowledge. For an individual, being independent is a strong driving force for their interest in robotics. Relatives are also positive when they see the benefits. There is an initial resistance to technology but it seems to disappear along with getting information.

It was mentioned that there is not enough understanding of the organisational changes that implementation of new technology involves. One participant representing a healthcare professional interest group in Sweden said:

> It is about organisational innovation as well. Organisational changes, if you put in a new technical gadget or new system, you will need to change the organisation, and you need to make a risk assessment of how the working environment is affected, and what consequences and what time-plan, what education, how should we organise the work in a different way …

However, the knowledge of, for instance, procurement challenges and requirements for technical solutions is gradually increasing, and technology will become a natural part of care work and do much good. It will, however, take some time and start with simple things. When people become more accustomed to technology, the use of care robots will likely increase. Continuous work within the area of care robots is seen as important, and education must keep up with what happens in the technology field. At least one Swedish representative of professional interest said:

> No, I do not think that we are sufficiently prepared for what is coming.

The need for knowledge in Sweden is extremely varied among professional staff, depending on age, interest, the use of digital technology privately and how to look at it in the profession. There is a need to develop readiness and competence, including all the professional groups—occupational therapists, unit managers, social managers and so forth. Some might find it exciting to work with digital technology, but the solutions must function well. It is typical that the staff uses digital solutions in their private lives, but have prejudices towards it in their working lives. There must be a technology module including e-health and digitalisation in the health care education programs. In the current situation, nurses feel that they do not have enough time to do their jobs. Giving information about what the technology can assist them with might change their views, so that they perceive technology as a support and not as a threat. The nurses must start to be demanding, so that the technology can be adapted to their work methods. One participant from a robot company in Sweden said:

> They don't sit in the back seat in the car and wonder where we should drive. Instead the nurses have to take the wheel, they have to drive.

Also, in Finland, it was highlighted that the door for care robotics seems to be open due to piloting activities on a general level, and due to the general change in a positive direction. However, the care robots have somewhat unexpectedly 'popped up' as part of the care sector, which had not been fully prepared, and this has also caused resistance to change. The use of financial reasoning and economic arguments in the context of care robots seems to cause resistance in the care sector, as traditionally the focus has been in the patients or client's wellbeing and not on economic factors. One participant from a robot company in Finland said:

> The door is opening, and people peek at what will be coming, and they are a little frightened. The fear and wonder come from… let's say complete lack of knowledge and information related to technology, usability, education and maintenance, and whole the lifespan of technology… And what has been a bit surprising to me, that in the situation where the door is just opening, there is no courage to make acquisitions.

Also, in Finland, older people are open and willing to participate in the development work and offer their opinions when something is developed. However, it has also been noted that ageing people are no different from other age groups; some are positive about robots, some are not. The same goes for family members of older people, who may think that using robots mean less human care, but when knowledge is provided on the tasks that the robot performs, the attitude usually changes.

The change of attitudes is already seen among care workers; nurses of all ages are no longer frightened when they see a robot. It is felt that the care systems will change with the introduction of robots. With ever-increasing technological influence, it is probable that robotics will be more common as they have been in other fields. To create a positive attitude, it is important that everyone in the work community learn to use technology. One participant representing a healthcare professional interest group in Finland said:

> What we highlight here (in an interest organisation of care workers) when we hear that 'but I will soon retire', that we definitely think that it is part of the work tasks so let's learn then. We try to promote the positive attitude here and that the employee has a right to demand it. But then the employee has to offer the opportunities and education for that. Everyone has responsibilities.

In social and healthcare education, there is almost no educational content related to technology and robotics at the moment, and therefore, the students are not skilled in this field when they enter the work force. Technological knowledge has depended on whether the student has had a chance to become familiar with technologies in workplaces or if she/he has chosen to voluntarily study technology. Welfare technology studies are, however, soon coming to be part of compulsory studies in the curricula of vocational education in social and healthcare.

There were also doubts about whether persons who have chosen to study care and nursing are primarily interested in technology or in people. There are also ethical dilemmas because technology is experienced as being a threat to prevailing care culture, where human encountering and 'the best of the customer' is important. In busy care work, the workers are often too tired to participate in developing projects. There have been some good experiences in piloting robots, and the care workers and customers have been happy, but the municipalities have not had money after piloting and the robot has not been implemented, which, of course, has been a disappointment.

The level of knowledge varies in all three countries, but generally speaking, it is felt that the knowledge level related to care robotics in Finland is superficial and is dependent on individual interest. There are more beliefs than evidence-based knowledge and practical experiences in the field, which is considered a problem. Not having enough knowledge and not preparing for the robots has also created a distorted, one-sided public discussion related to job reductions. There is knowledge about certain individual robots, like Zora and Paro, but systemic understanding about care robots and their impact on care work is completely lacking.

5.2. Advancing elements related to the use of robots

Advancing elements are seen as a present potential but interviewees' suggestions regarding how to improve the introduction of robots in care are also important. According to the interviewees, the elements that advance the use of robots in care are related, for example, to knowledge and information, for example, to currently improving general understanding about robots, good education level and information transfer. Education level is nowadays high, which provides curiosity towards new things. Especially, young people have digital skills, but better combination of health care and technology skills and knowledge would advance the use of robots. Attitudinal elements are crucial in advancing robot use; attitudinal change is slowly taking place, and a general curiosity and 'out-of-the box' thinking towards robots in care contexts seems to be growing. A participant from a public sector organization in Sweden said:

> A new way of thinking is needed…that one dares to change, what should I say, the history…this traditional care.

Co-creation in product development, which means user participation right from the start, was mentioned as a crucial advancing element in all countries for making user-friendly products. Common areas for collaboration and sharing experiences are needed. A participant representing a healthcare professional interest group in Sweden said:

> Systematise experiences, share experiences, create common areas for collaboration.

Economic elements were considered hindering elements (see Section 5.3), but also interestingly as advancing, meaning that economic pressures connected to demographic developments 'force' the use robotics in care. A German participant from a robotics company said:

> Clearly it is the nursing crisis [that promotes the use of the robotics].

This is similar to elements related to working life, where technology is expected to facilitate the work and give nurses more time for direct care. Nursing staff shortages call for new care models. There is market potential in robotics; larger production would lower prices, and robots would be more accessible for consumers. A budget for investing in technology in elder care as well as collaboration forms, like common robot acquisitions in specific regions, were suggested.

The big picture is quite similar in all the three countries but still some national differences in emphasises can be identified (see Table 2). For instance, in Sweden it was mentioned that a culture of willingness to cope by oneself instead of being a burden to others or having unknown people come to one's home may promote the use robots. One Swedish participant from a public sector organisation said:

> I'd rather go into a shower robot than to have a stranger undress me.

In Table 2, the identified elements for advancing the use of robots in each country are presented. A more detailed description of the advancing elements is included in Appendix A.

Table 2
Elements advancing the use of robotics in care in each country.

Advancing elements	Germany	Sweden	Finland
Knowledge, and expertise-related elements	X	X	X
Elements related to people's attitudes	X	X	X
Co-creation, participation	X	X	X
Economic elements	X	X	X
Elements related to working-life	X	X	X
Elements related to political will and state-level interest		X	X
General shift in digitalisation	X		
Cultural elements		X	
Technological elements	X	X	
Elements related to new procedures	X	X	
Elements related to the network		X	
Elements related to seeing the benefits and possibilities	X	X	

5.3. Hindering elements related to the use of robots

What is hindering the use of robots in elder care in all the three countries is related in many cases to economic elements like the expense of the technology and the question who should pay for it. The poor financial resources of the public sector (Finland and Sweden) and the elder care facilities (Germany) was highlighted by the participants. It is seen as a problem that huge amounts of money are invested in technology development but because of the lack of financial resources, one cannot sell what is produced. A participant representing the end users in Finland said:

> For instance, robot seals for individual use are still expensive. There could be some kind of leasing opportunities. Also, the availability of some robots can be a problem.

There is also a lack of knowledge related to several issues: the technology itself, direct hands-on expertise with robots, contexts where the robots can be used, their benefits and legislation and regulation issues. Education seems to have also lagged behind; there is shortage of people in the care industry with adequate technological skills. Attitudinal elements were brought up in all three countries; there is resistance and lack of trust among care personnel, and they are not always willing to see the benefits of robots. There are fears that technology will reduce the need for staff and eliminate human touch for clients or patients, which is partly due to the lack of knowledge related to robots and their task capabilities. The busy work and slow change in the working habits and processes was mentioned as a hindering element. Related to working life, management and leadership issues were also brought up in all the three countries in the terms of commitment of management in using robotics in care contexts, prioritising needs and lack of participation by the care staff. Elements related to structural and societal renewal, meaning, for instance, the lack of mechanisms in establishing permanent activities after piloting, the lack of evaluating models and the shortcomings in mechanisms in coverage of the costs hinder robot implementation. Also, political motivations and decisions as well as variety of interests were mentioned as hindering issues.

In addition to these social-type issues, there are shortcomings in technology and product research and development; there are not enough fully developed products, and the current systems are not user-friendly and ready to be used, which hinders even the testing of the products. One German participant from a robot company said:

> Perhaps [there are] also technical reservations. It does not work yet, and no one, including us, wants to be the first one to try it out.

Table 3
Elements hindering the use of robotics in care in each country.

Hindering elements	Germany	Sweden	Finland
Economic elements (society-related & technology related)	X	X	X
Knowledge and education-related elements	X	X	X
Elements related to people's attitudes	X	X	X
Ethical elements	X	X	X
Elements related to work (or working-life)	X	X	X
Elements related to structural/societal renewal	X	X	X
Elements related to technology and product development	X	X	X
Elements related to political motivations and decisions	X	X	X
Elements related to users' capabilities	X		X
Elements related to governance structures	X	X	
Elements related to regulations and legislation	X	X	
Elements related to communication and collaboration	X	X	X
Elements related to existing physical structures (problems of integration)	X		

In addition to shortcomings related to single technologies or robots, there is also a lack of integration of technologies, which causes problems in terms of incapability of the information systems. Table 3 identifies the elements hindering the use of robots in each country. A more detailed description of the hindering elements is presented in Appendix B.

6. Discussion: interpreting empirical data in the context of socio-technical transition dynamics: landscape developments, regime destabilisation, niche activities, and futures

In all the three countries, while being quite advanced in the field of technology, elder care is a field that has been traditionally associated with human beings and a 'warm touch'. It can be noted that the ongoing megatrend of digitalisation and pressures to implement technologies in care seem to cause some uncertainty and threat for many people in relation to the human nature of care. There seems to be a shift where this care provided solely by human caregivers is moving towards care that is provided in collaboration between human caregivers and technologies, but the rules and practices for this division of work are still unclear. The landscape pressures, like demographic changes and productivity gaps, are often repeated as a trigger for this inevitable change towards the use of robotics. There is quite a unanimous view that robots will be part of the future of elder care, with even almost mythical talk that 'the robots are coming', but when, how and in which conditions, what it means in practice and what their place will be in the care context are still largely undefined issues that are raising discussions. In socio-technical terms, there seems to be several 'socio-technical negotiations' (see Akrich, Callon, & Latour, 2002b) inside the regime; the collaboration still seeks a pathway, and in general, there is much interest in robotics in elder care, mainly due to economic pressures, but attitudinal and other constraints exist as well.

On the basis of the interview data, we can say that we have studied a phase of transitions where an existing regime is somewhat destabilised due to landscape changes, and a window of opportunity for niches seems be about to open. Old models, where care is performed solely by human beings, are not working anymore because of landscape changes in demographics, economic pressure and the overall digitalisation of society. Acceptance of robots seems to vary in all the three countries, but generally speaking, attitudes seem to be more positive when people become accustomed to technology. Technology acceptance and usage originate from interaction with other people and the structure of practices they sustain and evolve through changes, rearrangements and readjustments of the elements that hold a practice together. These elements include objects, infrastructures, competences, images and meanings (Frennert, 2019; Shove, Trentmann, & Wilk, 2009). For instance, there seems to be some negative connotations to the concept care robots and an ambiguity in terminology, which may lead to misunderstandings or 'coloured' (distorted) information. Thus, communicating the multi-faceted understanding of robots is needed. Likewise, there are misconceptions and stereotypes related to users' attitudes and capabilities related to using robots, concerning both private and professional users. Receiving relevant information is crucial in increasing the acceptance of care robots (see Johansson-Pajala et al., 2019). In order to achieve successful deployment of welfare technologies, it is important to consider and readjust the elements of social practices, such as 1) goals, incentives and leadership, 2) infrastructure, organisational structure and collaboration and 3) economy and resources (Frennert & Östlund, 2018; Frennert, 2019). It also seems that some kind of hybrid actors, either individuals or organisations that are able to create interaction between the levels and knowledge fields, are missing (see Elzen, van Mierlo, & Leeuwis, 2012; Smith, 2007; Kivisaari, Kohl, & Leväsluoto, 2014). True co-evolutionary dynamics of technologies, users and institutions remains to be seen (Elzen, Geels, & Hofman, 2002, 2004; Foxon, Hammond, & Pearons, 2010).

There are plenty of experimental niche activities and piloting in the field of care robots, but the actual implementation is very limited. Deep-rooted experiences and established activities to implement care robots to services are still missing. In addition, it seems that experiments are quite distinct from each other, and there is not very much learning and accumulation of knowledge. This begs a question about the alignment of niches, which is needed to work on a broader breakthrough. There are societal/structural issues in effect here; due to discontinuities in funding, it is typical that after a project ends, there is no continuity regarding implementation despite promising results. There are also technological shortcomings, and partly because of a lack of practical experiences, technology is often believed to be more capable than it actually is, and there are fewer ready products commercially available than there is thought to be.

Considering niche-regime interaction, even though it seems that the window is more open to robots in elder care, there seems to be several confrontations to the regime, which are related for instance to care values, working practices, organisational issues, leadership, political intentions and things related to physical environment and infrastructure, which are not fully prepared for robotic technology. One point where the technology meets institutional practices in elder care is, for instance, the existing professions and job descriptions. The technology companies appear to drive the development, but introducing technology within complex administrative systems like elder care is complicated; several practices need rethinking, and therefore change is slow. Education in elder care apparently lags behind; there is a need to have at least basic skills so that technology would not go unused. The professionals entering working life are not sufficiently skilled for technology use. Gaining, for instance, very deep and specific knowledge of artificial intelligence is not needed in elder care education, but skills to communicate across the disciplines are important. Particularly, there is a huge need for knowledge related to the actual supply as well as user experiences and benefits. Systemic understanding about care robots and their impact on care work seems to be lacking.

Advancing and hindering elements in the use of robots are related to, for example, technological issues, attitudinal/cultural issues and structural issues, which are interrelated and affect each other. The question is about the maturity of technologies but also about the mindset issues that interact strongly. For instance, maturity of technologies and increasing reliability and user-friendliness of technologies increase their acceptance, which encourages people to try out new technologies. This, in turn, helps gain additional user experiences and improves usability. In socio-technical analysis, the relationship between the technology and the user is more than diffusion because technology and the social environment that adopts it, simultaneously shape each other (Akrich, Callon & Latour 2002a, [2002b; Bennett, 2012). 'To adopt an innovation is to adapt it' (Akrich et al., 2002b, 209). The innovation is transformed and modified according to the site where it is implemented through multiple socio-technical negotiations (Akrich et al., 2002b).

Implementation of robots affects work practices, which, in turn, often pressures technology modification and creates a need for a new division of labour between human beings and machines. All this interrelates, for instance, to societal structures and policies. The question is essentially about systemic change, where technologies, policies, markets, user habits and cultural meanings affect each other. This is in line with Bennett's (2012) notion concerning previous literature on transitions as long-term evolutionary processes, where – even where unmistakable benefits are available from a new technology – its uptake by users is often slow and faltering unless there is a good fit with the norms and expectations of users and with the prevailing socio-technical landscape.

Related to management, these issues are quite complicated, and the interviewees mentioned them both as advancing and hindering elements, depending on the level; the strong expectations for technology use from political and governing levels are advancing, but practical management related to technology use and, for instance, worker participation has been considered a hindering element. At the general level, it can be said that the situation is quite unstable because there does not seem to be a unanimous view about the level of education or the status of the political will, even among the interviewees in a single country. Referring to Geels and Schot's (2007) transition dimensions, the timing is particularly challenging; the disruptive niche is hardly mature, but the regime already comes under great pressure.

The advancing and hindering elements can be drivers for different future scenarios. This study provided an MLP-based analysis of present trajectories, while indicating some needs and practicalities along transition pathways towards future goals (see also Geels et al., 2020). In line with our approach of seeing scenarios as 'learning machines' (Berkhout et al., 2002), our results enable reflection on the realism of robot use in elder care and on how stakeholders relate to different future possibilities (McDowall, 2014). Fostering new insights on policy issues with the help of scenarios is considered important in the literature on the use of evidence in policy-making (Hertin, Turnpenny, Nilsson, Russel, & Nykvist, 2009).

While this study did not include writing actual scenario storylines, a core question arose from the data – what is the division of labour between humans and robots in care? General-level scenarios can be listed with the help of this question, based on the data, and the dynamic and turbulent situation that largely concerns the relationship between humans and technology/economy; as follows:

(1) human-oriented care, where robots assist just a little or in certain tasks, mainly on an experimental basis;
(2) care produced by humans and robots together; with smooth and well-defined division of labour, or
(3) technology-oriented care, where humans mainly act only as 'interpreters' and 'backup'.

The advancing and hindering elements identified in this study would, in these scenarios, function as drivers for weighting how the division of labour takes shape in the years to come.

Future research is, however, needed – informed by participatory processes (McDowall, 2014) – for more comprehensive scenario construction on care robot use in elder care, also at the national level.

7. Conclusion

We have studied the dynamics in elder care regime, which is experiencing destabilisation due to landscape level changes like the elder care 'crisis' and digitalisation of societies, but also noted is the remarkable inertia, deriving from old path dependencies and trajectories (discussed by Geels et al., 2020; Foxon et al., 2010; Bennett, 2012), exists, in both technological development and socio-institutional adaptation. In the current situation, there is a growing interest in using robots in care contexts, but the 'ground' is not ready yet in every sense. There is a shift towards using robots in elder care, but the place of robots in elder care and the collaboration between robots and human caregivers are still seeking their pathways; with several possible scenarios. There are integration problems and issues to be taken into account related to, for instance, knowledge and education, people's attitudes, ethics and human values, working practices and leadership, governance, regulations, communication and physical integration processes. Among advancing and hindering elements in transition, there are both technical and social ones that are related. For instance, immaturity of technologies is likely to hinder their acceptance and embedding into society. Inversely, for instance, user friendly design is likely to advance the embedding of robots.

The impacts of digital transformation and the development of technologies are challenging to foresee until technology is extensively developed and implemented. In practice, however, technology is constantly developing, and technologies can be seen as 'moving targets' (Frennert, 2019), making it important to understand the dynamics in this process – the mutual effects between technology and social practices – which is relevant when trying to understand the transition in elder care. Social processes influence technological and political processes, which in turn influence the meaning of technology as well as the needs and usage patterns among end users. User participation in the development processes and continuous dialogue between different sectors and levels of society are likely to increase the benefits of robotic technology.

This study shows that the situation related to care robots in society is turbulent and their use has not found its pathway. The change of attitude and embedding robots into society is promoted, for instance, by having and raising relevant knowledge of robots at different levels. The role of knowledge in socio-technical transitions could thus be a promising avenue for future research.

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Appendix A

Table A1

Table A1
Detailed description of advancing elements in each country.

Element	Germany	Sweden	Finland
Knowledge-related elements	-Information transfer and good studies -Public communication on the available technologies (spreading information) -Good consulting and information policy	-Skills and knowledge in health care and technology -The skills of health and social care, the technology and expertise in innovative approaches need to be combined -Young people are very digital -High level of education	-Enough understanding, 'right knowledge' -Education, which gives curiosity to gain new knowledge
Elements related to people's attitudes	-If there is acceptance, this promotes the use of care robotics	-'Outside the box' thinking: must dare to change traditional ideas about how care should be provided -Eagerness to test new things	-Attitudinal change: curiosity towards the use of robots
Co-creation, participation	-User-friendly design	-Participation of the users from the start, in the development of products -The users should clearly express their needs -Creating common areas/spaces for exchanging experiences and collaboration	Continuous participation (e.g., care workers) in the development work and in the acquisition of robots
Economic elements	-Nursing crisis: more people needing care and fewer nurses -Grant programs would be driver for the use of care robots -Market potential	-A budget for investing in technology in elder care would promote -Cost-effectiveness would promote use of robots -Special housing is expensive and there are too few places -Larger production leads to cheaper prices	-If there were enough offerings, the price could go down -Possibility to get funding -Shared robot acquisitions in regions
Elements related to working-life	-Gives more time to nurses to direct care	-Technology should facilitate the work -Courageous leadership is needed, and they need to be prepared to be questioned	-Shortage of staff leads to thinking about new models -If there were enough personnel, it could give time and peace of mind to think about robots -Commitment of managers -The ability of managers to look into the future -Issues on how users in the grass-root level can participated
Elements related to political will and state-level interest		-An indication of political will; strong expectation from the political and governing levels that technology will be used	-State-level interest, management and steering
Digitalisation as phenomenon	-The pressure for digitalisation, the general shift in technology		
Cultural elements		-Will of independence; not wanting to be a burden for relatives or having strangers in home	
Technological elements	-Ongoing technological improvements	-New products available -Good infrastructure, like well-developed internet	
Elements related to new procedures		-Change procurement procedures; from technical requirements to functions (what the robot should do)	
Elements related to the network		-Need of neutral actors who can be advised in investments -National department on digital and e-services is needed for developing templates for needs assessment -Well-functioning social networks	

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Table A1 (*continued*)

Element	Germany	Sweden	Finland
Elements related to seeing the benefits and possibilities	-Increased autonomy of those requiring care and the possibility to live longer in their homes -Support for family members and care personnel; relieving their workload (Robot could take over simple tasks, like reminding to take medication) -Good practical examples and positive experience -Initial positive experiences on very basic and simple tasks; possibility of building on these tasks. -Robots should have a defined set of tasks they are allowed to perform	-Benefits of technology, for instance, in increasing security	

Appendix B

Table B1

Table B1
Detailed description of hindering elements of robot use in each country.

Element	Germany	Sweden	Finland
Economic elements (society-related & technology related)	-Funding (the question who is paying for the use) -Financial resources of the facilities -Assumptions that the costs will be too high -Developing robots is expensive	-Expensiveness of technology -Municipalities' lack of money - No investment budget for technology in elder care (as there is in hospitals) -A great amount of money is invested in innovation and development, but one cannot sell what has been produced -Many companies go bankrupt and products disappear because there is no one who can afford to wait -Lack of investors	-Poor financial situation of municipalities and the state -The differing views of decision-makers on the things that should be prioritised when there is a lack of funds -The high price of the robots -The lack of integration causes expenses
Knowledge and education-related elements	-Prevailing knowledge deficit and lack of information flow -Lack of direct hands-on expertise with robots (relying too much on second- or third-hand information) -Unfamiliarity and uncertainty with robots	-Knowledge on technology, how to sell a product –Uncertainty about laws and regulations -People planning the care today have opted out of technology to work with people instead, in their career choices (related also to attitudes- > lack of interest and knowledge) -Shortage of people with technological skills, difficult to recruit	-Inadequate knowledge related to applicability and contexts where robots can be used -Inadequate knowledge related to the benefits of robots
Elements related to people's attitudes	-Staff resistance -Lack of acceptance from the caregivers -Not seeing the benefits and efficiencies -Fears of technology	-The staff's attitudes, awareness and skills to use the technology affect -Attitude against trying and seeing the benefits -Old attitudes about what a robot is -Reluctance to change -Not enough courage to introduce technologies to people and ask individuals themselves and not speak for others -The low status of elder care; not a place of traditional investment	-Not trusting the capability of the robot to care 'in the right way'
Ethical elements	-If technology is to replace the caregiver, it will slow down its acceptance -There is talk about replacing employees and inhuman care -People wish to have personal touch and care (at least the present elderly generation) -Fear of reduced social contacts and not having personal care; caregiver may be the only contact person	-There is a fear that technology will reduce the need of staff	-Suspicions from the ethical viewpoint towards the surplus value brought by the robot -Lack of knowledge is causing juxtaposition of ethically sustainable and non-sustainable care

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Table B1 (*continued*)

Element	Germany	Sweden	Finland
Elements related to work (or working-life	-The lack of staff in the facilities in care settings -The lack of preparation to use care robotics in workplaces -Caregivers' fear of losing their jobs	-The need of change working habits and processes -The slow pace of change in management -Poor leadership - Lack of participation and influence (for care staff)	-Busy work -Commitment of the management to the use of robotics in care
Elements related to structural/societal renewal	-Existing structural framework prevents the necessary investments in technology; insurance systems cover only a part of the costs for patients and families	-No models to evaluate the impacts of technology -Overlapping structures; no clear division of responsibility between the municipality and county councils, which cannot share technology costs -Compensation models for technology use are not developed (for instance, what compensation does the municipality get for a video visit compared to a physical visit) -Shortage of capital, financing and investment, from an entrepreneurial perspective -The trend that if not everyone can take part, no one should take part (in the technology) -Historic legacy of publicly financed sector that leaves Sweden behind	-Incapability of establishing permanent activity after piloting due to project-based funding for a limited period of time
Elements related to technology and product development	-Inadequate infrastructure, e.g., lack of fast internet -Technical limitations: problems with articulation, limitations on manual activities -The current systems are not ready for real-world use. All we have now is the spectra of models -The way robots look	-Lack of fully developed products that can be implemented -Systems are not communicating with each other; better standards needed -Some products in the market that are not user-friendly and functional -Little research in care technology, compared, for example, cancer or heart diseases -Private companies see their tests as business secrets and do not share what they do -Lack of digital infrastructure	-Lack of integration of technologies -Technology gets old quickly -Problems of availability of technologies and a lack of options for acquiring, for instance, leasing options
Elements related to political motivations and decisions	-Use of robots is politically undesirable	-Poorly anchored political decisions	-Varying interests among political decision makers
Elements related to users' capabilities	-Cognitive limitations of older people		-Incapability to use technologies causes anxiety for the user and the benefits do not reach the full potential of the technology
Elements related to governance structures	-Structure of health care system (based on a different tradition; robotics is only a topic of recent times)	-Municipal self-government may hinder the procurement of systems	
Elements related to regulations and legislation	-Uncertainty about liability issues -Data misuse	-Requirements of technology and security -Law-related obstacles; the law is outdated -Legislation is not adapted to today's technology use -Too much legal interpretation	
Elements related to collaboration and communication	-Lack of information flow -Lack of transparency; implications must be communicated so that the need can be accurately determined -The name 'robotics' is off-putting -Lack of transparency in existing projects (it is always the case when something new is introduced) -Lack of follow-up/aftercare	-Shortcomings in collaboration on digitalisation; several actors test the same solution, but knowledge is not shared and does not accumulate -The companies find it difficult to get in touch with the care providers, therefore they cannot create suitable products -Lagging behind in networking -Each municipality cannot have their own solutions but need to share -Lack of systematic exchange of experiences -Difficulties or passiveness in expressing what is needed in care services -Speaking for others instead of talking to those who has the need (older people) Challenges in acquiring: how to control the user-friendliness, updating, licensing and up-grading the products -There are over-trials in procurement which halt the process -The threshold for purchasing and procurement is not adapted for innovations -Procurement and decisions take so long that technology will be outpaced.	-Organisation of procurement processes, prioritising technology needs

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Table B1 (*continued*)

Element	Germany	Sweden	Finland
Elements related to existing physical structures (problems of integration)	-It is difficult to embed technologies in existing structures and physical spaces		

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