ROBOTS AND THE DELIVERY OF CARE SERVICES

What is the role for government in stewarding disruptive innovation?
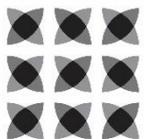
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EXECUTIVE SUMMARY

In the last two decades there has been significant reform in terms of what governments do, and how they work, as a result of the digital revolution. In some areas, governments have embraced these technologies and worked to enhance their effectiveness and efficiency. However, there have also been many cautionary tales of what can go wrong when technologies are inappropriately adopted or unintended consequences have emerged as a result of introducing disruptive innovations.

This report focuses on one particular area of technological development – robots – and their governance. It explores the roles that robots should and, even more critically, should not play in care delivery, and the role that government has as a steward in shaping these roles.

The importance of definitions – what is a robot?

One of the first findings of our study is a lack of clarity about what is, and is not, a robot. This exists in the literature and was echoed in the empirical research. This lack of clarity is potentially prohibitive to the creation of effective governance and regulatory structures for disruptive technologies in the robotics space.

For the purposes of this research we have defined a robot as something that has a *physical embodiment* beyond a projected avatar. This excludes tablets, phones, screens, or agents mediated by these, no matter how intelligent or realistic. A robot for our purposes also needs to have *a degree of autonomy*, even if this is relatively low-level.

What do robots do in care services?

Despite large amounts of media attention, the field of robotics in care is, in fact, nascent. As yet there has not been a strategic approach that has sought to consider the roll-out of robots in care services. At present there are only a limited number of potential applications that robots can undertake within home and residential care settings due to technological limitations, although this looks set to increase in the near future. The greatest current area of application for robotic technologies is facilitating social interaction.

Drivers for adoption of robotic technologies

The research identifies a number of drivers for adoption of robotic technologies, including changing demographics and shifts in workforce and workforce needs. Those operating in an aged care context were often particularly attuned to the fact that we are moving towards a larger and older population mix. Robots are also seen as a way to potentially enhance services. This enhancement was described in terms of both the delivery of services and also the regulation of relationships between carers and those they are caring for.

For businesses operating in care spaces, robotics offers the potential for efficiency gains. There is potential to cut costs in staff wages, if their roles are fully or partially replaced by robots, but robots can also reduce risk and injury claims and basic maintenance tasks. However, to get a return on investment in these new technologies, organisations typically have to wait five to seven years.

Finally, robotics was seen as way to differentiate services and potentially grow market share.

Positive and negative impacts of robotic technologies

Robots can do things that humans do not necessarily want to do. They can handle materials that are hazardous to human carers. Additionally, robots are able to undertake repetitive activities that humans may find less enjoyable. This includes, for example, repetitive interactions or conversations which can be challenging or monotonous for busy carers.

Robots are impartial, non-judgmental and can consistently deliver information in a predictable manner. Importantly, this benefit was often felt by both carers and those being cared for. Robots are less likely to abuse the person they are caring for, in comparison to the potential risks of this associated with human carers. Robots are immune to the psychological wear of a busy or frustrating workload.

Social robots and the impact of robotics on social interaction is an area of growing interest and in some cases concern. Developing a relationship with a robot was seen to be a way in which loneliness might be combatted. For some the impact of the robot was not necessarily found in the relationship between the individual and the robot, but in facilitating relationships with other humans.

However, there is concern over robots not yet being sufficiently tested in care settings, and the potential unintended consequences that could emerge with the introduction or expansion of these technologies. In particular, robotics raises questions around accountability and surveillance that have not yet been thought through. A host of legal issues could emerge from the use of robotics where it is not well established where responsibility ultimately lies.

Roles for government

The research sought to explore the critical roles governments can, or should, play in stewarding robotic technologies particularly in care settings.

One of the major roles is regulation. This is generally seen as a rather complex role that has a number of different facets to it; in terms of helping to regulate the market through creating a strong evidence base, developing standards, protecting data and privacy, and protecting the workforce. However, one thing that is clear across all these areas is that work is needed to change current regulation, as technology is developing so quickly that is outgrowing some aspects of practice. Critically, interviewees argued that we need governance and regulatory structures that do not attempt to presuppose the problem. We suggest that a responsive regulatory approach is most appropriate. This approach relies on actors to self and peer regulate, and escalate issues as they arise upon which governments can implement regulatory efforts of different strengths

There is currently a gap in government-led systematic thought in the area of care robotics. A role for governments is therefore outlined in terms of leadership of this space. Such a role would involve helping to support providers to understand the different technologies available and their evidence base. Many of the stakeholders we spoke to see a role for government around helping to generate an evidence base that is accessible to providers. This was seen to be important particularly where technologies may have been tested, but in a different national context.

Finally, governments have a responsibility to ensure that vulnerable populations are protected within the context of new technologies. Our research indicates that the potential impacts of technologies on particular groups or individuals are far from being clear cut. There is therefore an important role for governments in terms of upholding the social contract.

Where to next?

Overwhelmingly our research found respondents envisaging a strong role for government in terms of stewarding these technologies. Involvement of different levels of government is seen as being essential to the success of robots in care services. Based on the research presented in this report we argue that there is a need to:

(a) Develop clearer definitions of robotic technologies that are more nuanced and can guide effective legislative and regulatory frameworks

(b) Develop capability and capacity within governments regarding the potentials and challenges of different forms of technologies

(c) Develop responsive regulatory responses to robotic technologies that engage a wide range of stakeholders

(d) Develop stewardship frameworks more broadly, whereby governments assist in the collation and dissemination of evidence, identify opportunities and potential harms and ensure appropriate governance.

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TABLE OF CONTENTS

INTRODUCTION

Technological change and disruption to existing systems and processes posed by innovations have been a challenge for governments and public servants for as long as these institutions have existed. In recent years, we have witnessed significant reform in terms of what governments do, and how they work, as a result of the digital revolution (Veit and Huntgeburth 2014). In some areas, governments have embraced these technologies and have significantly enhanced their effectiveness and efficiency (Gil-Garcia 2012). Yet, the literature is also paved with cautionary tales of what can go wrong when technologies are inappropriately adopted or unintended consequences have emerged as a result of introducing disruptive innovations (Fishenden and Thompson 2013).

Many countries are presently experiencing significant changes in relation to care services (Carey et al. 2017). Groups in receipt of care services are increasing in numbers, becoming older, have greater levels of disability and chronic illness and higher expectations about the quality of services that should be delivered (Glasby and Dickinson 2014). At the same time, care service providers are finding it increasingly difficult to recruit an appropriate workforce (Australian Government Productivity Commission 2017). There have also been, sadly, a number of reports of individuals being abused by care workers, most recently illustrated in the announcement of a Royal Commission into the quality and safety of aged care services. Advances in technology have begun to offer a potential solution to these twin demand and supply-side pressures, through the development of robotics.

Robots are increasingly becoming a feature of our care services. Furthermore, education plays an important role in preparing a workforce with the necessary technical skills mix, as well as equipping individuals to live and work alongside these technologies. In this research we explore this phenomenon broadly across a range of care sectors including: health, disability, aged care and education services. Our aim is to examine how robots are being used across different care settings, the challenges that the implementation of these disruptive technologies creates and to begin to map out the future role of government in overseeing new technologies.

Although there is a burgeoning literature on the topic of robots in social and care settings, the majority of this commentary and empirical evidence tends to revolve around their technical efficacy, their acceptability to consumers, or the legal ramifications of such innovations. There remains a serious lack of attention within the public policy and public management to the actual implementation of robots in care settings.

This study explores the roles that robots should and, even more critically, should not play in care delivery, and the role that government has as a steward in shaping these roles. In doing so, we draw on interview data from 35 stakeholders across government, academia and technology providers. We argue that, to date, insufficient strategic thinking has been committed to the use of robots in care services from a government perspective. This is problematic because there are a range of potential unintended or unanticipated consequences that might flow from the use of these technologies. We conclude by setting out a number of roles that government should play in stewarding these disruptive technologies.

In setting out this line of argument, the report is structured as follows. In the next section we set out the background to the research, identifying the gap in the literature and defining what we mean by a robot. We then move on to set out the aims and objectives of the research and the method adopted. Following this, we set out the findings from the project illustrating particular themes including: the need for a common definition of robots; what robots do in care services; drivers for adoption of robotic technologies; positives and negatives of robot technologies; considerations when introducing robots; future applications of robotics; and, roles for government. In the discussion that follows we argue that close attention needs to paid to the ways in which we think about care and how robot tools fit within care models. This is followed by the conclusion for this project where we set out the research gaps that exist in this space.

Background

In recent years, we have seen significant attention being paid to what are collectively known as Fourth Industrial Revolution technologies. This category includes artificial intelligence, 3D printing, virtual reality, nanotechnology, quantum computing and a host of other digital and physical technologies (Schwab 2018). In the context of care services, robotics has started to take hold in recent years. Robots are already used in a number of ways across different care services and there are promises that there are many more applications to come.

In some areas these technologies will have positive impacts, creating efficiencies and enhancing effectiveness, quality and safety (Australian Centre for Robotic Vision 2018). Yet, as the Australian Human Rights Commission (2018) notes, 'like any tool, technology can be used for good or ill…modern technology carries unprecedented potential on an individual and global scale. New technologies are already radically disrupting our social, governmental and economic systems' (p. 7). New technologies are therefore a double-edged sword; offering significant advantages, but with potential misuse or unintended consequences that need careful consideration so that such developments do not negatively impact particular groups.

In the academic realm, there are many papers dealing with robotics in manufacturing and engineering (e.g. Michalos et al. 2015, Polygerinos et al. 2017), law (e.g. Calo 2015, Richards and Smart 2016), ethics (e.g. Sparrow and Sparrow 2006, Coeckelbergh and Stahl 2016) and medicine (Moyle et al. 2017, Broadbent et al. 2016). Yet, to date, there has been little consideration given to this within the public policy and public management literatures.

Indeed, Pollitt (2016) argues that outside of considerations of e-government, public management scholars have given insufficient attention to many aspects of technological change. As such, we lack a deep understanding of the implications of these changes and what the role of government is in relation to stewarding technological innovation. This exploratory project aims to fill at least part of this gap, examining an area that is of current and future interest to governments in Australia and New Zealand. In this project we explore the use of robots across a range of different care settings. We are interested in the public policy and public management facets of these disruptive technologies.

In setting out the background to this project it is important that we define the key term that we interrogate through our research. At present, the precise definitions of robot technologies are often conflated, and not well-understood. Without a common semantic toolbox, regulators, lawyers, ethicists, health experts, and technologists are in danger of mischaracterizing the capabilities and responsibilities of both present and future technologies. In particular, understanding the potential for both use and abuse rests upon a sound and agreed-upon set of definitions.

What is a robot?

Robots and Artificial Intelligence are becoming increasingly important technologies in the delivery of care services. A whole range of different applications have already been developed and many more look likely to appear in the near future.

Many different things are referred to as robots in everyday language, capturing the broad array of these technologies. Consequently, van Wynsberghe (2015) argues that 'robots may be one of the most difficult technological innovations to define' (p. 39). The term robot was originally coined by Karel Čapek in the play R.U.R in 1920 and is drawn from the Slavonic word *robota* which means forced labor. Since its earliest conception, the word 'robot' in the popular imagination has entailed some degree of autonomy and intelligence. However, it is only recently that this vision has moved from science fiction to reality.

The term 'robot' thus encompasses machines that undertake the most mundane of automated tasks, and increasingly, ones capable of learning and adapting to their environment. The issue of autonomy – or agency – is one that is important in defining robots. Richards and Smart (2016) define a robot as 'a constructed system that displays both physical and mental agency, but is not alive in the biological sense' (p. 6). Leenes and colleagues (2017) argue that key to the definition of a robot is its ability to execute a program (software) in order to carry out specific tasks – however complicated or complex this might be. For Thrun (2004), robots are autonomous entities that can complete tasks without direct human input. Importantly, robots 'have physical embodiment (they are not virtual characters), can act in their environment based on information they have sensed, and they have some range of automation' (p. 11).

The characteristics of today's robots vary widely and we arrive at different definitions depending on the class being discussed or the application area (Siciliano and Khatib 2008). This is illustrated by Leenes et al (2017: p. 4) who consider five dimensions of 'roboticity', namely:

1. *Nature* – the material in which the robot manifests
2. *Autonomy* – the level of independence from external human control
3. *Task* – the application or the service provided by the robot
4. *Operative environment* – the contexts of use
5. *Human-robot interaction* – the relationship established with human beings.

Although this schema does not help in defining the scope of what constitutes a robot *per se*, it is helpful in delineating between different forms of these technologies.

For the purposes of this research we have define a robot as something that has a *physical embodiment* beyond a projected avatar. This excludes tablets, phones, screens, or agents mediated by these, no matter how intelligent or realistic (excluding, for example, CareCoach and the Centrelink 'Robot-debt' program). A robot for our purposes also needs to have *a degree of autonomy*, even if this is relatively low-level. Here we exclude robots that operate with a 'Wizard-of-Oz' interface, where the robot is actually being fully or partially operated by an unseen human (this would, hence, exclude many or most surgical robots).

Having set out some of the key factors in terms in the background to this research, we now move on to set out the aims and objectives in more detail.

Aims and objectives of the research

This research explores the implementation of robots in care services, considering issues relevant to the roles that robots and government should play in this context. We sought to explore the roles that robots should and, even more critically, should not play in care delivery and the role that government has as a steward in shaping these roles. This project is exploratory in nature, and is relatively small, exploring the issues where there is a significant gap in the existing evidence base. To this end, the specific questions that underpin this project are:

• What roles should robots play in care settings?
• What roles should robots not fulfil in care settings and should remain the preserve of services delivered by humans?
• What role should different levels of government play in stewarding these disruptive technologies?
• What might be some of the implications of the implementation of these disruptive technologies?

In the next section we move on to set out the method adopted in this research to explore these questions.

METHODS

Before undertaking the research project, we sought ethical approval from the UNSW Human Research Ethics Committee (HC171025). As outlined in the previous section, this project is exploratory, seeking to fill a gap in the extant literature. As we sought to explore the various perspectives of different stakeholders, a qualitative approach to research was adopted making use of semi structured interviews for our method (Low 2013). Semi-structured interviews are typically used to gain a detailed picture of a respondent's beliefs or perceptions of a particular topic area (Smith 1995).

A purposive approach to sampling was adopted to identify interviewees (Palinkas et al. 2015). We sought to engage a range of experts from roles in policy (at different levels and different areas of care provision), provision of care services, academics and other expert commentators in the topic area, technology suppliers and across Australia and New Zealand.

As we will discuss further in the findings, identifying and engaging relevant policy makers to interview posed somewhat of a challenge. We approached a range of departments and agencies who oversee relevant care spaces (e.g. health, disability, education, social services, industry and innovation). A number of those agencies and departments that we approached were unable to offer interviewees with the relevant experience and knowledge for us to speak to. We adopted an initial approach that identified relevant organisations through interaction with experts and through searches of media and research documents to identify examples of robot technologies that are in use in Australia and New Zealand.

In total, 35 interviews were conducted with a range of different stakeholders (see Table 1). Interviews lasted between 30 mins and 90 minutes and were recorded and transcribed verbatim. After Kallio et al (2016), we developed an interview schedule that covered issues such as: where robots currently being used; advantages and disadvantages of robots; considerations when introducing robots; future roles for robots; and, role of government in overseeing robots.

Table 1: Interviewees by background

Organisation	Number
Academic expert/Expert commentator	12
Provider of care services	5
Government department/agency	13
Supplier of technology	5

Data were analysed using a thematic approach (Blaikie 2010) in NVivo. 'Like' data were grouped together to form categories and subcategories. These categories were developed into more substantive themes, by linking and drawing connections between initial categories and hypothesizing about consequences and likely explanations for the appearance of certain phenomena (Strauss 1987). All authors were involved in developing initial themes, with Helen Dickinson and Catherine Smith revisiting transcripts to further explore linkages and connections between the key issues being explored and other themes.

In the findings sections that follow, quotes are from interviews are reported to illustrate the points the points being made. In accordance with our ethical approval, quotes are not ascribed to individuals and are simply labelled according to the country that the individual primarily works in (e.g. AU01, NZ03).

FINDINGS

As alluded to in the method section, on the whole we often experienced difficulty gaining access to public servants to speak about robotics. A number of potential interviewees declined the opportunity to take part in the research as they felt they did not know sufficient amounts about the topic area to be a useful informant. A number of different state and territory government agencies informed us that they believe that robotics are important and figure in the future plans for their work, but they do not have an individual who is sufficiently knowledgeable to speak to us about this issue. Other agencies agreed to be interviewed for the project as a way of finding out more about robotics, explaining this is a gap in their existing knowledge base.

In some cases, we were directed to providers of services or to individuals involved with particular case studies or examples of the use of robotics in broad care services. This was helpful in terms of providing insight into the ways in which, for example, PARO is currently being used in aged care services (see Box 1), Kaspar in care of children with autism (see Box 3) or Pepper in library education programs (see Box 2). However, this gave us fewer insights into some important policy issues or ways of thinking about the stewardship of robotics from a more macro-level perspective. This also suggests that some public service agencies are yet to engage in the type of strategic thinking about these technologies that will eventually be needed.

The need for a common definition of robotics

As suggested in the background to this report, there are a number of different kinds of technologies that sit in and around the robotics arena and there is the potential for a number of different kinds of technologies to be conflated with one another. This was an issue that was keenly in the mind of a number of those we spoke to for this research. As one interviewee commented, 'I think you're going to find it difficult with this research just because there's so much out there and there's so many ways of using the technology and robots for that matter, or potential applications for robots' (AU01). Another respondent echoed this asking, 'where do robotics start and finish' (NZ02). Another explained that this is important because of the various applications and impacts that these technologies have. For example, 'I try to be very specific with the technology type and version. What I notice is people just say they've tested PARO; well, there's whole lots of different versions of PARO. They all work quite differently' (AU14).

Hence, our observations of the literature and media were echoed in the qualitative interviews. Interviewees identified that definitions of robots are important and that we need some sort of consistency in terms of how we speak about these entities and how they differ from others. Legally a number of robots are classified as toys for the purposes of importation, but are then used as tools of care. To some extent this is not particularly concerning, although there are different expectations in terms of safety and evidence base for these products.

As one commentator argued:

> *My point here is in order to get policymakers engaged, we need to give them a topology or a classificatory system of what we are talking about. I mean I even found having to explain what AI was to policymakers meant walking them through the difference between data, algorithms, machine-learning, sensing, reasoning, action and ethics. All of those things fit under the label of AI but you need to be really specific about what you mean and the problem with robots is the same right. We can say that a PARO is a toy but in fact it's wasn't built to be one so that's actually – it's a robotic object, so how do we decide what is toy? I mean I know people who use Roombas and play drinking games with them. Does that make them a toy or still a vacuum cleaner? (AU04).*

There are some attempts underway to re-classify some of these technologies. PARO (see Box 1 for an overview), for example, is classified as a medical device in the US and there is an aspiration for a similar status in Australia. Not only

does this process give the technology a different status, but it also means that some individuals may be able to seek subsidies from the state to purchase these.

What is clear from the interviews with various stakeholders is that there is yet much to learn about robotics in policy circles if effective policies are to be developed. Many of those we spoke to suggested that this would involve starting from a relatively low base. A number of people do not fully understand the different types of technologies and how they differ from one another. As such, there is a need for some sort of taxonomy or classification system that sets out the different types of technologies and how they relate to one other and is easily accessible to public servants.

What do robots do in care services?

Although we uncovered a range of robots in use in care services, the field is relatively nascent at present. As yet, there has not been a strategic approach that has sought to consider the roll-out of robots in care services. Therefore, it has typically been at a local level that providers have decided to adopt robotics technologies and in the next section we provide an overview of some of the drivers for those decisions. Before this, we provide examples of where robots have been used in different facets of care services and provide case studies of those technologies that had gained particular traction for a number of our interviewees.

In aged care we uncovered several current applications. One organization described using a robot to help take regular readings from residents: 'We had a robot, so a standing robot sitting out in our reception out in the foyer…and you'd put the Pulse Oximeter on and the blood pressure cuff on and it would talk to you and stuff like that. It was actually really cool and residents would go and sit down and do it themselves' (NZ01).

However, at present, there are only a limited number of potential applications that robots can undertake within home and residential care settings due to technological limitations. The greatest area of application of robotics technologies is actually the important role that robotics can play in facilitating social interaction: 'I think telepresence robots are crucial to our particularly Australian environment, because we have people in both nursing homes and also the community who don't get to see other people. So there is opportunity to be able to connect people with their family, and also with their community' (AU14).

For individuals with cognitive impairment of some form, therapeutic robotics can play an important role in engaging and calming. One of the robots we found mostly widely used is PARO, which fits into this category. Box 1 provides an overview of this technology.

When asked about robotics, many of the types of technologies discussed by individuals were not necessarily those we would describe as robots according to our definition set out above. Many of those we spoke to described use of online services for social interaction or the use of sensors in homes combined with monitoring equipment that are being used to support individuals to live independently. These are not further discussed in this report as they do not meet the definition we have adopted in this work, but this does illustrate the difficulties in isolating particular technologies in discussions and the lack of definitional clarity in the field despite the rapid expansion of technology. While not a robot according to the definition we have supplied, it is important to note that the reality is that many of these different forms of technologies are connected in important ways and robots may incorporate many elements from other technological innovations.

Box 1: PARO

PARO was developed by a Japanese company as an advanced, interactive robot. It built on an evidence base that demonstrates that animal therapy can be highly beneficial to particular patient cohorts. For various reasons (allergies, potential endangerment of animal/individual), live animal therapy is not always possible within care settings. PARO was developed as an option for use in environments such as hospitals and extended care facilities where live animals present treatment or logistical difficulties. PARO's physical appearance resembles that of a harp seal and it makes sounds similar to a baby harp seal. It has five sensors that are processed by machine learning software that allow it to respond to individuals and its environment. PARO interacts by moving its head, heavily-lashed wide eyes and flippers, making sounds and responding to particular forms of touch on its furry coat. PARO has been used extensively in aged care in the US, Europe and parts of Asia, typically with individuals living with dementia. It is argued that PARO can help to reduce behavioral and psychological symptoms of dementia and reduce the use of psychotropic medications, although the evidence of this is not entirely agreed upon (Moyle et al. 2017). PARO has also been used with children with autism.


Image provided by Kowa Australia Pty Ltd

Many of the examples we have provided so far have largely been aimed at users of aged care, but technologies are also being introduced that seek to reduce burden on staff within these settings. For example, MiCare has introduced autonomous mobile robots in aged care settings to undertake meal delivery, collect dirty linen, deliver clean linen and distribute medical and housekeeping supplies (Stoyles 2017).

In education, one of the issues that interviewees spoke about is the availability of a number of different types of robots. Some we spoke to expressed concern over the degree to which they understood the clear differences between these in terms of applications. Others described having to do some significant work to uncover which robot might be most effective for their particular context: 'different tech schools have chosen different routes for different reasons' (AU18). Students constructing robots may do so in response to a set of instructions in one school, while another school may be creating a problem to solve where the design and construction of the robot is part of the solution. Yet other schools may be teaching the students the coding required to have the pre-built robots perform tasks. In addition to this work, which positions students as creators and controllers, other schools are using robots as a tool to engage students in other learning tasks. Students work with robots in different ways has the potential to position their approach to technologies in the future in different ways (Genova and Gonzalez 2017).

Robots are being used as a teaching aid at school and university levels. One respondent spoke about using a robot in the context of undergraduate teaching. The robot being used is seen as a helpful way to engage students in the subject matter and the interviewee believes that this is particularly effective for international students: 'So for two years now all of my entrepreneurship projects, even the music stuff, the robot plays the drums, right, so whatever spaces I try to take them into for that reason, so to get them to engage…so he's this inanimate thing… not threatening. So there are other purposes for him as well, which is like an engagement strategy at a different level I think' (AU06).

Box 2: NAO and Pepper

NAO is an interactive companion robot developed in a humanoid form but standing just 58cm tall in height. NAO has gone through a number of different iterations and has been used for a variety of different applications worldwide from performing synchronized dance routines, being the robot of choice in the RoboCup, as a lab assistant, doing stand-up comedy, to help children engaged in paediatric rehabilitation (McCarthy et al. 2016), and in various educational and research institutes (ET Staff 2016, Gurney-Read 2014, Mubin and Ahmad 2016). NAO is fully programmable and can walk, talk, listen and recognise faces.
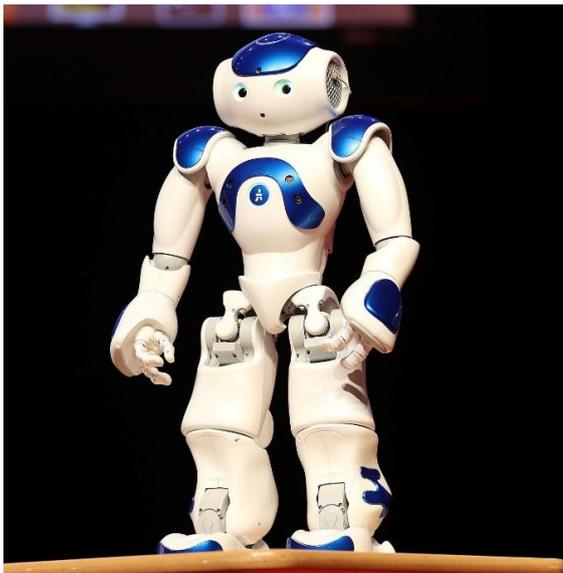
Pepper was developed as a semi-humanoid robot that has been used principally in shopping centres, airports and banks as a way of welcoming and informing customers. Pepper is capable of recognizing human emotions through analyzing expressions and voice tones and adapting its behavior to these. This robot was developed principally 'to make people happy', facilitating relationships and connecting individuals with the outside world. The company who developed Pepper also make it available as a research and educational tool for schools, colleges and universities to help teach programming and conduct research into human-robot interactions. Pepper is also currently being used in the Dudley Denny City Library in Mackay. Pepper has been taught to dance, play games, share historical stories with library attendees and is a part of the library's STEAM program (Tatham 2016).

Image of NAO by Yves Tennevin - CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=52269556

Image of Pepper by SoftBank Robotics Europe - CC BY-SA 4.0, https://commons.wikimedia.org/wiki/File:Pepper_the_Robot.jpg

Another interviewee spoke about the ways in which robots can be used to help maintain teacher-student relationships: 'So, if the robot is an impartial … thing in the classroom… then it's not the teacher struggling with the child; saying, no, you need to put that away now, we're doing this. So, that means that the interactions between the child and the teacher can simply be around the learning and not around the logistics around the learning; give those over to the robot and then that could potentially improve the relationship between the autistic child and the teacher, which is only going to make learning easier and all the better anyway' (AU09). As the previous quote emphasizes and we will pick up in more detail below, many of the applications of technologies in the learning environment are focused not on replacing teachers, but augmenting what they do to make these professionals more effective. Box 2 sets out two examples that have been used in broad education environments – NAO and Pepper – and both are owned by the same organization (SoftBank Robotics).

Many of the uses of robots in education spaces are inclusive of classrooms, although some also have particular applications in the disability space. Robotics are much spoken about in the context of the delivery of services to young people with autistic spectrum disorders. Given some of the challenges that individuals with autism face in terms of social interaction, robots have been used as a way of more effectively teaching and engaging in different activities. An interviewee explained why robots are particularly helpful for these groups:

> *a lot of the autistic children have anxiety issues or sensitives, sensory overload, when they interact with humans, there is judgement, there is unpredictability, there is some sort of fear which is connected through the anxiety. So robots are – physically speaking they can be smaller, simpler, and can provide less sensory overload to children to start with. They're predictable, they create repetitive behaviours which are coming up for the children…they are patient, and they can repeat everything without getting upset so they don't angry, they don't transmit their own emotion, they don't come with baggage that changes the interaction. They interact exactly the same day after day if we want them to. All of that means that – a combination of that means that the children feel more calm, feel better to interact with the robots than with a human (AU13).*

Box 3 provides the example of Kaspar, a robot designed to be used with children with autism.

Box 3: Kaspar

Kaspar is a child-sized humanoid robot developed in the UK to act as a social companion to improve the lives of children with autism and other communication difficulties. Kaspar has a flesh-coloured face, but no facial hair or additional details such as wrinkles. It has a neutral expression, is not specific to any age or gender and so children can interpret Kaspar however they wish. The appearance is human-like but slightly unusual as the features have been simplified to appeal to children with autism. Kaspar is currently undergoing a number of trials around the world (Huijnen, Lexis, and de Witte 2016), including a study between UNSW and CSIRO (Miller 2018).

Image provided by the Adaptive Systems Research Group, University of Hertfordshire, UK

This section has provided a brief snapshot into some of the different ways in which robot technologies are currently used across a number of care services. We now move on and consider the drivers for the adoption of these technologies.

Drivers for adoption of robotic technologies

One of the issues we sought to cover in this research was what respondents saw as drivers of these technologies; this might be as someone engaged in making policy or adopting these locally within a particular service area. Below we consider a range of the different drivers that interviewees spoke of including: shifting demographics and workforces; service enhancement; driving efficiencies; differentiation through innovation; and, networks and relationships. In illustrating these drivers what becomes clear is that in deciding to embrace robotic technologies there is rarely one driver for this, but more often an accumulation of several.

Changing demographics and workforces

Those operating in an aged care context were often particularly attuned to the fact that we are moving towards a larger and older population mix, which will lead to increased demand for these services. As one interviewee describes, 'I guess the anticipation with a lot of that talk is this sort of massive influx of baby boomers going into the aged care system, in a system that's already stretched. I think that's really what's driving it' (AU01). Several interviewees noted this was a significant issue that governments have a particular mandate to try and address given the impact it might have on multiple different systems:

> *Listen, I think government's always got a role to play … We know that we've got a … larger population that are ageing …We also know that because longevity has gone up, certain chronic conditions are more present in the population than they once were, notably dementia, Alzheimer's, cognitive decline …You have to imagine that there is a coming crisis and pressure put on these systems and how do you manage that? I think it's safe to say we know that in multiple countries around the world, governments are having to think about how do they manage burgeoning medical costs, care costs, that sector of the population. So if you thought that was a genuine emergent crisis … what do you need to do about it? Well you need to start thinking about it differently. (AU04)*

The main area that individuals expressed concern around supply in the context of aged care services is in relation to the labor force. As one New Zealand respondent explains:

> *So there are not enough carers …. you can see this across a lot of disciplines. It happens in farming. It happens in forestry and it happens in meat processing and it happens in factory manual labour. These days, there aren't enough manual labour and people don't want to really do it …There is a labour shortage and that – we think that's increasing around the world. As China gets more wealthy and maybe the same thing will happen in other places. Then cheap manual labour won't be so readily available. It's not very ethical either, the cheap workers working 12 hours a day in a factory ... So manual labour is a problem, certainly in older care it is. In New Zealand we're importing carers and nurses from the Philippines, for some years. It's not highly paid. It doesn't do us a lot of good in terms of economically for the country. I think technology has a role to fill that gap and the labour workforce and can help people with things that humans are not so much going to do. (NZ05)*

As this respondent outlines, aged care is not the only space seeing a reduction in a willing and qualified workforce. It is increased demand for certain sorts of roles – those that are repetitive or perceived as mundane in some way – that are looking to be filled by these technologies. Looking to the future to test out possible model of care enhanced by robotics was certainly a driver for one aged care provider that we spoke to: 'Because we like challenging the status quo and looking at the future, but also we know that there's not going to be enough people around to look after the number of older people who will need support. Testing robots seemed to be a good idea at that time, but it also fits the agenda that we've got to support research in aged care (NZ03)'.

Enhancing services

While media often emphasizes potential efficiency gains in adopting new technologies, for many we spoke to, the ultimate aim of engaging with robotic technologies is a desire to enhance the services that individuals access and therefore the quality of their experience. 'This is a common thread with all the products. They're very different but

they're all looking at enhancing the human experience if you need to work with something or incorporate something that is outside of your body and technological' (AU15). This enhancement to services was described in terms of both the delivery of services and also the regulation of relationships between carers and those they are caring for. One interviewee described a robot that was developed to monitor caring relationships for individuals with early stage Parkinson's. In these caring relationships it is argued that caregivers are not always able to perceive an individual's emotional state and the robot acts as a co-mediator in the transmission of this information through the use of artificial moral emotions (Arkin, Scheutz, and Tickle-Degnen 2014). They went on to explain: 'The real driver for us was, how can we preserve dignity in this relationship? When someone is mistreating someone else – and they may not even know it, is the other thing. The care giver isn't deliberately mistreating this individual, they just don't even know that they've gotten to that particular state. So, how can we manage that in a way where both will be better off, ultimately. That's the primary driver (AU08).'

In the context of education, the enhancement on offer was described in terms of supporting students to develop a different way of thinking: 'What's important to us in ours is that we want our students to develop what we call an innovation mindset. To be able to look at problems and formulate strategies to address them. So, we are probably not so much interested in fleshed out products as much as prototypes. We want students to be prototyping and testing and making sense of things' (AU18). What was important to this educational leader is equipping students to solve problems, which may in turn make use of different technologies. However, this is not solely driven by a specific technology (e.g. robotics), but as a way of helping students to think about situations differently.

Driving efficiency

For others, robotics is being used as a way of driving efficiencies and cutting costs. As one interviewee explains:

> *it's service enhancement but it's not- we're not doing this to improve, no one can make the sale, hey deal with this piece of machinery because it will enhance your experience in this aged care facility. The implicit thing is that, well it's going to cut cost and make things cheaper, it's going to cut cost with regards to OHS claims, it's going to cut cost with regards to repainting the walls because staff are banging their trays against the walls, and if you own a campus that really amounts to quite a bit. (AU01)*

As this interviewee explains, there is the potential to cut costs in staff wages, if their roles are fully or partially replaced by robots, but also the possibility of reducing injury claims and maintenance tasks. However, the same respondent also pointed out that to get a return on investment in these new technologies, organisations would typically have to wait five to seven years. It is not an overnight return, but very much over the longer term. This may mean that for some industries that operate under tight financial margins (e.g. aged care, disability services) it may not be possible to invest in robotics now with a view to saving money in the longer term. Or, if this does happen then savings in labor costs may need to be made in other places (see below for further on this debate).

Service differentiation through innovation

Using robotics as a way of driving down costs is one way of improving overall financial position. Another is the desire to grow income. A number of service providers that we spoke to described adopting robotics as a way of demonstrating that they are an innovative and forward-facing organization. This was seen as a way of differentiating their services from others and attracting a broader clientele. One interviewee described the way that PARO (see Box 1 for more detail) has been used by some aged care providers to achieve this: 'so the large care providers like Regis, Blue Cross, they always have the PARO on their home page and they of course – they're the organisation for profit so they utilise PARO in the best way. We are always doing something new; we are very keen on the new technologies, the innovation' (AU03). Another interviewee concurred adding, 'it is usually the CEOs of aged care organisations who look for: how can I promote my environment. They go out, they're at a- one of the aged care congresses, and they see some trendy little robot and they buy it, and then they push themselves all over the newspaper, the media, to say: oh, our facility is the best facility, et cetera' (AU14)

Another interviewee explained that the media drives some of these adoption behaviours in part: 'if you actually did good research on that, that you would discover that this was probably a conversation starter. And that the technology was doing very little. And that lots of the benefits disappear if you track it over the longer term. I suspect that would be an example of the media narrative trumping reality' (AU11). This line of argument was elaborated on further by

another interviewee who talked about the intrinsic attractiveness of robotic technologies, particularly in terms of younger people:

> *So robots … they're attractive, we live in a world where technology is engaging and it's interesting, particularly for the younger population, so that's where it all starts. Children find the robots novel, different, interesting, attractive, and engaging…So we leverage from that to say, okay, how can we use them to help or to teach children? That's where it all starts. Just like a tablet, tablets are interesting. The difference between a tablet or a computer is that robots are three dimensional. So when you talk about a human like robot, for example, there are more chances or more opportunities for new skills, for new learning to transfer into personal interaction when you learn through a robot than when you learn through a computer screen, or at least that's what we've seen and that's the theory as well. (AU13)*

In this case, robotics is something that helps to differentiate a service offering, but in turn this also enhances a service by gaining greater traction with the particular user population.

Networks and relationships

We discovered that particular providers came to have robotic technologies not through planned acquisition, but through serendipitous relationships. Although there had to be willingness to adopt these technologies, we heard a number of stories about service providers gaining robots through a series of relationships and chance events. In one case, the adoption of robots came about due to an international program between two countries on technology research led to a focus on human/robot interaction that would focus on aged care. This led to a search for a provider that would host the research. At the end of the research process the used robots were offered to the provider at a lower cost and they decided to invest in these. They already had some experience in using these and saw it as a helpful way to differentiate themselves from other providers as a technologically progressive organization.

Another service provider described how they were told that they would be getting a particular robot, which they were to use in their service context. The city in which they are based is twinned with a Japanese city where this particular robot was developed. During a twin-city visit, a senior government official had committed to the Australian party buying a number of these robots to use in various service areas. While an exciting innovation, the challenge for this provider became how to embed this technology into their existing practice given that no specific need for this innovation had been identified.

Positives and negatives of robot technologies

Above we set out the various drivers in terms of the adoption of robot technologies. In this section we briefly consider some of the positive and negative impacts of these technologies that our research respondents had encountered.

Positive impacts of introducing robots

One theme from our interviews is that robots would do things that humans do not necessarily want to do. For example, robots are able to undertake repetitive activities that humans may find less enjoyable. As one interviewee described, 'many of the things that robots do for us are jobs that people shouldn't necessarily do. They are not fulfilling things' (AU18). One of the examples of a caring task that is not necessarily a difficult role but carers sometimes feel challenged by in the context of a busy working context is that of repeating things. This is a common reality within aged care, particularly in the care of individuals with dementia. As one interviewee described, 'For people with dementia, the robot could remind someone a thousand times in a day and the robot wouldn't care'.

Similar issues can be faced in the context of disability services, for example in the care of children with autism: 'they [robots] are non-judgmental, they are patient and they can repeat everything without getting upset so they don't get angry, they don't transmit their own emotion, they don't come with baggage that changes the interaction … all of that means that … children can feel more calm, feel better to interact with the robots than with a human' (AU13). For a number of respondents this was seen to be a positive for both staff and those they are caring for: 'the benefit is always for both sides' (AU03).

For those individuals who may need reminders about medication or different aspects of daily living, robots can be a great help; 'the whole reminder system of the robot, taking pills and it's time for this and that' (NZ02). Interestingly, we were told by a number of respondents that individuals were more likely to comply with instructions when relayed by a robot: 'people were much more complaint with the messages that came from that computer when it is on a robot than

when it is just a tablet, because people are creating a relationship with the robot and don't want to disappoint it' (NZ03).

The issue of creating a relationship is an important one that came up a number of times. In the contexts of aged care and disability services, many of the professionals we spoke to were concerned about the fact that individuals could become socially isolated and lonely. Developing a relationship with a robot was seen to be a way in which loneliness might be combatted: 'it's a way to combat loneliness and reduce agitation, particularly in the dementia units … for the residents that it's [robot] used with you get really good results' (NZ01).

For some individuals the robot was used a tool to help settle them and overcome agitation. When asked why this works a respondent explained: 'Probably an emotional connection, whether it brings back a memory or something … we've got some people that will ... think it's a baby … it's just that holding and that nurturing … a tactile connection' (NZ03). In this way, robots were described as giving individuals a purpose. In caring for another entity (even if this happened to be a robot), this was seen to give individuals a 'reason to get out of bed in the morning' (NZ01).

Others described the use of robots to enhance relationships, but in a rather different way. For some the impact of the robot was not necessarily in the relationship between the individual and the robot, but in facilitating relationships with other humans. As one respondent explained; 'Really, it's not so much what this robot can do but its agency resulted into some conversations between … a group of people in that nursing home with mild dementia kind of condition' (AU15). In aged care settings robots are also seen as a useful way to enhance intergenerational relationships: 'Whenever people were there with the robots – especially their grandchildren came to visit. They always wanted to show the kids the robot because they thought they would be interesting to the kids and would generate positivity for the grandparents' (NZ05).

Negative impacts of introducing robots

As outlined above, many of those we spoke to saw many positive implications of introducing robotics. However, some others we spoke to were concerned over the potential for robots to harm individuals. Some of those we spoke to raised concerns over robots not being sufficiently tested yet in care settings or the potential unintended consequences that could emerge with the introduction or expansion of these technologies. Some raised issues of how to think about issues of accountability in the context of agents that are acting independently: 'there's a liability issue in there as well, presumably, as well that you keep a human in the loop because you're going to have some sort of – the robot can't be liable for that' (AU01).

Others talked about harm differently, seeing interactions with robots as a way of changing the ways that individuals behave with other humans. This is an argument that is central to the Campaign Against Sex Robots, spearheaded by Professor Kathleen Richardson. They make a virtue ethics argument, which suggests that behaving in a particular way will strengthen and encourage that behavior. In the minds of Richardson and colleagues, if we allow individuals to behave badly towards female sex robots then this will encourage negative behavior towards women more broadly – although this is a point that is significantly contested within the literature (Danaher 2017).

A further point of concern for some is that people might come to rely on robots too much and this would be to the exclusion of humans in care processes: 'the main issue I would think in the long term is people relying on robots too much. I think if we look at robots being there to help, and not people in general, but let's say in a clinical sense to help therapists, to help educators, to help clinicians do their work better but not replace them in anyway. If we aim to start replacing people for machines that would be my main worry because we still need that human touch' (AU13).

The concern here is not that robots per se are a bad thing, but that people might become reliant on these technologies to the exclusion of human interactions. Given the evidence connecting social interaction with health outcomes, this does have significant implications. Some of those we spoke to expressed concern that individuals might be left with robots as their only form of social interaction and staff would therefore not do other activities that might ordinarily be done to try and engage individuals: 'Are we still going to be as fastidious in doing all that physical stuff or it this toy going to be a bit of a panacea to free up staff to do things that they need to do … is it a give and take between more time to do admin as opposed to looking after clients' (AU 11).

Technology obsession is another potential danger as one individual explained, 'one challenge that we encounter always with the use of technologies, is this kind of sense is the possibility of the kids getting obsessed with the

technology and just wanting to interact with the technology and not with humans…that would be one of the risks in the long term if it's not well managed' (AU13).

A number of people raised the issue of costs. Many of these technologies are quite expensive, particularly the early release versions. Some we spoke to suggested that technologies are being bought not because they fit well with the model of care, but because it makes an organization technologically distinctive in some way. One interviewee described: 'If I go in there, I'm going to say ten times out of ten they either don't use it, don't know how to use it, staff are very negative towards it and they've got no idea of how to use it. They buy a product without actually thinking: well we're buying it for this purpose' (AU14).

Many of those we spoke to described the current robotics context in care services as being one that is supplier-driven. The implication of this is that technologies are acquired, but they may not actually do all that is promised in the marketing or organisations don't know how to use these effectively. One interviewee said of a bulk purchase of a model of robots by a state government: 'they're apparently sitting in a cupboard and have done for the couple of years. This is the problem; this is what gives technologies a very bad name' (AU14). Others expressed concerns that in a supplier-driven context, solutions are not necessarily well embedded within the reality of service delivery contexts: 'It's really difficult to get a fix on any of this to be honest so coming from a provider's mindset, that becomes even harder because their job isn't necessarily to see this trend-wise, nationwide, they just look at it from a business standpoint' (AU01).

The costs of these technologies also affect how they are used. Many of those who had acquired robots talked about having to find ways to protect them, because they are fearful about accidental damage or mistreatment. Professionals reported finding ways to be vigilant over when and where robots were being used and who has access. Some reported that one of the implications of this in aged care is that companion robots are locked away until they are specifically requested because of fears that they might be stolen or broken. One interviewee explained: 'I knew they had … robots so I went down and said where's your robot? Asked around and yeah, it's very valuable, it's locked away. So the whole purpose of this thing was to actually have it out there so they can use it. Because it's got a value to it, they didn't want it to go walking. So you had to kind of say can I have the robot please?' (NZ04).

Although some robots are easy to use and fairly straightforward in terms of the technology, others need considerable programming. While PARO (Box 1) can simply be switched on, other robots (e.g. NAO, Pepper – Box 2) need programming in order to undertake any actions. As one interviewee explained, 'it took us four hours to do the programming … for like a three-minute speech. Then somebody would say something unplanned' (AU06). Having access to individuals with the skills and capacity to do this coding was sometimes an issue for those we interviewed. Some talked about the need for some rapid upskilling in order to be able to undertake these roles. Others had to recruit staff with new skills and typically then go through a process of supporting them to understand the core business of the organization. The creation of new roles is an interesting facet to the debate given that some respondents reported being concerned that robots might potentially take some jobs.

Considerations when introducing robots

As described above, there are potential positive and negative implications in introducing robot technologies. As such, interviewees described a number of considerations that need to be taken into account if they are to be used to their greatest effect. One of the challenges with a number of these technologies is that not all of the effects of these are immediately obvious. Although some may be helpful in delivering particular improvements there are other impacts that need to be thought through. As one interviewee explains: 'There's a lot of secondary and tertiary effects associated with this stuff. A lot of it is things that we don't foresee. It's like invasive species. You can think you're doing a good job when you're adding them in but you don't really understand. That's why we need more people thinking about what the secondary and tertiary consequences are' (AU08).

One of the areas that interviewees cited as particularly challenging is around the potential for robots to generate data and the concerns that this might compromise the privacy of individuals. As one interviewee described:

> There's probably stuff about data collection that's going to be hugely important. So most of these objects are not one way objects. They are also collecting data. So there will be questions there about access that are really complicated. So the early stuff I know from the States about instrumenting aged care facilities. So not smart technology but smart infrastructure. There were some really interesting questions about if you were

collecting data about an aged person, who had access to that data and under what circumstances? So did their kids? Because by privacy law, their kids can't unless there is a particular kind of set of waivers that have been signed. So there's probably some protocols that need to get developed, which I can imagine government might also care about. Like you know, what access to information do children of aged care people have and does everyone get it or is it just the person that is signing your power of attorney has access? Hard to know. What happens to that data should a person die, is a really interesting question? …There may be some ethical questions about that that I'm sure no one's considered. (AU04)

A number of those we spoke to were concerned that insufficient thought has been given to this issue to date. Many individuals do not know that data is being collected, who owns it, how it might be shared, where it is stored (particularly if it moves across international boundaries) and how secure it is – for example, whether it could be hacked in some way. Many also expressed the perspective that there is no simple answer to these issues and for some people there is a calculation in terms of how much independence is gained as a result of some degree of surveillance: 'They're happy to trade some elements of privacy for autonomy. You know, I'm happy for you guys to have this information if that means you'll leave me alone to be me' (AU09). Several interviewees spoke about this issue as one of ethical concern, rather than being simply one of a technological issue.

None of the robots we came across in our research were designed and manufactured in Australia. A number of those that we spoke to raised issues with this, expressing concern that what makes sense in terms of care in one context may not in another: 'there's the cultural element too with technology because most of these robots are coming out of Asia … so there are different philosophies of aging implicit … so does that necessarily gel within a Western society' (AU01). Interviewees expressed concerns that there might be different ways of thinking about care and care delivery that might not fit with an Australian context. A further interviewee explained that even some basic elements may not be consistent across different settings:

I mean you know, which could run the gamut from how long is enough time in a bed before you need to be turned or moved? How much is an appropriate amount of sleep? How much is an appropriate amount of movement? Those things sound like they might be medical decisions but they're being coded in by someone using some standard that may not be our national health standard, that may be one written by an American based on a place that has private health care and … who have completely different notions about well bodies than Australia. I mean you know the difference between the US and Australia in terms of blood pressure, cholesterol – those are not universal measures, right? They are in fact culturally constituted and driven by medical insurance capacities, so knowing- sitting inside those robotics objects, what mechanisms are built in there that are based on medical data, that are based on expectations about human activity? How do we get to scrutinise those? Are there rules about importation and if so, who is determining that? (AU04).

A key issue raised is that the context that the technology is built in will inform the inherent design assumptions, and these need to be consistent with the implementation setting. Similarly, another important issue is how technologies fit within a model of care. Some of the organisations we spoke to described an approach where they carefully thought through what they were trying to do in terms of their care context, and then considered how the robot would contribute to this. Not having a clear sense of how a robot fits within a model of care was cited often as increasing the likelihood that this would not be successful.

As is indicated by much of what we have described so far in this report, the introduction of robots can lead to changes for a number of different stakeholders. Several respondents talked about the need to invest in staff training: 'the fact that for every one dollar of technology invested, there's a corresponding nine dollars invested in stuff like education, system redesign and all of that' (AU01).

What is clear is that robot technologies are often more complex than simply being introduced and left to work. Staff need to be brought onboard with the technology and educated about how it works. This technological literacy does not just apply to staff – it also applies to those who are being cared for. If those being cared for do not know how to use these robots, or what their limitations are, then the technologies will not be effective. Given that internet connectivity is vital to many of these devices, the provision of a fast and functional internet service is of significant import. A number of respondents suggested that this is a problem in various parts of Australia and New Zealand.

Future applications of robotics

By and large those we spoke to suggested that they could only imagine that the use of robotics would extend further in the future in the context of care services. Future applications were discussed in relation to a whole host of areas from more practical assistance and automation in hospitals and aged care settings, to autonomous vehicles and intimate robotics (not necessarily sex robots, but robots that individuals develop an emotional attachment to).

However, others were keen to note that some of the types of robots that we see in film or read about in books are not within the near future. There is still some significant technological advancement to be made before the reality of domestic robotic agents that fulfill a range of different roles will be realised. A number of other interviewees suggest that as advanced as robotics might become, they will never replace humans. This argument was presented in a number of different ways. Firstly, there is the argument that so much care work is not routine and would therefore be difficult for robots to assume. As one interviewee explains:

> *a lot of the frontline level work isn't routine and it's not repetitive so you'd find it difficult, for example, I mean you might have AI agents that could inform on medical decision making, let's not go as far as say, replace doctors, but the role of nurses, gardeners, home maintenance, staff, cooks, chefs. That's not going to be replaced any time soon. So a lot of that presentation was, okay well this is the body of work that's been done, this is the cause and effect of disruption. (AU01)*

Another interviewee explained that something intrinsic to care is human contact: 'there's nothing that can replace completely human touch I would think and not only in a physical sense but the human contact' (AU13). One interviewee brought these arguments together in arguing for the importance of robots over screen-based training programs for children with autism:

> *It's not about replacing humans. We are not interested in creating technologies that replace humans unless they solve human tasks, unless there's some very good reason for it … It's not here's a robot, you don't need therapy or here's a robot, you need less teachers or here's a robot, you don't play with your kid as much at home. It's a robot, something that they're working on is about empathy and some social skills and touch … What's great about robots in the form of play, it's teaching in the form of play. The robot can be there doing the same thing, the same repetitive thing until the cows come home and even afterwards … By having all these screens you make this contact with people, with face-to-face even more remote. Screen training is very, very bad for them. You create another layer of- so having all these games on screen when you're trying to encourage eye contact and face-to-face communication with these children (AU15).*

Mostly we came across a perspective that robots will not replace humans in care delivery systems in the future, but instead will be tools that will help to augment human skill. As one interviewee describes: 'So we're not necessarily talking about using a robot to deliver the intervention without the human getting involved, but we talk about using a robot to support the intervention. To practise, for example, so if it's doing therapy there is still a therapist but we can use a robot to practise some of the skills instead of having to practise at school with another child for example' (AU13). An important implication of this is that these technologies need to be agreed with professionals: 'it's got to be a partnership with people. It's no good just making a robot and saying here is your robot communication toy or whatever it is. It's really got to- what I found is you've got to really understand what people need. We design the robot for the- software for the particular scenario where it's going to be used. Because it also has to be integrated with what everyone else is doing, both the IT systems and the other people who are involved' (NZ05).

Regarding the question as to whether there is anything that robots should not do, there were only a few parameters suggested within interviews. One of the lines for some of our interviewees was in terms of robots touching individuals. As one interviewee explained: 'We've avoided touching people with robots … I think you have to be pretty careful. At the moment you have to be careful about touching people with robots because that's getting pretty close' (NZ05). This was a perspective shared by another interviewee, although as this quote demonstrates it is not just that they think robots should not touch people, but because this might lead to a lack of engagement with humans: 'The touching, it's probably going a bit far the touching, but putting the flesh of other humans I think people- I wouldn't want people to get more isolated with the security of a robot companion that they choose not to engage with other human beings probably, because that human touch is so important for our wellbeing as well' (NZ02).

Another thing robots should not do is appear to be too human. Linked to the previous point, there was a consistent trend in interviews that robots should not in any way attempt to replace or mimic humans too closely. A number of those we spoke to expressed the belief that robots should not be made to look too similar to humans and that attempting to mimic humans too closely is something that could confuse or upset individuals.

Roles for government

Given the broad array of different applications of robots discussed in this study and the wide ranging potential implications and ramifications of these technologies, several different roles for government flowed from this research. We discuss the most prominent of these here.

Regulation

The major role that interviewees discussed as being relevant for government in this space is that of a regulator. This is generally seen as a rather complex role that has a number of different facets to it; in terms of helping to regulate the market through creating a strong evidence base, developing standards, protecting data and privacy, and protecting the workforce. However, one thing that is clear across all these areas is that work is needed to change current regulation, as technology is developing so quickly that is outgrowing some aspects of practice. As one interviewee described:

> *Well, it's beyond the conversation phase now, because the technology is already outpacing our ability to regulate and legislate for it, so we're way behind. The real question is, what are we going to allow – are we just going to be a big experiment, where all the stuff is thrown upon us and we see what happens? Then just say, oops, sorry if that was the wrong answer. Or are we going to then end up overreacting and throw the baby out with the bath water and there was good there but now it's- we can't use that because all of it's dangerous ... So, the conversation is absolutely essential, there's no doubt about that. We need to even move beyond the conversation now and start talking regulation and find frameworks through which that can be done. (AU08)*

Critically, interviewees argued that we need governance and regulatory structures that do not attempt to presuppose the problem. As noted earlier, technologies are emergent and also have unintended and unpredictable consequences once in use. Interviewees largely therefore spoke about the importance of approaches consistent with ideas of responsive regulatory approaches. A responsive regulatory approach relies on actors to self and peer regulate, and escalate issues as they arise upon which governments can implement regulatory efforts of different strengths. Importantly, responsive regulation approaches emphasise a 'light touch' approach first. In the case of disruptive technologies, this is important to ensure the environment is still conducive to technological innovation

Responsive regulation is about 'tripartism' in regulation (Braithwaite 2008). The approach emphasises the the limits of regulation as a transaction between the state and business. Rather, unless there is a third party (or a network) engaged in regulation, regulation will be captured and corrupted by money power or will not be fit-for-purpose. Importantly, responsive regulation involves listening to multiple stakeholders and making a deliberative and flexible choice (Braithwaite 2008).

As outlined in the previous section, many see a clear role for government in terms of regulating data collection and protecting privacy. Current policies and practices around data collection were seen as flawed in the context of advances in technology and in need of revisiting. One interviewee ironically comments:

> *I think there actually needs to be strong regulation about what sort of data can be collected. I think the sort of-there's that British experiment where they buried in the user agreement that you'd sell the company to your first-born child ... That's a dead model when it comes to consent to these kinds of technologies … So I think that makes this stuff really difficult at a policy level. Because in other contexts you'd go for a kind of consumer choice model that I just don't think works here. I've said the privacy stuff and I think for me that includes sale and use of data. (AU11)*

The final regulation issue we discuss here relates to the workforce. As many of the previous points discussed suggest, there will likely need to be changes to workforce skills, roles and capabilities. A number of interviewees discussed the need to pay close attention to where there might be skills gaps that might need to be filled. Others again drew attention to where we draw the line in terms of what humans should do and whether any facets of this

could or should be replaced by robots. As one interviewee explained: 'There is something to me around where … do you cross that line between the robot facilitating human potential and the robot replacing human potential? Is that a policy issue? Does that come into where robots are taking jobs? ... I think, something that perhaps policy and regulation needs to come into' (AU09).

Leadership

As outlined above, one of the areas that many interviewees feel that there is currently a gap is in terms of government leading systematic thought in the area of care robotics and their uses. One of the tasks many felt is needed is in terms of thought leadership on this issue: 'But to the best of my knowledge, I'm not really seeing any work or thought leadership that's happening around, how do we think about these in the healthcare setting, as a nation are these things that are reimbursable through the NDIS? All these questions that will be rapidly being asked, as the technology becomes able to do the things, that the people require' (AU05).

Such a role would involve helping to support providers to understand the different technologies available and their evidence base. Some of those we spoke to expressed concern that many of the research projects into robots in care services are relatively short term and we are lacking high quality long terms studies of the impacts of these technologies. 'We don't have sufficient testing. We don't have enough development. Still, there's a lot of excitement but we're still in baby steps so we have to be very careful and make more informed decisions, especially in Australia about our own people here, on execution, how we want to adapt something.' (AU15). Many of those we spoke to expressed concern over the fact that there are a large number of small care providers who do not have the resources to invest in understanding the range of technologies available and the evidence for these. In a largely supplier-driven market this poses a potential risk that providers buy technologies that they do not fully understand or that technologies are not adopted.

Consolidating the evidence base

Many of the stakeholders we spoke to, therefore, see a role for government in helping to generate an evidence base that is accessible to providers. This was seen to be important particularly where technologies may have been tested, but in a different national context: 'I think maybe a good place for policy to start looking is around policies that allow, or frameworks that allow those things to be evaluated and assessed for use in the Australian context, so maybe that's a starting point, and whether or not- if we can get those frameworks into place that will allow us to evaluate different technologies around, then we can streamline the implementation into our own systems here. Maybe that's a place where policy can be effective in the first instance, rather than running and trying to catch up' (AU09).

One of the challenges in developing an evidence base relates to the types of metrics that we use to demonstrate success:

> *So I mean I would say step number one in thinking about what does policy making look like in this space is being really clear about what we imagine we are making policy around. I think that means getting down to terms and then I think the second piece there is well you know, having defined robotic objects, what is it that we want to use as the evaluative mechanism of their virtual value? Like you know, are we talking about classic automation? So it's about time and labour saved, so productivity and efficiency gains. Is it about an aged care facility's- an absence of labour? (AU04)*

Of course, the range of settings and purposes that robotics are used in and for means there is not just one indicator that we can use to judge success, but most we spoke to believed that technologies should have some evidence based underpinning them if they are to be used: 'I just always assumed that if a healthcare provider was going to fund it, then- going to approve it, then they would expect to have evidence based- published evidence based stuff, to show that it actually did something' (NZ05).

Related to the point about the need for an evidence base and metrics is a sense that technologies need to have clear standards. As one interviewee explains, these need to describe: 'That it does what it says it does and that it- the benefits that it says it has, it's delivering. You want evidence based studies, to show that it was beneficial. You want economic analysis to show that it was cost okay. Then you want some kind of acceptability' (NZ05). One of the areas identified as in need of some form of standard is a guarantee about the length of time that a piece of technology will be supported. Some interviewees we spoke to were concerned about organisations or individuals investing significant amounts of money into items that would no longer be supported after a few years. This is something that already

happens in other jurisdictions: 'So when the United States government buys technology from certain vendors, one of the requirements when you tender for that process is that you guarantee that the technology will be supported over a particular lifetime. It's part of the RFP' (AU04). A number of interviewees suggested that there might be a quality assurance label that technologies could receive once they have been determined to meet various evidence and quality standards.

Upholding the social contract

A number of interviewees highlighted the need to ensure that vulnerable populations are protected within the context of new technologies. As one interviewee explains one of their concerns, 'I've always thought that most of that technology is really good if you're a batterer or a purveyor of domestic violence, we've just created the perfect technology for you. You know exactly where she is all the time. That's a little scary when you turn that in on itself.' (AU04).

This is not to say that robotic technologies are responsible for creating social inequities, but that they have the potential to reinforce these divides. Some we spoke to expressed concern that only particular socio-economic groups might be able to access these technologies, or that for some all of their human care might eventually be replaced by robots. A key point here is that for many of those we interviewed they saw an important role for government in considering the potential impact of new technologies and to ensure that they do not exacerbate any inequities or social divides.

Many of the discussions about the potential impacts of technologies on particular groups or individuals are far from being clear cut. Many we spoke to suggested that government should therefore play a role in leading a discussion about these technologies and their potential uses and that this would need to incorporate a broad range of different stakeholders:

> *Ethicist should be there not to comment afterwards but at the beginning. Social scientist. Behavioural scientist. This is not only for designer to judge. I don't think as someone who comes from interactive design, I don't have the knowledge to make a decision about what's good for society alone. I shouldn't have that power. I can talk about myself, I would always take advice from an ethicist, from social behaviourist. I will do research. I am not going to reinvent the wheel because we have amazing colleagues that can apply for that, their papers and books. That's why informed design from the beginning. (AU15)*

The need to involve a wide range of stakeholders was reinforced by another interviewee who described that:

> *governments and policy makers are not experts in these areas and … it has to be dealt by academics and researchers too. … I think we should start talking about it at that level and people who are experts in the different areas…So I do think it has to be there, conversation at the general level, public level I think …I'm not sure if we're ready to have all those conversations as open as that just because we're still at the beginning of the research…I think the same thing needs to happen with policy makers. They need to work very closely to perhaps clinicians and roboticists and create the whole team where they can see and understand what's happening from all perspectives. (AU13)*

DISCUSSION

As we have demonstrated through this report, we are at a relatively early stage of the adoption of robotics technologies in care services, although this is advancing quickly. Although many of those we spoke to are advocates for new technologies and are broadly supportive of using more robotics in the context of care services a number of warnings about these have been issued. Many were concerned about the lack of systematic thinking about robots in care services perceived within different levels of governments. This was seen as problematic because many decisions are currently being made about these technologies and without thinking through the longer term or unintended consequences of these. Technologies cannot just simply be adopted to deal with a specific problem, they require careful consideration in terms of how they integrate with care delivery systems and how they impact on professionals and users of care services. Indeed, this has been one of the mistakes that has been made in a number of attempts to introduce large-scale IT projects (Flyvbjerg, Bruzelius, and Rothengatter 2003).

As we outlined within this report, a number of different technologies are already in use in care contexts. As part of the process of analysis, we identified the technologies mentioned by interviewees[1], and where specific product names were mentioned, grouped them according to operative environment (contextual domain). A frequency-scaled word-cloud showing these results can be seen in Figure 1. Unsurprisingly given the context of the interviews, 'service/care' robots dominated the conversations. But we find that medical devices compete for second place with socially assistive devices, indicating people are aware of the potential for technology to impact social inclusion – how much of this awareness is due to marketing and media attention is hard to discern. Industrial automation was often mentioned as a point of contrast – indicative of a set of characteristics that people did not want to see in care settings. Meanwhile, technology that is often considered by industry experts to offer the greatest potential for lifestyle enhancements – i.e. smart homes, rehabilitation devices, telemedicine – has less of a presence in these discussions.

The picture that emerges is one that is dominated by a few widely-disseminated products which have some-to-little proven health benefits, while subtler technological implementations that present an equal regulatory challenge fly somewhat under the radar. 'Robots' are often a point of interest or concern, but technology with the same capabilities in a different physical package provokes less reaction, indicating that the definition of 'robot' is largely perceptual, and this perception may skew responses and reactions, both from end-users and legislators.

Overwhelmingly our research found respondents envisaging a strong role for government in terms of stewarding these technologies. While this may be a product of the interview sample, even providers of services and technology suppliers viewed involvement of different levels of government as being essential to the success of robots in care services. Certainly the view of most of those we interviewed was that the role for government went beyond simply providing money to pump prime research or to set some basic standards. Interviewees were largely cognisant of the potential for unintended or unanticipated consequences and therefore see that when using these technologies careful consideration needs to be given in not just the planning but the ongoing processes of care delivery.

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[1] Technology introduced into the conversation by interviewers or facilitators was only included if the interviewees subsequently spoke on the subject from their own experiences.

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Figure 1: A snapshot of care technology in Australia/NZ in 2018.

To help tease out the commonalities and regulatory intersections of this ever-growing set of products that seek to make inroads on challenges in care, we grouped the features and capabilities of all technologies mentioned in the interviews by the areas of regulatory concern that could be provoked. Figure 2 shows one potential clustering of regulatory considerations (note that each specific product should ideally be evaluated on its own merits, and while we have included some broad categories as examples of each regulatory intersection, the domain boundaries are extremely porous. For example, many semi-autonomous appliances now have internet connectivity).

Notably, while terms like 'AI' have precise definitions amongst experts (even though they are used very loosely by lay-people), the category of 'robot' is acknowledged by experts and lay-people alike to be a difficult concept to draw a firm boundary around, partly due to the role of perception mentioned earlier. Yet, when presented with a possible definition by interviewers, all interviewees had little trouble agreeing with and adhering to the taxonomic boundaries set by the investigators, indicating that the term 'robot' has a broad semantic agreement across the population, even while being taxonomically vague. To reflect this mutually indeterminate understanding, we have placed 'robots' as a general category occurring at the nexus of the regulatory concerns presented in Figure 2, while acknowledging the flexible and evolving boundaries around the term. Notably, this nexus aligns conceptually with the dimensions proposed in Leenes et al (2017), where nature/physicality and contextual conditions play a significant role in determining how 'robotic' a technology is perceived to be.
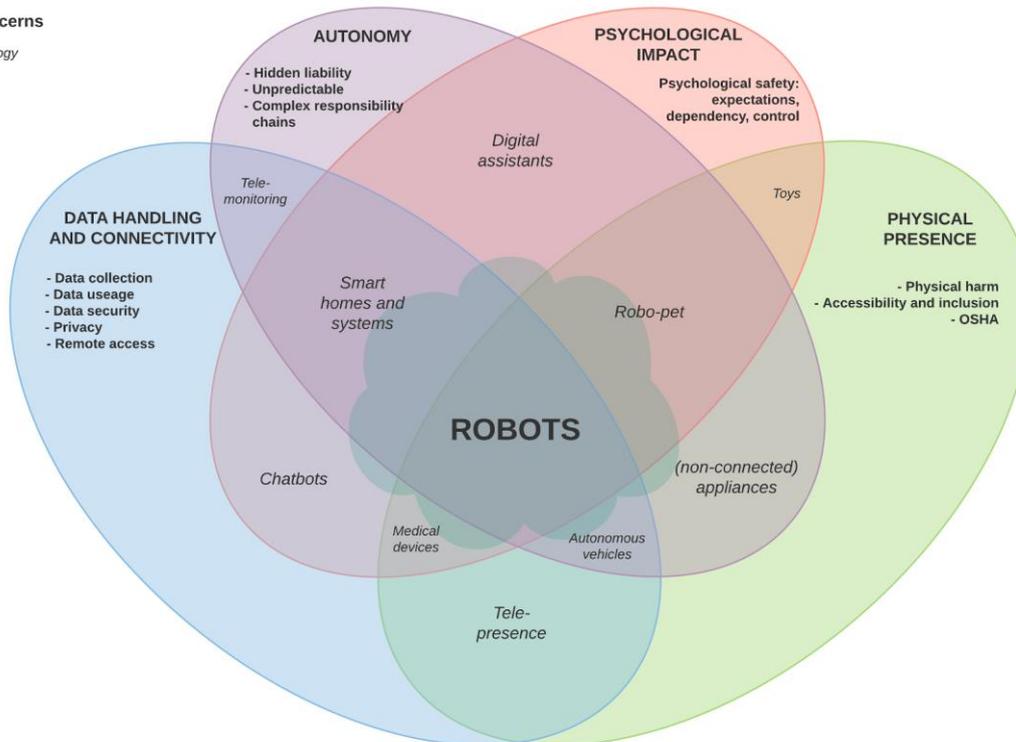
In terms of how care was described, this largely went beyond seeing care as just a series of activities that are done to individuals. It may be worth at this point reflecting on the definition of care.

Figure 2: A guide to regulatory concerns in robotics and related technology in the care sector

Care is a term that is used all around us in everyday life and something that will be familiar to us all. Yet we often do not stop to interrogate what it is that we mean when we use the terminology of care. Care is used in everyday language to denote a number of different things. In government we speak about different activities of care, e.g. care for older people, people with disability. It is also used to indicate responsibility through a service, e.g. child care centre, children in care. But, we also use this terminology to express that we have an affinity for some sort of entity, e.g. I care about climate change/the result of the AFL Grand Final. The concept of care is often understood as a practice because care is only realized through a set of activities and/or actions that are construction of social and cultural experience (Tronto 1993, 2013, Rankin and Campbell 2014, Hamington 2014).

The ways that care was spoken about in this project seems largely to be consistent with that put forward in the ethics of care literature (Tronto 1993). Ethics of care is a normative theory of care in the sense that it has an understanding of care as a moral action. This perspective sees care as operating a number of levels: from the political and global through to the everyday personal relationships between family and friends. One of the aims of this theory is to transform the structures within which practices of care operate so that they are not oppressive (Held 2006, Hines 2007, Barnes 2012, Hankivsky 2014). An important facet of an ethics of care perspective is that it does not view care as something that is simply done to individuals, but as a reciprocal practice. If we consider there are two parties in a caring relationship – the 'cared-for' and the 'caring' – then it is important to acknowledge that both parties have some kind of obligation to care reciprocally and to meet the other party morally, although this will not take the same form (Noddings 1984, Kittay 2011, Tronto 2013).

When interviewees discussed a number of robots they told us that a crucial part of their use was the relationship developed between the individual and the robot. Individuals gained positives from these interactions because of the reciprocal relationship they developed with the robot. Interviewees also raised possibilities about the impact that robots might have on existing relationships (for both good and bad). The majority of those we interviewed argued that humans are essential to care relationships and that the use of robotics should not be as a replacement. Robots were

largely spoken about as tools that should augment human capacity and skill. Although a subset of those we spoke to did express the concern that in particular care contexts, where finances are tight, that robots might end up being used as an inappropriate substitution for professional carers. This was cited as being a particular possibility in the context of aged care services.

What is clear from these discussions is that these are technologies that do have the potential to impact relationships and are not simply neutral tools. In stewarding these technologies, governments will be required to play multiple and complex roles.

The concept of "stewardship" has risen to prominence and is considered an important driver of contemporary public service practice in Australia and internationally. The Productivity Commission considers it core to the reform and delivery of human services in Australia (Productivity Commission 2017); the Commonwealth Superannuation Corporation identifies it as the crux of the trust relationship with its members (Commonwealth Superannuation Corporation 2017); the Australian Future Fund has adopted it to guide its long-term asset strategy (Future Fund 2017); and the Department of Prime Minister and Cabinet describes its entire role in stewardship terms (Department of Prime Minister and Cabinet 2017).

Although stewardship might seem like a new term in a public service context, it is, in fact, one that has been around for some time and has been applied in a number of ways over the years. The diversity of contexts in which stewardship is central suggests the concept is capable of broad application across an array of areas and to seek a range of outcomes. However, Moon et al (2017) set out an alternative reading of this situation, sounding warning bells that this concept is being applied beyond its logical and theoretical constraints. Part of the attraction of the term might be that it exhibits strongly normative dimensions, as a seemingly positive and desirable state.

From a review of the literature, Moon et al (2017) find that there is no single meaning of stewardship to be found and its definitions vary across disciplines and policy fields. Although it is applied in a diverse range of ways, the concept does have a set of universal features: all stewardship models involve taking responsibility for something, within a context of constrained resources and for particular beneficiaries. In terms of who is stewarding, in a public policy context it is typically government agencies, but not exclusively – other partners, or potentially networks, play important roles in stewardship. In the context of the public service, stewards are not typically individuals, but collections of individuals who may or may not share similar sorts of goals and aspirations. These individuals could be located in a dedicated agency, or networked across the public sector.

The features of stewardship provide the basis for starting to consider the introduction of robots into care service contexts. At a minimum, we should be asking:

- What the robot is being introduced to do?
- What is the target group for this technology?
- What should be delivered as a result of this?
- What is the evidence base for this?
- What are the anticipated cost of the technology and any necessary development for staff/users?
- What are the anticipated impacts on relationships in the care context?
- Are there any potential adverse impacts or misuses that can be anticipated?

Unless we carefully consider the impact that these technologies have on models of care, they will not be capable of being used to their full effect and there is danger of greater degrees of adverse impacts.

Finally, it is worth noting that this research is not without its limitations. As we outlined at a number of points, we encountered some difficulty in securing interviewees from across different levels of government and care agencies. As such, there may be some perspectives that are found to missing from our research. We cannot claim any degree of broad generalisability in terms of those we spoke to. However, the intention of this work was to be exploratory, mapping out the major features of the terrain within a public policy and public management context against a background that is largely unpopulated by empirical data at present. To this extent, this research should be seen as the start of a conversation, rather than an end point, asking more questions than it answers. In the final section we move on to summarise the main messages and to outline a number of the gaps in the literature that require further research to uncover.

CONCLUSIONS

> *During the twentieth century it was commonly argued that care was other to technology. Care had to do with warmth and love while technology, by contrast, was cold and rational. Care was nourishing, technology was instrumental. Care overflowed and was impossible to calculate, technology was effective and efficient. Care was a gift, technology made interventions…engaging in care is not an innate human capacity or something everyone learns early on by imitating their mothed. It is infused with experience and expertise and depends on subtle skills that may be adapted and improved along the way when they are attended to and when there is room for experimentation. Technologies, in their turn, are not as shiny, smooth and instrumental as they may be designed to look. Neither are they either straightforwardly effective on the one hand, or abject failures on the other. Instead they tend to have a variety of effects. Some of these are predictable, while others are surprising. Technologies, what is more, do not work or fail in and of themselves. Rather, they depend on care work. On people willing to adapt their tools to a specific situation while adapting the situation to the tools, on and on, endlessly tinkering (Mol et al. 2010, p. 14-15).*

As the quote above illustrates, technologies are not neutral and their introduction has the potential to have a number of implications intended and unintended. As such, it is not just a matter of introducing robot technologies and watching for their impacts to unfurl. Their process of implementation is instead one of 'endless tinkering'.

While based on a limited (though diverse) sample of interviews, the research provides important insights into the current state of robotics in care settings, their benefits and the potential risks and harms. We found that robotic technologies offer a range of benefits and that these are for both carers and those being cared for. Interestingly, the adoption of robotic technologies is not necessarily being driven by positive impacts on social relations of carer workloads, but rather by the desire to be seen to be offering innovative service products or because robotic technologies were provided to services through serendipitous opportunities and networks. In practical terms, this means that the introduction and growth of robotics in care settings is not necessarily being driven by the needs of carers or those being cared for. This means that products are less likely to fulfil the potential of robotic technologies in care settings, and may even increase the risk of harm because sufficient attention and thought is not being given to how such technologies will be used within complex care settings.

The research points to the need for governments to play a more active and considered role in robotic technology – from development through to implementation and regulation. We discovered that one of the major barriers to this at present is the lack of clear definitions of what robots are, and the different types of regulatory challenges they present. Related to this is the potential for policy workers to have poor or limited understandings of what technologies exist, what is emerging, and what their different capabilities are. Given the speed of innovation in this area, we suggest that a responsive regulatory approach is most appropriate as it relies more on networks of actors across industry, communities and other fields of practice than government alone. This means that government does not need to be the sole holder of knowledge.

Having said this, the research identified a clear role for government in collating and disseminating information about technological developments and their potential for harm. At present, there is no systematic consideration of what robotic technologies are emerging, how and where they are being used in care settings and the flow on effects for individuals, carers or organisations.

Based on the research presented in this report we argue that there is a need to:

(a) Develop clearer definitions of robotic technologies that are more nuanced and can guide effective legislative and regulatory frameworks

(b) Develop capability and capacity within governments regarding what the potentials and challenges of different forms of technologies are

(c) Develop responsive regulatory responses to robotic technologies that engage a wide range of stakeholders

(d) Develop stewardship frameworks more broadly, whereby governments assist in the collation and dissemination of evidence, identify opportunities and potential harms and ensure appropriate governance.

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