AGED AND COMMUNITY SECTOR TECHNOLOGY AND INNOVATIVE PRACTICE

A REPORT ON WHAT THE RESEARCH AND EVIDENCE IS INDICATING

DISCUSSION PAPER 2019

UPDATE FROM THE ORIGINAL ACIITC LITERATURE REVIEW THAT INFORMED THE DESIGN OF THE TECHNOLOGY ROADMAP FOR THE AGED CARE SECTOR

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Aged Care Industry Information Technology Council

ACSA
Aged & Community Services Australia

LASA
LEADING AGE SERVICES AUSTRALIA
The voice of aged care

ACIITC

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FOREWORD

We are living in a new era for the delivery of Aged and Community Services.

Given the speed of the technological change, this area is unprecedented and there are opportunities for the Aged and Community Care sector to embrace new technologies which are of essential importance.

This new research agenda for the Aged Care Industry Information Technology Council (ACIITC) details the opportunities that evidence is showing from research and the impact of new technologies on the delivery of care, services and business structure.

This activity of the ACIITC builds on the previous work we have undertaken in research and developing of Australia's first *Technology Roadmap for Aged Care* and it accompanies the first literature review (focused on the period 2011 – 2016). This research spans the period from this previous research (2016 – 2019) and is building a body of research around the impact of Innovation and Technology on the sector.

I trust you will find this important research activity essential reading and impactful when considering strategic direction for your organisation.

The ACIITC continues to work to provide the industry with a vehicle to consider and debate Innovation and Technology related opportunities and to disseminate the lessons learned from that progress to the wider Aged and Community Care industry. We strive to improve the quality of care providers through supporting and educating Aged and Community Care service providers about the efficiencies and service improvement capabilities that well managed Innovation and Technology system deployment can achieve.

Dr George Margelis
Chair
Aged Care Industry Information Technology Council

18 December 2019

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1. INTRODUCTION

THE ACIITC

The Aged Care Industry IT Council (ACIITC) was formed in 2007 by the two industry peak bodies - Aged and Community Services Australia (ACSA)and the Aged Care Association of Australia (ACAA) now Leading Aged Services Australia (LASA). The Council was designed to provide the sector with a vehicle to consider and debate Technology and Innovation-related opportunities and to disseminate the lessons learned from that process to the wider aged care industry.

1.1 CONTEXT AND METHODOLOGY FOR THE 2019 DISCUSSION PAPER

In 2016, the Aged Care Industry IT Council (ACIITC) commissioned Australia's first *Technology Roadmap for Aged Care*[1] which was published the following year. The Roadmap was informed by consultation with the aged care sector and with organisations providing technology to the sector, as well as by a review of the literature (Barnett, Reynolds, Gordon, Hobbs, Maeder et al 2017).[2] Its development was managed by the Chairs of the three ACIITC Committees. [3]

A summary of the ***Aged and Community Sector Technology and Innovative Practice – A Report on what the Research and Evidence is indicating Report*** was provided in the form of a Discussion Paper. Given the speed of technological change, the Council commissioned an updated literature review (focused on the period 2016-2019) and this Discussion Paper updates its 2017 predecessor. The 2019 Literature Review provides detail for those who wish to read beyond the Discussion Paper. Findings from the literature review are presented in two main categories which also structure the Discussion Paper (to enable easy cross-referencing):

- Technologies that support positive ageing (Section 2)
- Technologies that support the care of older people (Section 3).

Section 1 brings together findings from the grey literature that suggest future directions and possibilities but as yet lack a strong research evidence base.

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[1] ACIITC (2017) *Technology Roadmap for Aged Care in Australia,* Aged Care Industry Information Technology Council. Available at http://ACIITC.com.au/roadmap/

[2] The first literature review and the *Technology Roadmap for Aged Care* were developed for the ACIITC by a team from the Flinders University Medical Device Research Institute led by Professor Karen Reynolds, with Dr Kate Barnett from *Stand Out Report* as the Lead Writer. Other team members were Professor Sue Gordon, Dr David Hobbs and Professor Anthony Maeder from Flinders University.

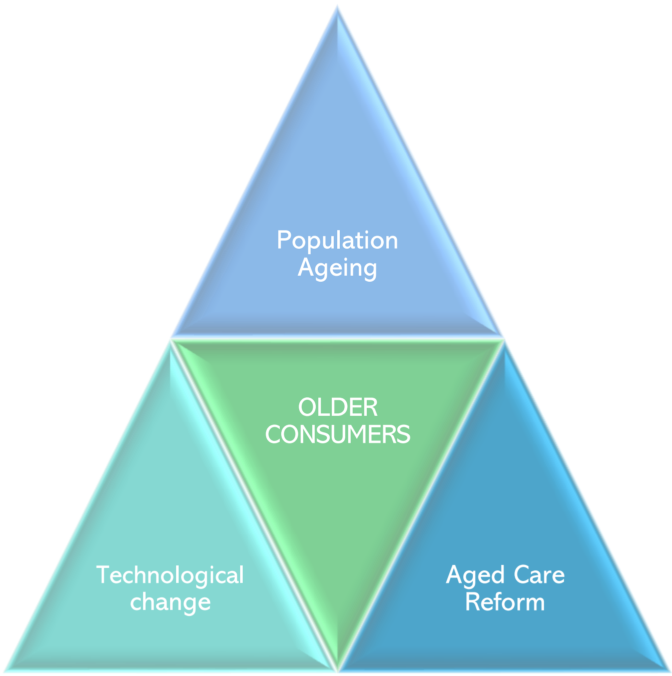
[3] **Technology Roadmap Management Team:** Ms Anne Livingstone, Chair ACIITC National Home Care Committee; Mr Gavin Tomlins, Chair ACIITC CIO Forum; Mr Rod Young, Chair ACIITC ITAC Committee

The *Technology Roadmap for Aged Care* in Australia acknowledged the challenges and opportunities for the aged care sector arising from three intersecting meta-influences –

1) population ageing that has never been experienced to the same level as now
2) the rapid development of new technologies and
3) reform in the aged care sector that fundamentally changes the way in which older Australians are supported.

Central to all three is the **consumer**. These three influences continue to be significant.

FIGURE 1: META INFLUENCES SHAPING THE TECHNOLOGY ROADMAP FOR AGED CARE

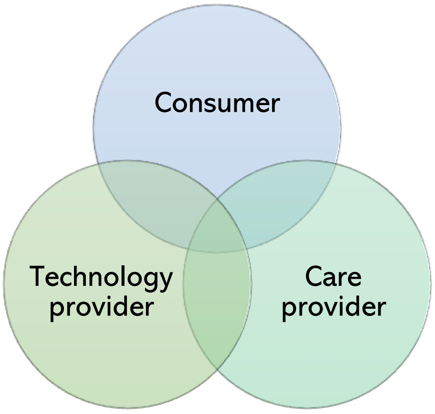


1.1.1. Intersecting transformative change: the growing significance of partnerships

As technology has evolved a new intersection is emerging that is reshaping who delivers health and aged care, and how this care is delivered. In addition to health and aged care service providers, technology providers (developers and vendors) are now key players, most effectively when they work in **collaboration** or formal **partnerships** with health and aged care providers. Many technologies are invented without the purpose of providing care or support to older people, but have that outcome and are, therefore, relevant (eg Smart Homes, voice-activated technology).

In addition, consumers are increasingly part of a collaborative delivery process because of their increased ability (through technology) to monitor their health status and share findings with their care providers, and therefore, to self-manage some of their care and support (as discussed in Section 2.3). Again, this is most effective if it is based on a *partnership of care* to ensure that the technology involved is appropriate, and if that technology has been co-designed with end-users. For the first time, each of these three stakeholder groups has become a *co-provider* and a *co-supporter*.

FIGURE 2: A NEW PARTNERSHIP OF CARE PROVISION



As part of this process, new providers have entered the care 'market', for example, Apple and Google (see Case Study 1, Section 2.2.3). In 2014 Apple developed, with input from the Mayo Clinic, the *HealthKit*[4], designed to fit into health and fitness apps in order to track and generate health and activity data. The Apple-Mayo Clinic partnership brings a range of benefits for both[5] organisations but exemplifies the disruption occurring in the care sector as a range of new (non-care) providers become part of the delivery landscape. The *GoogleFit* platform also organises data from multiple health-focused apps and it too has developed partnerships with health providers. Google's presence in the healthcare field has grown significantly and can be expected to continue to do so as new technologies, particularly Artificial Intelligence, play an increasingly important role.[6]

Advances in communication technologies, devices connected to the Internet and data analytics are occurring at a much quicker pace than at any other time in history. As a result, many believe we are now living through a fourth industrial revolution, referred to as 'industry 4.0' (i4.0).

> ***Industry 4.0 refers to the current point of rapid technological change that is disrupting how businesses conduct their operations across all industries (RMIT Digital Enterprise Centre: 2019).[7]***

The diagram below illustrates the magnitude of our Internet-based lives, showing human interactions on a number of platforms in the space of a minute.

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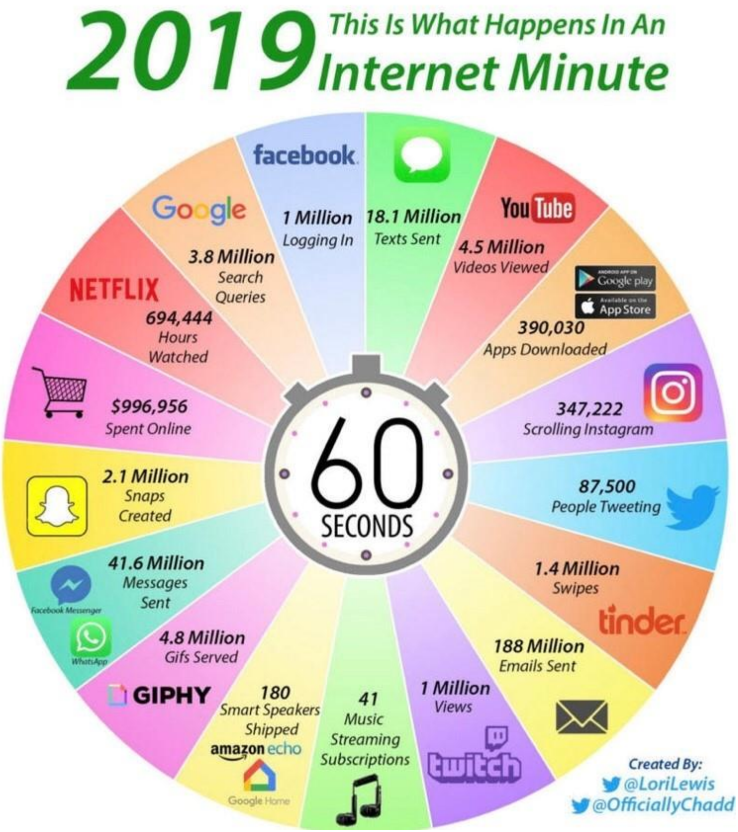
[4] https://developer.apple.com/healthkit/

[5] https://www.forbes.com/sites/dandiamond/2014/09/09/iphone-6-apple-and-mayo-clinic-partnership-could-be-smart-medicine-2/#47f2b38974e6

[6] https://www.cbinsights.com/research/report/google-strategy-healthcare/

[7] https://www.rmit.edu.au/industry/develop-your-workforce/tailored-workforce-solutions/c4de/industry-40



The major difference between industry 4.0 and the industrial revolutions that came before is that technology is something that is **embedded** into every aspect of our lives (RMIT Digital Enterprise Centre: 2019).[8] Increasingly, this will be the case for aged care, with technology being less of an after-thought and central to business operations as well as care provision. The changes overviewed in the next section give an indication of that future.

1.2 AN OVERVIEW OF KEY RECENT TECHNOLOGICAL CHANGE

> *Technological innovation isn't a straight line. It's not like a skyscraper with one floor of scientific achievement built vertically on top of another. Innovation is better represented as an inverted pyramid where one idea leads to several more which support yet more ideas (Hajkowicz & Dawson 2018: 10).*

In recent years, and particularly since the ACIITC's initial literature review in 2016, there have been significant advances made in a number of technologies that hold promise for enhancing the lives of older people as well as their formal care. The research evidence base is still building in relation to these technologies, but an overview is provided here because of their potential. *While they are discussed separately, it is important to remember that they are also being used in combination with significant effect.* As one technology advances, it affects the

[8] https://www.rmit.edu.au/industry/develop-your-workforce/tailored-workforce-solutions/c4de/industry-40

development of others, with Artificial Intelligence (AI) being a common denominator. For example:

- falls technology (discussed in Section 2.4.1) has evolved from detection to prediction (and therefore, prevention) status because of the combination of sensor technology and artificial intelligence.
- AI-based data analytics can be applied to predict likely health events, including hospital admissions.
- AI-enhanced software can be harnessed to improve care providers' performance and quality outcomes, enabling an automated compliance system (aligned to industry standards) but also linked to planned consumer outcomes.
- The combination of AI and Blockchain is transforming information exchange, supporting cross-sector data sharing while addressing concerns about security and control of data.
- The ongoing evolution of the Internet of Things and the integration of smart devices into everyday living is being accelerated as AI and Blockchain combine to determine how these different devices communicate and interact.

1.2.1 Advances in Artificial Intelligence and Automation

> *Artificial intelligence isn't a single system nor single technological breakthrough. It's what happens at the convergence of multiple technologies and multiple fields of scientific research. Today's building blocks for tomorrow's artificial intelligence are more powerful, and more diverse, than ever before in history. This creates a future world with vast potential for transformative artificial intelligence technologies (Hajkowicz & Dawson 2018: 10).*

Artificial Intelligence (AI) increasingly forms part of everyday reality as it is applied to technologies that make life easier, but increasingly, as a key component of technologies that support health and aged care provision. It is the *combination* of AI with specific technologies that are significant for the aged care sector.

> ***In artificial intelligence (AI), machines are programmed to develop cognitive functions for learning and problem-solving. AI has the potential to augment human intelligence just as machines increased physical capabilities a century ago (World Economic Forum 2018: 2 7).***

Advances in machine learning, in particular, in *deep learning* which replicates the structure and function of the human brain, meaning that machines now can learn and solve complex problems without human guidance. For example, Google scientists recently developed *AutoML* - an artificial intelligence software tool that codes its own artificial intelligence.

The ability of AI to automatically analyse huge amounts of data holds significant potential for the health and aged care sectors, not only in care provision but also in achieving business efficiencies by reducing errors and streamlining processes (see the *CSIRO Data61 and Commonwealth Bank* collaborative initiative below in Section 1.2.2). The CSIRO's Data61 team predict significant advances in AI generally, and in particular, in sensory systems, machine learning and predictive analytics (Hajkowicz & Dawson 2018: 9).

1.2.2 Advances in Blockchain and Data Analytics

> ***Blockchain is defined as a distributed, decentralized data ledger but can be simply described as a shared database. The technology enables the creation of digital records and their sharing and management securely on a network. Each participant has an identical copy of the database, which is updated as changes are made in real time (World Economic Forum 2018: 32).[9]***

A significant feature of Blockchain is its capacity to exchange information without the need for an intermediary and became well known because of its use in cryptocurrencies. Applying the technology to healthcare is expected to 'revolutionise" the sharing and management of health (and aged care) records because of its ability to document, exchange (with multiple stakeholders) and track data while safeguarding security and control of the data by its owner. For this reason, Blockchain's capacity to provide a transparent data trail is seen by some experts as having the potential to overcome interoperability challenges currently limiting data exchange (Rupasinghe et al 2019; World Economic Forum 2018). As with all technologies, it does require accompanying standards and ethical guidelines to safeguard privacy and data protection.

> *The need for data analysis and informatics will continue to dramatically expand as the digital revolution changes the ways people make decisions and the very ways in which people live their lives (Hajkowicz & Dawson 2018: 17).*

Please refer to Destination 1: Technology-enabled operational, business and communication systems of the *Technology Roadmap for Aged Care* for a discussion of the need for interoperability, open standards and common platforms to support digital data sharing within the aged care sector and with other sectors, particularly health.

[9] World Economic Forum (2018) *These are the top 10 emerging technologies of 2018.* https://www.weforum.org/agenda/2018/09/top-10-emerging-technologies-of-2018/

CSIRO DATA61 AND COMMONWEALTH BANK: TRIALLING BLOCKCHAIN-POWERED SMART MONEY

In 2018, a partnership between CSIRO's Data61 and the Commonwealth Bank (CBA) successfully trialled a new type of Smart (or programmed)[10] money, powered by Blockchain, with the NDIS as the first proof of concept case study. The trial demonstrated that Smart money could be used to help budgeting and the management of trusts and charities in Australia, as well as to manage insurance payouts, while also benefitting NDIS participants.

Enabled by a prototype App, the system enabled participants to manage their plan, to locate, book and pay for services from NDIS service providers without the need for paperwork or receipts and the time and effort involved by paper-based procedures. It was tested with 10 NDIS participants and carers in the CommBank Innovation Lab as well as a small number of medium-sized disability service providers.

Among the benefits identified for participants were greater choice and control over their disability support services, while the NDIS benefitted from reduced administration costs and paperwork as well as from reduced fraud risk and accidental misspending. Participants and carers estimated that the prototype App could save them *between one and 15 hours per week*, while service providers estimated potential annual cost savings as a percentage of revenue of *0.3 per cent to 0.8 per cent.*

CBA modelling highlighted significant potential for the entire NDIS ecosystem with a conservative estimate of savings of hundreds of millions of dollars annually if the proof of concept was implemented as part of a full-scale solution across Australia. Those benefits could have application across the aged care system.

See: data61.csiro.au/smartmoney

MANAGING ALGORITHM BIAS AND VALIDATION

The grey literature identifies two areas of concern in relation to the algorithms that drive AI. One of these relates to their validation and the other to their susceptibility to subjectivity and bias.

Best practice requires that an AI algorithm must be validated on external datasets from multiple institutions before being applied on a wide scale. However, recent research points to a preponderance of proof of concept technical feasibility studies rather than the robust validation of real-world clinical performance assessment (Kim et al 2019). This is a criticism that could be applied to much of the 'research' associated with new technologies – their focus is on technical feasibility (ie if they work or not) without determining their effectiveness for individuals who will be affected by them.

[10] 'Smart' or 'programmable' money allows for conditions to be attached to payments to allow tracking of who spent what, where and to identify merchants (https://www.itnews.com.au/news/cba-data61-build-prototype-app-for-blockchain-based-ndis-payments-513682)

Algorithms are written in the first instance by humans and cannot be guaranteed to be bias-free. This is a significant concern for AI-driven technologies designed for older people, with widespread ageism likely to shape algorithms.

> ***Algorithms are written and maintained by people, and machine-learning algorithms adjust what they do based on people's behaviour. As a result, researchers in computer science, ethics and law have noted that algorithms can reinforce human prejudices (World Economic Forum 2018: 35).***

1.2.3 Continued evolution of sensor technologies

Apart from sensors which are installed in specific environments, the development of *wearable* devices that achieve similar outcomes has created significant scope for those able to move independently outside of the home. Key enablers for their development include the widespread use of Smartphones (especially in Australia), longer-lasting batteries, and new materials and fabrics (including smart clothing, textiles and jewellery). AI-enabled sensors are allowing the collection of information about individual patterns of behaviour in *real-time*, enhancing assessment but also supporting the prediction of outcomes, which in turn, enables early intervention and prevention by health and aged care providers.

The evolution of sensors has been boosted by developments in nanotechnology that enable the development of *implantable or injectable sensors* that can be placed in the human body, and like wearables, support personalised treatment. These devices offer the potential for targeted treatments and avoid the side effects commonly associated with traditional medicine formats and injectable drugs.

> ***Interventions that speak the electrical language of the body will become central treatments in a host of major chronic diseases such as diabetes, asthma, hypertension, arthritis, pain and possibly even cancer (British pharmaceutical firm GlaxoSmithKline website).[11]***

Nanotechnology also makes possible the printing of sensors with very fine features onto flexible rolls of plastic, in large quantities, at low cost. Recent advances in nano 3D printing support the production of lab-grown retinas, new bones and nano-robots designed to deliver precise chemotherapy.[12] Changing the structure of materials through nanotechnology holds a range of possibilities, for example, creating water-repelling textures, adding coatings that allow materials to repair when damaged and creating textiles that can regulate temperature. Such developments have significant potential in the support and care of older people.

More than 1,700 consumer products containing nanoparticles have been introduced into the marketplace since 2005 (World Economic Forum 2018: 25).

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[11] http://www.meddeviceonline.com/doc/gsk-sets-trials-for-electroceuticals-for-chronic-diseases-0001

[12] Liam Mannix (2019) *Nano-scale printing promises lab-grown retinas, custom-made bones,* The Age, 30/3/19 https://www.theage.com.au/national/nano-scale-printing-promises-lab-grown-retinas-custom-made-bones-20190329-p518tn.html

1.2.4 Ongoing development of Virtual Reality and Augmented Reality

Appendix A provides definitions of Virtual Reality and Augmented Reality.

One of the sectors where Virtual Reality (VR) is most effective is in serving as a scalable alternative to traditional training methods, which otherwise require face to face, personally delivered programs to have the best learning outcomes (Bozorgzadeh 2019). There are a growing number of VR supports to the provision of dementia care, enhancing provider (and carer) understanding by replicating the dementia experience (see Section 3.6.1, and Case Study 4) and more recently some enabling early identification of dementia through sensors and through the use of machine learning (see Section 3.6.2).

1.2.5 Voice-activated technology

Voice-activated technology has become key to smart home connected devices, providing virtual assistants for a range of daily tasks. Voice recognition technology can include converting voice to text (see below), setting up reminders (eg to take medication), searching the internet, and responding to simple questions and requests, such as playing music or sharing weather or traffic information. Combined with artificial intelligence this is becoming a powerful tool making the use of technology easier but also requiring interventions to protect individual privacy. It has significant potential in supporting independent living and access to aged care services, as illustrated in Case Study 1 in Section 2.2.3.

Voice to text

Voice to text technology has significant potential for health service providers burdened by the time taken to enter information for electronic health records. AI-driven voice to text technologies record and transcribe conversations between health providers and consumers, transferring them directly to electronic records. This can reduce transcription errors[13] and in combination with smart clinical devices (ie that automatically record readings) has the potential to enhance efficiencies and enable providers to spend more time interacting with consumers.[14]

2 TECHNOLOGIES THAT SUPPORT POSITIVE AGEING AND INDEPENDENT LIVING

2.1 OVERVIEW: TECHNOLOGIES THAT ASSIST INDEPENDENT DAILY LIVING

The research literature provides a growing evidence base for the effectiveness of certain technologies in relation to a number of service types but also in targeting specific needs –

[13] At this stage, human checks are still required because transcription errors have not yet been eliminated.

[14] Meskó B (2019) Voice to Text Technologies Shape the Future of Electronic Medical Records, *Medical Futurist Newsletter*, September 12th 2019 - https://medicalfuturist.com/voice-to-text-technologies-shape-the-future/

highlighting its relevance for enhancing independent living – with or without aged care services.

A major systematic review of the literature published from 2000-2015 (unfortunately not updated since then) and based on robust methodologies categorised technologies found to play a significant role in the following:

- Promoting independent living (mainly through monitoring technology).
- Improving medication management.
- Reducing social isolation and increasing social connection.
- Identifying and managing falls, and more recently, predicting the risk of falling.
- Managing chronic disease (mainly through the telehealth and telecare technologies).
- Supporting people with cognitive issues, particularly dementia.
- Reducing or managing depression and enhancing well-being.
- Supporting family and other informal carers (Khosravi & Ghapanchi: 2016).

Since that review, these technologies have continued to be significant in supporting independent living and better quality of life, augmented by advances in other technologies that intensify their impact – particularly in relation to artificial intelligence and automation – and by improvements in specific technologies – for example, voice activation and robotics.

2.1.1 The growing importance of Apps and Smartphones

Apple launched the iPhone in 2007 and opened its App Store in 2008, quickly followed by other competitors in this disruptive and still growing market. Smartphones and Apps are inextricably linked in their growth and their impact on everyday lives, as well as on businesses.

> ***It's not an exaggeration to speak of a global App Economy, with an army of app developers writing mobile applications for billions of users. For businesses, apps have become the essential front door for their customer …. What's more, the App Economy still has room to grow (Mandel & Long 2019: 2).***

Analysis of government occupational statistics and data on posted job openings by the Progressive Policy Institute has yielded an estimate of 136,000 App Economy jobs in Australia as of January 2019, up from 113,000 in March 2017 – a *20 per cent gain* in the last two years (Mandel & Long 2019: 3).

Apps have quickly become an integral part of everyday living for many people and are now a key part of accessing government services. Not only do Apps have a role to play in providing services, but the data generated through their use offers significant secondary benefits by providing reliable and real-time data on patterns of service use, needs and preferences. (This is exemplified in Case Study 4: Sea Quest which is presented in Section 3.6.1). This can drive service reform, design and modify services that are responsive to consumer preferences and achieve a range of efficiencies (assuming they are designed appropriately and with user ease in mind).

Smartphone ownership in Australia has been increasing steadily. Deloitte's 2018 *Mobile Consumer Survey* found that 89% of 2,000 Australians surveyed owned a smartphone, a slow increase from 84% in 2016 and 88% in 2017, and is considered to have reached a point of saturation in 2018.[15] This is higher than ownership of laptops and makes the Smartphone central to providing older Australians with access to a range of technologies designed to support independent living.

Importantly, the evolution of the Smartphone has seen them include technologies such as sensors (accelerometer, gyroscope, GPS), that can generate data obtained in 'real-time', which if linked to appropriately designed Apps, not only provide feedback to the individual about their health-related status but can also be utilised by care providers. (See Section 3.2 which describes the role of Smartphone inbuilt technology in falls prevention and detection.)

The developing Smartphone and App economies, by originating outside of the care provision environment, are *normalising* health promotion and support technologies, avoiding the stigmatisation associated with many Assistive Technologies. This is critical for their adoption by older people, and also makes them highly accessible.

2.2 SMART HOMES SUPPORTING INDEPENDENT LIVING

The transformative impact of technology on everyday lives and living is particularly apparent in the developing 'Smart' living market. Smart home technology, also often referred to as *home automation* or *domotics*[16] embeds a range of largely digital technologies designed to produce greater automation, energy efficiencies, convenience, security and easier management of day to day activities. Smart Home systems and their linked devices and appliances operate as part of the Internet of Things (IoT)[17] and are controlled by a master home automation controller, often called a *Smart Home Hub,* that can be controlled remotely, usually by a Smartphone. *Amazon Echo* and *Google Home* are well-known examples of Smart Home Hubs.

Machine learning and Artificial Intelligence (AI) are increasing the sophistication of Smart Home technology, allowing personalised home automation applications reflecting user preferences and patterns of behaviour. Recent advances in *Voice Activation* technology (see Section 2.2.2) make it possible to control smart home technology without also needing high levels of digital literacy – a significant advantage for many very old people. Voice Assistants like *Alexa* and *Google Home Assist* have a growing share of the Smart Home market, but also

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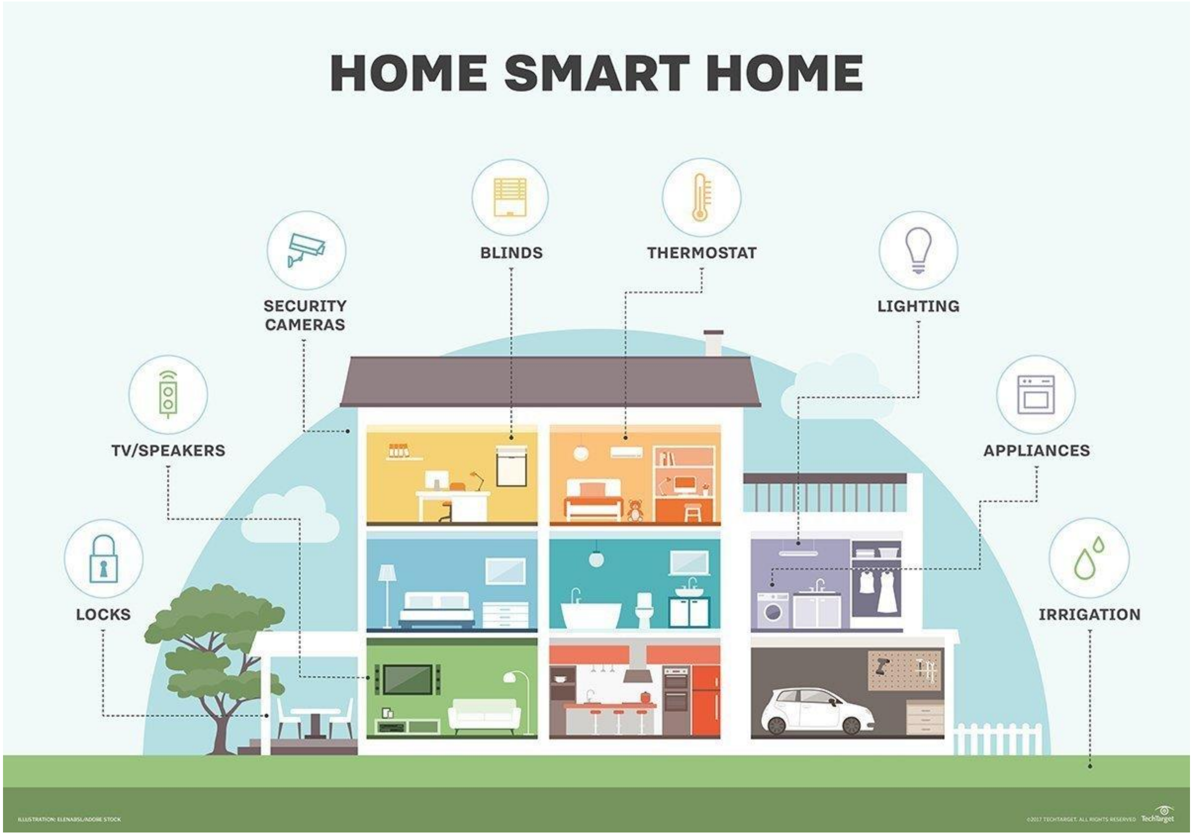
[15] Deloitte (2018) Mobile consumer survey. https://www2.deloitte.com/au/mobile-consumer-survey

[16] from the Latin "domus" meaning home

[17] *The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects … that are provided with unique identifiers … and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.* https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT

involve partnerships with care providers to tailor solutions for those needing support and care (see Section 2.2.3 Case Study 1).

FIGURE 3: ILLUSTRATION OF THE SMART HOME CONCEPT



Source: https://internetofthingsagenda.techtarget.com/definition/smart-home-or-building

As these technologies evolve, they highlight the critical importance of people's homes and local environments to their independence, and to healthy and positive ageing. As such, they can reduce the likelihood for many people of entering residential aged care as a result of functional decline and illness. However, these advantages need to be weighed against concerns related to security (when hackers can gain access) and data privacy (particularly in relation to Voice Assistants), and therefore, need to be accompanied by protection and security audits as part of the installation process.

There is a relatively small amount of robust research testing the effectiveness of Smart Home technologies to support older people to live independently, while the amount of essentially descriptive studies is large (Peek, Aartsa & Woutersa 2017; Morris et al 2014; Peetoom et al 2014; Reeder et al 2013; Calvaresi et al 2016; Brownsell et al 2011).

There is a trend for studies to focus on technical issues without also exploring the extent to which smart living technologies meet the needs of end-users (Marikyan, Papagiannidis & Alamanos 2019; Calvaresi et al 2016). While the literature continues to grow, it has *followed* rather than led this technology sector driven field (Wilson, Hargreaves & Hauxwell-Baldwin 2013: 3).

SMART HOMES: A RAPIDLY EXPANDING MARKET

The Smart Home market continues to grow rapidly, Data from the latest ***Telsyte Australian IoT@Home Market Study 2019*** report[18] identifies the following trends:

- Expansion of the Australian Internet of Things at home (IoT@Home) market by 57 per cent in 12 months to reach $1.1 billion in 2018.
- More than 50 per cent of Australian households (5 million households) are consumers in this market - an increase of more than 30 per cent in 12 months that is attributed primarily to the adoption of smart speakers.
- In terms of revenue, the smart energy segment is now worth more than one-third of the total IoT@Home market – driven largely by the adoption of smart energy solutions.
- In the longer term, Smart connected appliances (e.g. white goods) are expected to represent some 40 per cent of the industry's annual revenue by 2023.
- At present, the IoT@Home market is being driven by younger age groups, particularly younger families and 'tech enthusiasts'.

Source: Telyste (2019) https://www.telsyte.com.au/announcements/2019/5/14/australian-iothome-market-cracks-1bn-paving-the-way-for-iot-commerce-services

2.2.1 What do older people want from Smart Homes and other technologies?

Research findings indicate that older people hold *mainly positive* attitudes towards the Smart Home concept, particularly because of its capacity to support independent, assisted living, health monitoring and enhanced quality of life. However, while they perceive the potential to increase their safety and security at home, they also express concerns (as do consumers of all ages) about privacy and data security issues (Debaiyoti, Triyason & Funikul 2017; Morris et al 2013). One systematic review found that older adults …

- expect to be active participants in the design and ongoing implementation of the smart home in which they will live;
- want to share decisions about when they are monitored and with whom to share monitoring data;
- have identified as useful bed sensors and gait monitors;
- regard camera and video monitoring of sensor-based results as raising privacy concerns - although it is accepted that videos play a role in detecting emergencies;

[18] The 2019 report is the seventh in a series that uses a representative survey sample of 1,025 people aged 16 years and over. The survey process is supplemented with interviews with executives from service providers, network operators, manufacturers, retailers, financial analysts and channel partners, monitoring and analysis of local, global and vendor trends, and analysis of industrial reports and reviews.

- want devices to be user-friendly, reliable, with low purchase and maintenance costs, and not intrusive;
- value the provision of training in how to use devices; and
- are motivated to use smart technologies which address needs of independence and safety, and more broadly, which are perceived to be needed by them (Jacelon & Hanson 2013: 116-118; Morris et al 2013: 6).

2.2.2 A growing role for Voice Assistants

In recent years, the growing importance of voice activation technology has been evident in the popularity of 'digital assistants' or 'virtual assistants' – well-known examples being *Alexa* (made by Amazon) and *Google Home*. These take the form of 'speakers' that respond to a voice(s), which in turn activates commands. While research concerning virtual assistants is still in its infancy, these devices have great potential for older people (Mc Ardle, Morris & Hickey 2018).

This is exemplified with *My Carer Alexa* which supports people with early-stage dementia to set reminders for daily tasks, such as when to prepare meals or take medicines and can assist in recalling facts about family and friends,[19] Again highlighting the importance of partnerships between technology experts and aged care experts, it was developed through a partnership between the UK Alzheimer's Society, digital studio *Skilled* and the *McCann Worldgroup* marketing firm. Changes in speech patterns can indicate early-stage development of Alzheimer's Disease, creating the possibility of Digital Assistants playing a role in future diagnosis.

Zion Market Research recently estimated that the speech and voice recognition market will increase from a value of USD 6.19 billion in 2017 to USD $22.3 billion by 2024, with the addition of Artificial Intelligence augmenting its uses and impact https://www.zionmarketresearch.com/news/speech-and-voice-recognition-technologies-market.

Case Study 1 (below) illustrates the potential for voice-activated digital assistant technology to support independent living for older people. Voice activation overcomes the challenges faced by those who did not grow up in the digital age and who lack the skills associated with digital literacy as it does not require the use of a computer or tablet. This technology can compensate for challenges associated with dexterity issues, vision or memory that limit the ability to interact with computers or Smartphones.

[19] https://voicebot.ai/2019/05/23/alexa-skill-aimed-at-assisting-alzheimers-patients-launches-in-the-uk/

2.2.3 Case Study 1: Feros Care using Voice Command Technology to support independent living

Feros Care has partnered with Google to integrate the *Google Assistant* voice-command platform into its home care services, enabling consumers to find information on their *MyFeros* Portal and interact with services. The Portal was implemented as a pilot in March 2018 and since then its uptake by consumers has been increasing. A key advantage of the Portal is that, at its most basic level, it provides an alternative to the phone-based Contact Centre. Two months after its introduction, calls to the Contact Centre had reduced by 85 per cent, for those who were using the *MyFeros* Portal.

The Portal also supports a wide range of technology-enhanced services and timely communication between staff, volunteers and consumers and used in combination with Google Assistant, allows consumers to find information about upcoming appointments or carer visiting times, as well as information about their accounts and whether they have any messages, simply by saying '*Hey Google, ask Feros Care*'. Analysis of usage shows that the most common initial commands begin with requests for the day's weather and latest news, followed by queries about which Feros care worker will be visiting that day, whether there are new messages and when the next service will be provided.

The partnership with Google enables Feros Care to leverage from their ongoing innovation and to access all new products. Feros Care intends to extend the program to become a standard offering for clients and to incorporate Artificial Intelligence and automation technology. For example, this could allow consumers to receive medication reminders, to initiate music therapy designed for those with dementia or to provide health monitoring information to Feros Care (e.g. measuring their blood pressure or weight with approved, but inexpensive devices).

At a cost of $40 per Google Assistant, this can deliver basic telecare without the expense associated with video technology, with the information provided able to be studied via data analytics, and in turn, supporting proactive care. Although it requires internet access, Google Assistant can operate over low bandwidth making it accessible in most parts of Australia.

The empowering nature of this initiative is evident at the individual consumer level. Pilot participant Pamela, aged 73, returned home from a short hospital stay and relied on the technology to do so. Her MyFeros account was connected with Google Assistant via Google Home – a smart speaker that allows users to use voice commands to seek information and interact with services. Pamela can monitor and reschedule her upcoming services and carers, access her financial account and share messages with staff – all without picking up the phone. Pamela commented -

"*I couldn't get out of bed to use the computer but was able to ask Google Assistant what Feros Care services I had that day, which staff were coming to see me, and at what time. I've found it to be an excellent tool and I just hope people use it. They certainly shouldn't be daunted. I would be lost without MyFeros portal now.*"

Pamela and another Feros Care consumer who is living with multiple sclerosis discuss the positive impact on their lives made by this integration of voice-activated technology into their care at https://www.youtube.com/watch?v=9e84zw_q8TQ&t=30s

Feros Care has granted permission to the ACIITC to include this Case Study in the Literature Review

2.3 Technology-based Chronic Disease Management

Digital technology has an important role to play in the management of chronic health conditions but is being pursued to a far greater extent by the health sector (*eHealth*) than by aged care providers, with significantly *under-developed* potential in the aged care sector.

2.3.1 The tele-technologies and their role in chronic disease management

The tele-technologies are a cluster of related services that provide remotely delivered care and support, and address access barriers, particularly distance. Definition of the different variants of services involved in this cluster is provided in Appendix A.

Telehealth, Telecare and other virtual models of care and support are increasing due to growth in both the use of Internet-based technologies (e.g. Smartphones, tablets) and the growing number of homes having access to wireless Internet or NBN. This is creating increased opportunity for service providers to create new models of care and support where clients can connect more easily and more often to social programs, rehabilitation programs, education programs and to health professionals and case managers.

The tele-technologies are central to technology-enabled management of chronic illnesses and a significant portion of the research literature related to the care of older people with these conditions is focused on the use of *telemedicine*. Chronic conditions such as cardiovascular disease and diabetes can be monitored remotely, for example, by the measurement of vital signs (including temperature, blood pressure and respiration), measuring blood glucose levels and heart rates. Technologies being applied to transmit the resulting data to clinicians include remote monitoring equipment as well as computers, mobile phones and tablets. This is now a field of *rapid growth* in the research literature (Wootton 2012: 212).

Effectiveness of Telemedicine

Reviewing the literature as a whole, *telemedicine* emerges as very effective in managing chronic health conditions, improving functional status, general health and wellbeing (Khosravi and Ghapanchi 2016; Wootton 2012; Wildevuur & Simonse 2015; Vedel et al 2013; Lindberg et al 2013).

Effectiveness of mHealth

Research is also identifying a positive role for *mHealth* in achieving significant improvement in some health outcomes, including through the application of Apps – although it is important to differentiate between commercial mobile health Apps available to the public and those designed for use within the health system (Lee et al 2018). Among the *mHealth* approaches found to enhance self-management of chronic health conditions are

- automated text reminders
- frequent and accurate symptom monitoring (often in real-time), and
- improved communication between patients and healthcare providers.

However, gaps remain in the evidence base (Lee et al 2018).

Technology supporting self-management of health

These technologies also support *self-management* of health, which research has found to be effective in addressing chronic health conditions because the consumer is more actively engaged in the process and therefore more likely to take ownership of their health (Pellegrini et al 2014; Morrison et al 2012). Their use can improve health status, increase symptom control and thereby reduce the use of general practitioners and admissions to a hospital (Tegart et al 2014).

Such outcomes also bring benefits in the form of cost savings and efficiencies to health systems and evidence is growing about their effectiveness. In Australia, the CSIRO (Telehealth) Home Monitoring project highlights what is possible having identified:

- a 36 per cent decrease in hospital admission and a 42 per cent reduction in length of stay if admitted to hospital during the 12-month trial; and
- a reduced mortality rate of more than 40 per cent among participants.

See Case Study 2, Section 2.3.2 below.

Please refer to Destination 2: Technology-enhanced Care and Support for Older People of the *Technology Roadmap for Aged Care* for a discussion of the importance of monitoring technologies in improving health and care outcomes.

2.3.2 Case Study 2: CSIRO Home Monitoring of Chronic Disease for Aged Care

CSIRO Home Monitoring of chronic disease for aged care telehealth project

This two-year project (2013-2014), Australia's first multi-state and multi-site randomised controlled trial of *Telehealth*, sought to develop advanced modelling and data analytics while supporting chronically ill people through home-based Telehealth services.

Six fibre and fixed-wireless NBN-connected sites around Australia provided the location for the project and involved a diverse range of care models. Each site involved both participants in the home monitoring services and control patients who received usual care services. A total of **287** patients participated in the trial and were supported with Telehealth devices that included participant/clinician video conferencing capabilities, messaging features and the delivery of clinical and study-specific questionnaires, as well as vital signs devices to monitor their heart rate (electrocardiogram), blood pressure, oxygen saturation (spirometer), body weight and body temperature, with provision of a glucometer an optional add-on for people with diabetes. Important outcomes from this project were identified for **both** participants and the health system:

- ✓ significant change in the way participants understood their health condition and adapted their behaviours accordingly – highlighting the important role of *health literacy* and *self-management* of health and the role of technology in enabling this outcome;
- ✓ reported improvements in anxiety, depression and quality of life;

- ✓ savings to the healthcare system through reduced falls, reduced number and cost of GP visits, specialist visits and procedures;
- ✓ a 36 per cent decrease in hospital admission and a 42 per cent reduction in length of stay if admitted to hospital during the 12-month trial.
- ✓ a reduced mortality rate of more than 40 per cent among participants.

The project was funded a total of $5.47 million by the Australian Government Telehealth Pilots Programme, CSIRO and project partners. This funding proved to be a good investment, yielding a return on investment in the order of 5:1 due to reduced use of hospital inpatient and outpatient services, GP visits, community nurses visits and an overall reduced demand on increasingly scarce clinical resources.

CSIRO (2016) http://www.csiro.au/en/Research/BF/Areas/Digital-health/Improving-access/Home-monitoring

2.3.3 The monitoring technologies and their role in chronic disease management

The various monitoring technologies enable care providers to determine health-related status virtually, and outside of clinical settings – in people's homes or whatever location they happen to be visiting. Not only does this create greater flexibility of care but it also enables data to be captured in 'real-time'. Sensor technologies (including Wearable sensors) play a prominent role in remote monitoring and remote delivery of health consultations.

Typically, these technologies involve installing alarm systems and monitors that are capable of alerting service providers, carers or other supporters when something occurs that is out of the ordinary. Sensors are usually non-intrusive and rely on infrared or movement sensors that are embedded in the environment. Sensors are now significantly more-portable because they are designed to be *wearable*, and because of advances in nanotechnology, can take the form of *implantable* or injectable sensors that support personalised treatment (but will be available for care providers further into the future).

While the use of monitoring technologies is driven largely by the health sector, these could also be used by the aged care sector (in both residential and community services), ideally based on *partnerships* between both sectors and with key technology providers. Monitoring technology holds significant potential for supporting older people but, as with the broader literature, there is a need for additional reliable research evidence in order to evaluate their cost-effectiveness and capacity to prolong independent living (Peetoom et al 2014: 291).

2.4 Technology-based Monitoring and Surveillance

A range of monitoring and surveillance technologies exist that can enable older people to continue living in their own homes, noting that this will involve a trade-off for them between privacy and independence (and between the older person's desire for this and the peace of mind of their supporters). There is a tension between these trade-offs which is particularly evident in relation to the more intrusive monitoring technologies.

It is important to recognise that a *continuum* of monitoring technologies exists, ranging from least to most intrusive as well as from least to most effective in enabling quality of care and promoting safety. Sensors sit at the least intrusive end of this continuum while video surveillance is far more intrusive and, therefore, the least likely to be regarded as acceptable by older people (often in contrast to family carers' wishes for their safety) (Hawley-Hague et al 2014). This range is illustrated in the Fall Detectors – discussed in greater detail in Section 3.2, together with the role of sensor technology.

2.4.1 Fall Detectors: Illustrating the Range of Monitoring Technologies

At present, the aged care sector has been made highly aware of video surveillance through a series of incidents in residential aged care facilities that documented the abuse of older people, but there is a need to acknowledge that this is but one in a range of monitoring technologies, and to discuss the place of all of these in the care system. The need for a more *nuanced* approach is illustrated in relation to fall detectors. These can be broadly categorised into three groups, each of increasing technological sophistication and reflecting a shift from "Consumer-Push" to "Data Pull" initiation:

1. *First-generation* systems involve alarms relying on the user to detect the fall. Typically worn as a pendant around the neck, the user must push a button to contact a call centre or emergency services. These can be stigmatising and rely on the older person to be wearing them at the time of a fall.
2. *Second-generation* systems augment first-generation systems with an embedded level of intelligence. These comprise fall detection devices worn by the person that can trigger a call for assistance automatically without having to press a button.
3. *Third-generation* systems use data, often via ambient monitoring systems, to detect changes (e.g. in activity levels) that may denote increased risk of falling and support a preventive rather than reactive approach. Examples include the development of 'smart shoe insoles' that can send data regarding the wearer's gait to a central database, detecting changes in gait to prevent a fall; incorporating a fall detector into a walking stick able to measure abnormalities in gait which could predict increased fall risk; and embedding fall detectors into a 'smart floor' to detect whether the carpet is being walked on, or whether someone is lying prone on the floor (Ward et al 2012; Maki et al 2011). Recent technologies that facilitate correction of imbalance are an emerging fall prevention technology, as seen for example, in the *B-Shoe*.[20]

ETHICAL IMPLICATIONS OF MONITORING AND SURVEILLANCE TECHNOLOGIES

Awareness of video surveillance technology has increased significantly in recent years as a growing number of homeowners use it to protect their properties, More broadly, this reflects the need to continue sector-wide conversation about all forms of surveillance and their appropriate role in care provision (initiated by ACSA and the Older People's Advocacy Network (OPAN), both of whom have developed Draft Position Statements on this issue).

[20] https://b-shoe.com/

2.4.2 Addressing older people's attitudes to falls management technology

Regardless of how effective the technology, it must be acceptable to the older people for whom it is intended. A systematic review provides useful information about older adults' attitudes to technologies aimed at falls prevention, detection or monitoring (Hawley-Hague et al 2014) with much of the information being applicable to the adoption of other technologies able to assist in independent living at home. Across 21 studies reviewed, the following key insights emerged:

- **Control** over the technology and how it is used is very important to older people, particularly with regard to the protection of privacy. For this reason, video imagery depicting them after falling is seen as highly intrusive while alarms that cannot be turned off (e.g. when falsely activated) are unlikely to be used, mainly because of not wanting to 'bother' significant others and care workers, but also because of the nuisance caused to the person.
- Linked to control over technology was a **choice** of technology, with preference for user-friendly technology that older people are able to manage, thereby enhancing choice and control.
- Perceived **relevance** to individual need also emerges as affecting uptake, particularly for older men.
- Technology is also more likely to be used if it is perceived to improve personal **safety**, particularly in relation to real-time monitoring and connection to response systems.
- **Usability, reliability** and how well the technology **integrates into the home** also affect adoption and long-term use of technology. Large buttons and easy to read screens and signs are part of this, as are design aesthetics – older people do not want stigmatising technology that identifies them as 'fallers' or that makes their home look like a hospital or other institutional environment (Hawley-Hague et al 2014: 422-424).

2.5 Technologies that support enhanced social, emotional and psychological wellbeing

2.5.1 Technologies designed to reduce isolation and enhance social connection

Social isolation and loneliness have a negative effect on the health and wellbeing of older people. Various technology-based interventions exist to reduce social isolation but research demonstrating their effectiveness among older people is limited. A shared conclusion across all studies reviewed is that there is a need for further research on the role technology can play in reducing isolation and increasing social connectedness (Baker et al 2018; Khosravi, Rezvani & Wiewiora 2016).

2.5.2 Technologies designed to reduce depression and enhance psychological wellbeing

The effectiveness of technology-based interventions in promoting the mental health and wellbeing of people aged 65 and over has a limited and inconsistent evidence base (Forsman et al 2018).

Smartphone Apps for treating depression symptoms: encouraging potential

The first meta-analysis of Smartphone Apps for the treatment of depression symptoms (Firth et al 2017) identified that depressive symptoms reduced significantly more from Smartphone Apps than Control conditions ($p<.001$). However, this applied to those with self-reported mild to moderate depression, and particularly when Cognitive Based Therapy (CBT) interventions were involved.

The authors noted that this field can be expected to grow, with 14 of the 18 eligible studies published in the preceding two years. They concluded that Smartphone Apps offer a promising self-management tool for depression (Firth et al 2017: 287).

2.5.3 A role for robotics

The different types of socially assistive robots are defined in Appendix A.

There are a number of ways robot technologies can assist older people to live independent lives, with two types featuring in the literature – pet or companion type robots, and lower limb ATs that assist with mobility (most of these being exoskeletons that are fitted to the outside of the limbs). The majority of studies focused on the latter group of technologies have been limited to controlled laboratory settings or a laboratory situated within a clinical environment. Social robots designed to communicate and interact with people offer the *potential* to contribute to improved social and emotional health outcomes. However, evidence from randomized controlled trials (RCTs) on health and well-being outcomes requires further development (Morris et al 2014).

An Australian review of 1,035 studies focused on the use of *Telepresence robots* to improve social connectedness in people with dementia concluded that despite being limited, the existing research evidence base *"… suggests that telepresence robots have potential utility for improving social connectedness of people with dementia and their carers."* (Moyle, Arnautovska et al 2017: 22).

Pet robots

Pet-type robots have been found to be effective in reducing depression and stress levels, improving mood, and reducing social isolation (Khosravi & Ghapanchi 2016). However, the research evidence base is still growing (Minmin et al 2019; Robinson et al 2019).

A cluster-randomized controlled trial conducted in 28 residential aged care facilities in south-east Queensland tested the effects of PARO (Version 9) on the emotional and behavioural symptoms of 415 people living with dementia in those facilities (Moyle, Jones et al 2017). PARO was found to be more effective than usual care in improving mood states and agitation, but only more effective than a plush toy in one outcome area, namely, encouraging engagement (Moyle, Jones et al 2017: 772). The authors concluded that while these findings partly supported the efficacy of PARO, they also indicated that aged care providers with limited resources could use a soft toy animal effectively with someone living with dementia, and that PARO should not be used as a replacement for care workers but rather to compensate for staff being busy with other tasks or as a comforting mechanism (Moyle, Jones et al 2017: 772).

Please refer to Destination 2: Technology-enhanced care and support for older people of the *Technology Roadmap for Aged Care* for a discussion of the issues associated with supporting independent living and wellbeing, and the actions needed to implement this Destination in Australia.

2.6 TECHNOLOGIES DESIGNED TO SUPPORT FAMILY CAREGIVERS

As Australian aged care shifts increasingly to community-based care, the role of family caregivers will become even more important because they are often the linchpin in this model. There is a limited but growing amount of reliable research in the current literature on the impact of technology on informal carers, although that which exists has a strong emphasis on carers of people living with dementia.

Systematic reviews identify that technologies contribute to carers' wellbeing by reducing the amount of time, assistance and energy required to provide support and care, reduced depression, pain and stress among carers of people with dementia and significantly improved mental health status, self-efficacy, and social support (Marziali & Garcia 2011; Hu et al 2014; Lorig et al 2012), a lessening of anxiety and fear, task difficulty, safety risk (particularly for activities requiring physical assistance) while increasing the independence of the person in their care (Marasinghe 2016). Telemedicine and monitoring technologies have been found to be effective in reducing carer stress and sense of 'burden' (Chi & Demiris 2015; Sherifali et al 2018).

However, caregivers' relationship with technology is complex as the workload related to caregiving can itself be a barrier to adopting, experimenting and using technology, while reducing that workload can be an enabler to technology usage (Marasinghe 2016). One systematic review identified strategies for enhancing the use of technologies, in particular:

- Providing information about potentially useful technologies early in the process of diagnosis.
- Ensuring that this information led them to user-friendly and practical AT solutions. Most carers were unaware of new and available technology supports (Siriam et al 2019: 20).

3 TECHNOLOGIES THAT SUPPORT AND ENHANCE THE CARE OF OLDER PEOPLE

3.1 ASSESSMENT OF NEED

As technology evolves, its contribution to the tailored supports designed for aged care consumers is significant, but this is not reflected in the aged care system's requirements for assessors (neither for entry to residential nor to community care). Whether or not new technologies that can transform the capacity for independent living will or do form part of the service response is a matter of chance, rather than design, and will depend on individual assessors' familiarity with these potential solutions (ACIITC 2017: 22-24).

> ***Despite the availability of technology that supports assessment of function and need these technologies are not an embedded feature of assessment processes. These technologies have the capacity to save resources in the resource-demanding aged care sector, increase time savings, improve the capacity to track and maintain client records, facilitate more effective assessment and monitor changes in capacity. Some technologies, for example, sensors, can yield information which a single or even repeated assessments may miss (ACIITC 2017: 24).***

The effective uptake of technology-enabled assessment is likely to be hindered by an absence of supporting systems for technology-enabled assessment (Lowe et al 2013) and workforce capacity that may involve those performing assessment roles having the clinical knowledge required, but not the training, skills and knowledge of technologies.

At present reviews by aged care service providers are undertaken (in most instances) by administering assessment instruments manually, at isolated intervals and without the benefit of 'real-time' data collection. There is scope for greater use of technology-enabled assessment, allowing for more frequent assessment in 'real-time' as well as for self-administration by consumers - empowering them to play a more purposeful role in monitoring their status over time. Smartphones also offer significant promise because of their ability to capture a range of data, including sensor-based information, making assessment a portable activity whose data can be analysed anywhere at any time. Their increasing ownership by older Australians, with agreed and appropriate Apps installed, makes them a potentially vital part of assessment infrastructure.

Reviewing the available research, there are two trends evident. The first involves the application of technologies, particularly sensors, to accurately measure functional capacity in 'real-time', to send that data to service providers, and to automate assessment. The second is associated with the evolution of Smartphones whose inbuilt sensors can be utilised in assessment, involving consumers in the assessment process, and capturing real-time data rather than episodic data (as occurs through appointed assessment sessions).

In one study, a self-administered, Smartphone[21] application that completely automates the *Timed Up and Go* or TUG was trialled (Milosevic et al 2013). The application *(*the *sTUG)* provides instantaneous feedback to the user and allows for automatic uploads of the results into their medical record. The sTUG was found to be affordable and offering immediate quantification of TUG results (Milosevic et al 2013: 6). Another study used a sensor-enabled chair to automate TUG assessment *(aTUG)*. This avoided the need for wearable sensors, offered scope for older people living at home to self-administer the TUG, and the potential to be further developed into a 'smart chair' capable of also collecting various biometric information (Sprint et al 2015; Frenken et al 2011).

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[21] sTUG is developed for Android operating systems and requires a smartphone with the accelerometer and gyroscope sensors running Android 2.3 or above (Milosevic et al 2013).

Automated assessment is likely to be a further feature of technology-driven assessment reform, assuming it can achieve a high utility to cost ratio and support scalable health and aged care (Sprint 2015: 13).

Please refer to Destination 4: Technology-enabled assessment of eligibility and changing need of the *Technology Roadmap for Aged Care* for a discussion of the issues associated with technology-enabled assessment, and the actions needed to implement this Destination in Australia.

3.2 FALLS PREVENTION, DETECTION AND MANAGEMENT

In relation to falls, assistive technologies can be divided into (1) those designed to *prevent* a fall from occurring; and (2) those which aim to *manage* the outcome of a fall after it has occurred. There is emerging evidence that falls could be prevented with appropriately designed intervention programs, although it is important to acknowledge that technology is a critical (but not stand-alone) component of overall falls prevention strategies.

THE ROLE OF SENSORS

Sensor technologies have a key role to play in falls prevention and detection. Typically, these technologies involve installing alarm systems and monitors that are capable of alerting service providers, carers or other supporters when something occurs that is out of the ordinary. Sensors are usually non-intrusive and rely on infrared or movement sensors that are embedded in the environment.

Sensors are now significantly more-portable because they can be designed to be *wearable*, and *wearable* technology has advanced significantly since the era of large and stigmatising alert buttons worn around the neck. This is due in large part to the recent popularity of lifestyle wearables like *Apple Watch* and *Fitbit,* which are being used widely by the general population for health promotion purposes, and are increasingly accessible and affordable.

Wearable sensors can measure users' manner of walking as a key indicator for predicting falls. When the device detects a change in gait, it alerts the users that they may be headed for a fall. *Inertial sensors* can collect relevant data associated with gait characteristics. Accelerometers and gyroscopes have been used in this context in a number of studies. Combining *ambient* sensor data with sensor data from *wearables* is important to be able to recognise context and activity for falls prevention interventions (Danielsen et al 2016: 187-189).

THE INCREASING ROLE OF ARTIFICIAL INTELLIGENCE (AI)

Early technology-enabled falls prevention was based on the use of sensors but more recently, the addition of Artificial Intelligence (AI) enables an individualised record of normal and abnormal movement, analysis of which can generate *predictive* information. This is part of a wider and growing trend to incorporate Artificial Intelligence with accompanying data analytics into health care programs. Next-generation monitoring technologies apply machine learning technology (Artificial Intelligence) that enable them to learn and analyse behaviours in 'real-time', supporting prevention and early detection of fall risk.

3.2.1 Falls detection technology

Fall detectors exemplify the growing sophistication of technologies as they move from simple detection to fall prevention (as discussed in Section 2.4.1). Examples include:

- the development of 'smart shoe insoles' that can send data regarding the wearer's gait to a central database, detecting changes in gait to prevent a fall;[22]
- a fall detector incorporated into a walking stick that is able to measure abnormalities in gait which could predict increased fall risk;[23] and
- embedding fall detectors into a 'smart floor' to detect whether the carpet is being walked on, or whether someone is lying prone on the floor.[24] The 'smart carpet' also has the benefit that it does not require the user to remember to maintain batteries. It does this by using "energy scavenging sensors" that can harvest energy (such as light, thermoelectric and vibrational energy) from the surrounding environment (Ward et al 2012: 206-207: Maki et al 2011: 474).

Remote health monitoring and sensor technologies have been found to improve older people's safety and reduce their risk of falls (Khosravi P & Ghapanchi 2016: 18 citing Lancioni et al 2013; Cowan et al 2012). Fall risk assessment sensors and wireless bed sensors have been found to be effective technologies in reducing falls – each achieving an 18 per cent reduction in fall rates (Khosravi & Ghapanchi 2016 citing Lancioni et al 2013 and Cowan et al 2012).

3.2.2 Falls prevention technology

A recent systematic review by Sun and Sosnoff (2018) examined research evidence that synthesised findings of studies focused on specific types of sensors and identified the range of sensors that can contribute to accurate prediction of falls.

- Four major sensing technologies (inertial sensors, video/depth camera, pressure sensing platform and laser sensing) were reported to provide accurate fall risk diagnostics, with sensing technology being found to constitute a viable assessment tool for fall risk assessment.
- Wireless pressure insole devices were found to have a role in fall prevention by continuously monitoring daily living activity and by deriving gait parameters for diagnostic purposes (Sun & Sosnoff 2018).

Overall, these sensor-based technologies were found to provide "*... accurate, inexpensive, and easy-to-administer objective fall risk assessment.*" However, the variation in measured parameters, assessment tools, sensor sites, movement tasks, and modelling techniques led

[22] eg http://newamericamedia.org/2017/02/smart-soles-and-other-high-tech-ways-to-stop-falls.php
[23] eg https://pdfs.semanticscholar.org/abae/d0232d4f43b39d0a9cfda9838dad91f1bce1.pdf
[24] eg http://www.silvereco.org/en/sensfloor-a-smart-floor-to-detect-falls/

the authors to conclude that further research was needed to accurately confirm their ability to predict future falls (Sun & Sosnoff 2018).

> ***In the long term, such ambient sensing technology may provide an unsupervised, automated fall risk screening tool in a community and/or assisted living settings (Sun & Sosnoff 2018: 8).***

3.2.3 Interactive technology: video games, virtual and augmented reality

Interactive games using digital technologies can play a role in falls prevention by educating and increasing awareness of fall risks, and by engaging older people in physical activity designed to improve mobility and reduce the risk of falling. Game consoles and sensor devices such as *Nintendo Wii* and *Microsoft Kinect* are often used in this context.

A small but growing area of research is comparing the effectiveness of VR based training with traditional training methods, indicating that VR can be an important training tool in falls management (Phu et al 2019). Multiple studies have identified that interactive games have a role to play as an *adjunct* to (rather than alternative to) existing falls prevention interventions. They have been found to motivate participation in physical activity interventions, in part because of their ability to provide feedback on performance (Hamm et al 2016).

3.3 Medication management

Paper-based medication brings multiple problems relating to duplicated information, conflicting information, illegible handwriting and lost faxes – all of which create the potential for errors and wastage of resources. Furthermore, medication is one of multiple risk factors associated with falls, often because of side effects, such as, dizziness, or because of the interactive effect of polypharmacy (Coggins 2019).

By early May 2019, residential aged care providers had reported in excess of 112,000 incidents of substandard clinical care to the Royal Commission into Aged Care Quality and Safety. Of these, some 68,000 incidents involved medication mismanagement. Among the findings of the recent review of research by the Pharmaceutical Society of Australia were that 250,000 hospital admissions annually are a result of medication-related problems of which half are preventable. In relation to residential aged care, the review identified that -

- Over 90% of residents in aged-care facilities have at least one medication-related problem, with an average of 3.2 problems per person.
- As many as 80% are prescribed potentially inappropriate medicines (PSA 2019: 6, 14).

There is significant potential to improve quality and increase safety through purpose-designed medication management technology and around Australia, individual providers have begun to invest in such technology. Case Study 3 (below) illustrates the importance of establishing cross-sector ecosystems that support information sharing across aged care, health care and pharmaceutical service provision. It exemplifies how one provider, Adelaide-based *Life Care,* has used technology to automate medication ordering and dispensing, and established digital communication that links their nursing and care staff, GPs and pharmacists, in the process reducing risks associated with human error in providing medication to their residents.

3.3.1 Case Study 3: Technology-enabled Medication Management at Life Care

In New Zealand, most aged care providers and many health care providers use the *Medi-Map* technology to manage medications. Evaluation of *Medi-Map* in New Zealand found a 22 per cent decrease in medication wastage over 12 months. Participating doctors identified improvements in the speed at which they could review records, chart medication and send or receive notifications. Feedback from nurses cited the freeing up of their time to care for patients as a result of the system's efficiencies. [25]

Medi-Map provides a cloud-based means to chart, store and share medication records and was developed by a New Zealand pharmacist working in collaboration with technology partners. It has been found to generate quality care benefits as well as resource efficiencies (through time-saving automation and reduced medication errors and wastage). It is stock control and stock-taking software also support detailed tracking of pharmaceuticals and automated re-ordering.

In 2017, Adelaide aged care provider *Life Care* became the first provider in Australia to adopt *Medi-Map,* which apart from its quality care outcomes, also overcomes the lack of interoperability and sharing of health and aged care consumers' health needs and records by creating its own GP-aged care provider-pharmacist ecosystem. This involves Life Care's five residential facilities, a well-known Adelaide pharmacy chain and clients' GPs (with the latter controlling its operation, preparing prescriptions and updating these as needed onto *Medi-Map.)*

A number of similar products have been, and are being developed, including Telstra Health's *MedView* [26] - a national cloud-based platform that health professionals access to obtain information about their patient's medication history and provide advanced medications management capabilities. *MedView* has transmitted more than 2 billion prescription and dispensing records, involving in excess of 22,000 prescribes and 4,900 pharmacies nationally.

Life Care has given permission to the ACIITC to include this Case Study in this Literature Review.

3.4 CONTINENCE MANAGEMENT

Most assessments of continence in Australian residential aged care are undertaken manually by care staff (Fish & Traynor 2013: 35). This is labour-intensive, time-consuming and intrusive. They are also reliant on older people being able to communicate their toileting needs, which is not always possible when incontinence co-exists with dementia. Although technology has been found to hold promising potential for addressing all of these challenges, the evidence base remains *limited*.

There are very few systematic reviews of the effectiveness of technology-enabled continence management among older people. Fish and Traynor (2013) reviewed the small number of studies that have involved sensor-based 'smart' continence aids, used in combination with

[25] Case Study - Spark Digital (2017) Medi-Map - https://www.sparkdigital.co.nz/case-studies/medi-map/
[26] MedView (2019) MedView is powered by eRx Script Exchange, a wholly owned subsidiary of Fred IT Group - https://www.medview.com.au/

wireless monitoring. These record continence patterns in real-time and automatically send this information to central data management systems. Each of these studies yielded positive findings, highlighting the *potential* for technology-enabled continence management (Fish & Traynor 2013: 35-39).

3.5 PAIN MANAGEMENT

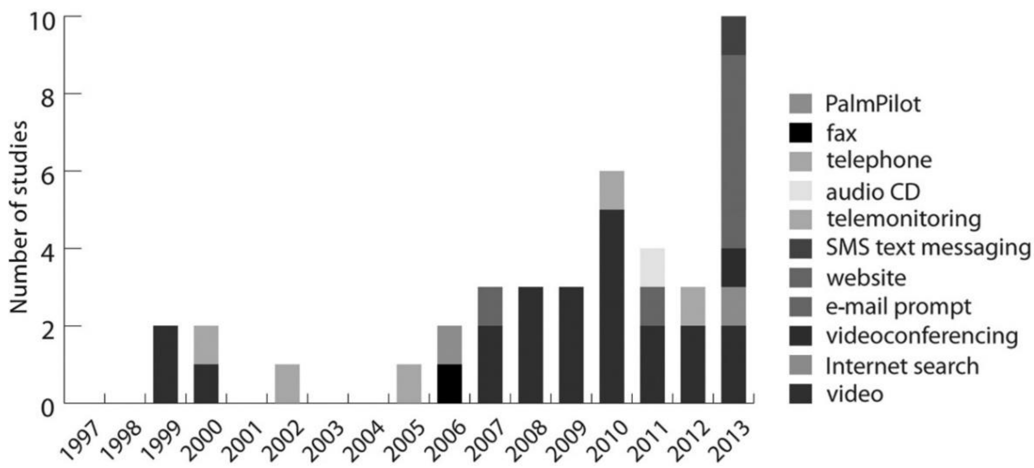
As Smartphones become an increasing feature of daily life, it can be expected that the use of mobile health (mHealth) technology will increase, including for people living with chronic pain. These technologies include electronic pain diaries, digital pain assessment programs, Smartphone pain Apps, activity trackers and Internet-based therapies.

At this stage, research evaluating the effectiveness of health technologies focused on older people's pain management is scarce (Bhattari & Phillips 2018) but can be expected to grow. There are a number of studies that focus on using technology to manage pain associated with a specific or chronic condition experienced by many older people, for example, arthritis. One systematic review identified 373 pain self-management Apps relevant to arthritic pain management and concluded that few offered a comprehensive pain self-management approach incorporating evidence-based strategies (Bhattarai et al 2018). Another systematic review investigated empirical applications of mHealth technologies designed to support self-management of osteoarthritis. It too found a lack of research evidence on the effectiveness of mHealth apps focused on this condition (Choi et al 2017).

3.5.1 Technology supporting pain management and end of life care

The use of ICTs in End of Life (EOL) care is a small but growing field of research (Ostherr et al 2016). A recent systematic review filled a gap in available research by identifying the uses and effectiveness of ICTs in EOL care. From the 38 relevant articles identified, eleven types of technology were identified: video, website, telephone, videoconferencing, e-mail, telemonitoring, Internet search, compact disc, fax, PalmPilot, and short message service (SMS) text messaging. This review also documented the significant growth in research on ICTs in EOL care in recent years. The Figure below plots this trend against the 11 technologies identified as supporting EOL care.

FIGURE 4: CHANGING USE OF TECHNOLOGY IN END OF LIFE CARE



Source: Ostherr et al 2016, Figure 2, page 416

Noting the ethical and logistic sensitivities associated with conducting research on patients nearing EOL, the authors concluded that technology-enabled end of life care is a rapidly growing area of enquiry, with a *maturing* evidence base.

3.5.2 Technology supporting pain management for people with dementia

Technology can assist in the identification of pain among people with moderate to severe dementia by compensating for individual inability to self-report pain and human error in assessing their pain because of reliance on subjective decision-making. One study reported an evaluation of the electronic pain assessment tool (ePAT)[27] – a point-of-care App that utilizes facial recognition technology to detect facial micro-expressions indicative of pain. The ePAT also records the presence of pain-related behaviours under five additional domains - Voice, Movement, Behaviour, Activity, and Body (Mustafa et al 2017). It was developed by a research team at Curtin University, Western Australia, in collaboration with nViso SA.

The ePAT's psychometric properties were evaluated against the widely recognised *Abbey Pain Scale* which was also designed to measure pain for people living with dementia. Based on 350 paired pain assessments, the ePAT performed well in relation to concurrent validity, discriminant validity, inter-rater reliability and internal consistency and demonstrated a strong correlation with the Abbey Pain Scale. Furthermore, ePAT's automated facial expression assessment was found to provide 'objective and reproducible evidence of the presence of pain' and to *automatically* calculate a pain severity score.

3.6 SUPPORTING PEOPLE WITH DEMENTIA

Technology has an increasing role to play in supporting people *living with dementia* in multiple ways, including:

1) *safety-related devices* (especially tracking or way finding and cooking safety).
2) *Memory aids*.
3) Technology designed to *prevent social isolation* (including by the use of companion robots).
4) Technology designed to *promote wellbeing* (a growing number of Apps are being developed specifically with this goal in mind).
5) *Clinical care support* of various kinds (for example, *music therapy* and *symptom monitoring*). The literature identifies a growing acceptance by service providers of these technologies and of *videoconferencing for diagnosis and monitoring*. Reliable findings have identified the role of video telemedicine being used for neurocognitive testing and neurological examination (Bossen et al 2015: 4-5).
6) An increasing number of aged care providers are incorporating *virtual reality* technology into their dementia-specific services providing a range of virtual

[27] Hughes J, Hoti K & Atee MAW (2016) Electronic Pain Assessment Technologies (ePAT) Pty Ltd, assignee. A pain assessment method and system, World Intellectual Property Organization (WIPO), Patent 025989, 2016-02-25.

experiences tailored to past experiences (such as, countries visited) with outcomes that include mood, wellbeing and engagement enhancement. See Section 3.6.1 for further discussion.

7) Another emerging field is the *'gamification of therapy'*, that is, the use of video games as therapeutic tools (Ienca et al 2017; Marasinghe et al 2016; Bossen et al 2015; Evans et al 2015). This can be used as part of virtual reality technology applications in the care setting – a good Australian example being the **VDE™** training tool described below in Appendix B.

However, despite the potential offered by rapidly developing technologies, research assessing their clinical effectiveness, and the translation of technological knowledge into dementia care, continue to be slow in growth (Moyle 2019; Ienca et al 2017). The research literature on the role technology can play in supporting people with dementia is as notable for its gaps as it is for its contribution to the evidence base.

3.6.1 Virtual reality as a dementia-specific training tool

There has been a recent but growing application of virtual reality (VR) technology to the care of older people living with dementia. At this stage, there is *limited* underpinning research evidence, but a small number of evaluations indicate its promise as an *educational* tool (Slater et al 2017; Adefila et al 2016; Doube & McGuire 2016; Beville 2014, 2002).

Three well known VR training programs - *myShoes* (Adefila et al. 2016), the *Virtual Dementia Experience™ (VDE™)* (Alzheimer's Australia Victoria 2014) and the *Virtual Dementia Tour® (VDT®)* (Beville 2014, 2002) each apply virtual reality to increase dementia awareness from the perspective of the person with dementia, enabling participants to experience the world as they experience it. Each has been independently evaluated, with positive impacts identified for the sample groups involved, but more robust, large scale evidence is still required (Slater et al 2017: 19). Appendix B provides more details about these programs.

Case Study 4: Virtual reality, gamification and research - Sea Hero Quest

Sea Hero Quest provides an example of an effective partnership between technology and ageing experts.[28] Designed by game studio Glitchers in 2016, in association with Alzheimer's Research UK, University College London and the University of East Anglia, this virtual reality game measures spatial navigation ability. The data generated every two minutes by ***Sea Hero Quest*** players has been quantified as equating to five hours of traditional laboratory research (Bozorgzadeh 2019). This is an important contribution to knowledge about dementia.

Recent research used the Smartphone App version to monitor how more than 27,000 players aged between 50 and 75, with or without a genetic predisposition to Alzheimer's, navigated a virtual world, using their thumbs to move a boat through a series of maritime mazes. The spatial navigation big data from the playing of ***Sea Hero Quest*** game was analysed to yield a benchmark distinguishing low risk people from those who were high risk because of their genetic profile (based on the APOE gene). The researchers concluded that high-risk

[28] See https://www.alzheimersresearchuk.org/our-research/what-we-do/sea-hero-quest/

preclinical individuals could be 'reliably distinguished' from low-risk participants using big-data spatial navigation benchmarks – despite being undistinguishable based on neuropsychological episodic memory tests (Coughlan et al 2019).

3.6.2 Emerging technological interventions to predict dementia

SENSOR-BASED GAIT ANALYSIS

Gait is emerging as a potential diagnostic tool for cognitive decline, being one of a number of clinical biomarkers that include changes in walking characteristics and behaviours, and that are known to be important in the detection of early indicators of dementia. Application of sensor technology holds potential for 'affordable, multi-centre and home-based monitoring' bringing benefits for individuals as well as service systems (Mc Ardle et al 2018).

ALGORITHMS TO PREDICT DEMENTIA

A new algorithm-driven model developed at MIT has been found to predict if people at risk of developing Alzheimer's Disease will experience clinically significant cognitive decline by predicting their cognition test scores up to two years in the future. MIT researchers analysed the world's largest Alzheimer's disease clinical trial dataset – the *Alzheimer's Disease Neuroimaging Initiative* – which holds data from 1,700 participants, with and without Alzheimer's, recorded during six-monthly visits to doctors over a 10 year period (MIT News 2019).[29]

The researchers used the data to train a population model, personalised for individual participants, and for the first time, applied a "metalearning" scheme to track cognitive decline due to Alzheimer's Disease (AD).

> ***This automated approach for forecasting of cognitive changes in AD could augment and assist clinicians by providing them with intelligent data summarization and decision support tools for early identification of at-risk subjects and construction of informative clinical trials (Rudovic et al 2019: 14).***

3.7 ETHICAL ISSUES

The inclusion of technology in the provision of services to older people requires an assessment of ethical issues. Unfortunately, these tend to be identified once a product has become available, again because much of the research is focused on technology feasibility studies and far less on its impact on older people. A focus on ethical issues associated with technologies that can support older people is largely absent in the research literature (Zwijsen et al 2011). Where such studies have been undertaken, the ethical challenges receiving most focused attention involve concerns about *safety, security* and *privacy* (Novitzky et al 2015: 758).

[29] MIT News (2019) *Model predicts cognitive decline due to Alzheimer's, up to two years out.* http://news.mit.edu/2019/model-predicts-alzheimers-decline-0802

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APPENDIX A: DEFINITIONS OF DIFFERENT TECHNOLOGIES

TELECARE TECHNOLOGIES

TELEHEALTH

Telehealth involves the *"… use of telecommunications and virtual technology to deliver health care outside of traditional health-care facilities"* and as the *"… most basic element of 'eHealth' which uses a wider range of information and communication technologies (ICTs)"* (WHO 2010) https://www.who.int/sustainable-development/health-sector/strategies/telehealth/en/

Telehealth can involve a broader scope of remote healthcare services than telemedicine, such as provider training, administrative meetings, and in-service medical education, in addition to clinical services. It has been described as having the advantage of being able to diagnose faster, identify potential medication interactions, and update and secure health records in real-time (Tegart et al 2014: 8).

TELEMEDICINE

Telemedicine signifies the use of various types of ICT to a) provide clinical support b) overcome geographical barriers, connecting users who are not in the same physical location and c) with the goal of improving health outcomes. (WHO 2010) https://www.who.int/goe/publications/goe_telemedicine_2010.pdf

TELECARE

While *Telehealth* services are delivered at home via information and communication technologies (ICTs), *Telecare* involves the use of (usually, sensor-based) alarm systems and monitors installed in the home and capable of alerting significant others, health services and care providers when something occurs that is out of the ordinary, signalling a possible crisis. It has been defined as – *"… the continuous, automatic and remote monitoring of real-time emergencies and lifestyle changes over time in order to manage the risks associated with independent living."* (Telehealth and Telecare Aware) http://telecareaware.com/what-is-telecare/

MHEALTH

The proliferation of mobile devices (phones, personal digital assistants and other wireless devices represents a group of technologies that can contribute positively to health. These are known as *mHealth* which is a component of *eHealth* (WHO 2011). https://www.who.int/goe/publications/goe_mhealth_web.pdf

DEFINITIONS OF DIFFERENT TYPES OF SOCIALLY ASSISTIVE ROBOTS

Socially Assistive Robots are designed to assist people with a range of daily tasks and to assist with social interaction by engaging users in lifelike social behaviour (Moyle et al 2017: 4). Within this category, a further four types of robots have been identified:

- *Healthcare robots* - promote or monitor health in order to prevent further health decline.
- *Rehabilitative robots-* perform physical tasks or make tasks easier for people with physical or functional limitations.

- *Social robots* – sometimes called *Emotional robots* designed to provide emotional support including companionship (without also assisting with tasks).
- *Service robots* - provide assistance with mobility, household tasks and health monitoring (but are not designed to provide companionship or emotional support).
- *Telepresence robots* - provide both companionship and assistance with the addition of videoconferencing technology (Moyle, Arnautovska et al 2017: 3-5, citing Robinson et al 2014).

Definition of Virtual Reality and Augmented Reality

> ***Virtual reality (VR) is an artificial, computer-generated simulation or recreation of a real-life environment or situation. Augmented reality (AR) is a technology that layers computer-generated enhancements on top of an existing reality to make it more meaningful through the ability to interact with it (World Economic Forum 2018: 32).***

APPENDIX B: VIRTUAL REALITY DEMENTIA TRAINING

THE VIRTUAL DEMENTIA TOUR ®

Developed by American not-for-profit education provider *Second Wind Dreams,* the ***Virtual Dementia Tour ®*** is used for workforce development in more than 20 countries, including Australia. For example, it has been undertaken by more than 2,500 staff employed by Churches of Christ in Queensland since July 2017, with a positive impact reported on participants' understanding of dementia.[30]

The ***VDT®*** aims to replicate moderate dementia, including its distortion of cognitive and sensory functions. While enhancing empathy, this experience has been found to generate a range of negative emotional response (such as, fear, helplessness, frustration) in participants. Evaluations have identified the increased understanding of the lived experience of dementia (Slater et al 2017; Beville 2002, 2014).

However, one researcher has raised **ethical concerns** about the virtual experience of the range of negative emotions involved and its promotion to all carers – including family caregivers (Merizzi 2018). Apart from providing 'an abusive reality' where participants have been found to experience increased levels of blood pressure and anxiety, frustration with not being able to complete tasks, and agitation when requests for assistance were ignored by the researcher (citing Beville 2002), the negative focus of the experience is seen as providing only a narrow view of living with dementia.

… it does not consider the persons' ability to adapt to life experiences and people's resilience in terms of experiencing love, attachment, enjoyment and beauty. In fact, the VDT® proposes a very narrow way of experiencing dementia and this can easily increase generalisation, pessimistic views and stigma about dementia (Merizzi 2018: 150).

Merizzi also raises methodological concerns about the promotion of the ***VDT®*** to all carers because of the lack of scientific evidence of its validity when extended to a broader population, being based on a single study in which only professional carers participated (Merizzi 2018: 150). For both of these reasons, she suggests caution in using this program.

THE VDE™

The **VDE™** is a multi-award winning Australian based program created by Alzheimer's Australia Victoria (AAV) [31] in collaboration with Melbourne game developers, *Opaque Multimedia,* and with carers, people with dementia and AAV's educators. It uses virtual reality gaming technology to promote empathy for and understanding of issues faced by people living with dementia. It aims to increase knowledge about person-centred dementia care, to assess the impact of environmental design on people with dementia and assist carers to gain insight about their care provision practice.

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[30] Cheu S (2019) Virtual experience improves care of residents with dementia, *Australian Ageing Agenda,* May 1st 2019

[31] See https://www.dementia.org.au/information/resources/technology/virtual-dementia-experience

In an evaluation commissioned by Alzheimer's Australia Victoria, Doube and McGuire (2016) reported that the VDE™ program's experiential learning achieved statistically significant increases in its intended empathic understanding and knowledge compared to usual classroom training. However, this is a single study and more robust evidence is required (Slater et al 2017: 19).

MYSHOES

The **myShoes** training program (Adefila et al. 2016) shares the learning and empathy-enhancing goals of the VDE and VDT initiatives. It uses a stereoscopic head mounted device and gaming technology to immerse the wearer into an avatar body in order to simulate the reality of the dementia experience. The session concludes with a debriefing exercise where learning and other outcomes are analysed.

Evaluation of the program (Adefila et al 2016) with 55 care professionals identified that its intended outcomes were realised, with increased understanding, empathy and compassion at a level that was statistically significant. As with the evaluation by Doube and McGuire (2016), this is a small size study but its findings are positive and encouraging.