

**Cost benefit analysis for adoption of technologies that improve
quality of life for elderly people living in their own home within
the RDAFCW region**

Final Report

Dr. Delwar Akbar, Dr. Azad Rahman, Julie Nguyen and Prof. John Rolfe

**Prepared for Regional Development Australia Fitzroy Central West
(RDAFCW)**

**School of Business and Law
CQUniversity, Rockhampton, QLD 4702
October 2018**

ACKNOWLEDGEMENTS

This research has been supported by Regional Development Australia Fitzroy Central West (RDAFCW). The material utilised in the preparation of this document incorporated a wide range of reports, papers, discussions, state government websites and library research. The research team also express their sincere gratitude to the workshop participants from Queensland government departments (Health, Science, Information Technology and Innovation), service providers (Centacare and Blue Care) and local IT and allied health specialists.

DISCLAIMER

The School of Business and Law (SBL) has made every attempt to ensure the accuracy and validity of the information contained in this document, however, SBL cannot accept any liability for its use or application. The user accepts all risks in the interpretation and use of any information contained in this document. The views and interpretations expressed in this report are those of the author(s) and should not be attributed to the organisations associated with the project.

Project leader:

.....
Dr. Delwar Akbar

School of Business and Law
CQUniversity,
Rockhampton, Qld 4702
Tel: 61 7 4923 2316
Fax: 61 7 4930 9156

Research team:

Dr. Delwar Akbar
Dr. Azad Rahman
Ms. Julie Nguyen
Prof. John Rolfe

This report should be cited as:

Akbar, D., Rahman, A., Nguyen, J., and Rolfe, J., 2018, Cost benefit analysis for adoption of technologies that improves quality of life for elderly people living in their own home within the RDA-FCW region, School of Business and Law, CQUniversity Australia, Rockhampton (pp. 58).

TABLE OF CONTENTS

HIGHLIGHTS	6
EXECUTIVE SUMMARY	7
1. OVERVIEW OF THE PROJECT.....	10
1.1. Introduction.....	10
1.2. Scope of the project	10
1.3. Aim of the project	11
1.4 Rationale of the Study.....	11
1.5. Organisation of the report	13
2. METHODOLOGY	14
2.1 Identification of relevant technologies, relevant cost and total cost estimation	14
2.2 Estimation of benefits in monetary value.	17
2.3 CBA Result Validation Workshop.....	18
3. POLICY INITIATIVES AND SERVICES FOR ELDERLY POPULATION.....	19
3.1 Chronic diseases and assistive technology for different group.....	20
4. DEMOGRAPHY OF FCW REGION.....	26
5. COST ANALYSIS.....	28
5.1. Elderly population forecasting for RDA FCW region	28
5.2: Elderly people need assistance for aging in place	29
5.3. Number of diseases of people aged 65 years and over	30
5.4. Costs estimation	31
6. BENEFITS ESTIMATION.....	34
6.1 Retention in HCP and BHS with the assistance of assistive technologies	37
6.2 Reduction in aged care services	38
6.3 Increase in quality adjusted life years (QALY)	39
6.4. Reduction in hospital admission	41
6.5 Net Benefits	41
7. CONCLUSION.....	43
REFERENCES	46
APPENDICES	49

LIST OF TABLES

Table 3.1: Care Needs Categories.....	21
Table 3.2: Technologies for Chronic Diseases	22
Table 4.1 Estimated resident population, by age group at 30 th June 2016.....	26
Table 5.1: Death Rate - Qld	28
Table 5.2: Elderly Population of FCW (progressive forecasting).....	29
Table 5.3: Percentage of Australian population aged 65 years and over living in household and need assistance.....	29
Table 5.4: Number of chronic diseases of Australian population aged 65 years and over (in 1000) ...	30
Table 5.5 Comorbidity matrix of chronic diseases Australian population aged 65 years and over (in 1000)	30
Table 5.6: Estimated population of FCW with different number of chronic diseases	31
Table 5.7: Breakdown of FCW elderly population with one chronic disease.....	31
Table 5.8: Cost estimation for assistive technologies	32
Table 6.1: Summary of literature review	34
Table 6.2: Expenditure on aged care services QLD (2016-17).....	38
Table 6.3: Services in QLD for aging in place	39
Table 6.4: Monetary values of QALY	40
Table A1: List of price of digital assistive technologies for elderly people.	51

LIST OF FIGURES

Figure 2.1: Framework of cost estimation.	15
Figure 2.2: Operational model for cost estimation for technological adoption	16
Figure 3.1: Home care package pathway	19
Figure 3.2: Percentage of budget share for different aged care sector.....	20
Figure 4.1: Map and location of FCW region (RDAFCW, 2015)	26
Figure 4.2: Change of percentage of elderly people in FCW during the last decade.....	27
Figure 5.1: Per capita cost for technologies adoption for different group	33
Figure 6.1: Patterns of aged care service use before first entry to PRAC in 2013–14 (AIHW, 2017)	37
Figure 6.2: potential savings for retaining in HCP and BHS	38
Figure 6.3: Savings for service hours reduction	39
Figure 6.4: Monetary value on increasing QALY	40
Figure 6.5: Benefits for less hospital admission	41
Figure 6.6: Net benefit analysis	42

HIGHLIGHTS

- **Purpose:** This study estimated the costs and benefits of adopting digital assistive technologies to improve the quality of life of the elderly people living in their own home within the FCW region.
- **Methods:** A five-stage hybrid model was developed to estimate the costs of the technological intervention. Four types of benefits were estimated by using the secondary data and a set of basic assumptions. The year 2016 is considered as base year.
- **Results:** This study estimated that annual per capita cost for technological intervention could be from AUD 4,169 to AUD 7,551 on the basis of different price ranges of the technologies. The total costing for 2016 would have been ranges from AUD 46 million to AUD 83 million. The net benefit (after deducting the net cost from the gross benefits) for technological intervention would have been AUD 110 million in 2016 and total net benefits could be reached to AUD 160 million by year 2026.
- **Conclusion:** To support the estimated results of the current study, a randomized control trial (RCT) study should be undertaken. Further study is recommended on more specific estimates about changes to QoL to update/existing or previous research on QoL measures.

EXECUTIVE SUMMARY

The School of Business and Law at CQUniversity has been commissioned by Regional Development Australia Fitzroy Central West (RDA-FCW) to conduct a preliminary costs and benefits analysis of adopting digital technology that can improve the quality of life of elderly people living in the Fitzroy and Central West (FCW) region.

Ageing in their own home is one of the greatest desires of elderly people, which is sometimes not possible due to the presence of chronic diseases and health condition at the later stage of life. Research suggests that assistive digital technologies could potentially delay the institutionalisation of the elderly people and allow them ageing in place. Digital technologies have a multitude of benefits include safety and security of elderly people, increasing connectivity with health practitioners, reducing social isolation, increasing functionality and increasing mobility. The aim of this study was to provide an estimate of costs and benefits of adopting digital technologies that can improve the quality of life of elderly people within the FCW region. A stakeholder workshop was also organised to understand the perceptions of the participants in technological intervention as well as to determine the future priorities.

The study team developed a five-stage hybrid model, which comprised of the progressive forecasting and direct cost estimation methods. The forecasting and cost estimation models have been set for a 10 year period because the accuracy and validity of the findings from cross-sectional data is better in the short to medium-term compared to long-term predictions. Therefore, we used progressive forecasting, which is appropriate for a short-term population projection. The elderly population (aged 65 years or over) in the FCW region was 30,314 in 2016. Our forecasting model predicted that number of elderly people will be 43,824 by 2026, about a 45 percent increase. The analysis also revealed that amongst this cohort, about 11,098 people lived in their own home in 2016 and needed assistance with at least one core activities; and this number will be 16,044 by 2026, i.e., about a 46 percent increase.

The identification of required assistive technologies with life-cycle cost is a vital component for accurate cost estimation. The literature review revealed that elderly people mostly suffer from eight chronic diseases, which are:

- Arthritis
- Asthma
- Back pain and problems
- Cancer (such as lung and colorectal cancer)
- Cardiovascular disease (CVD) (such as coronary heart disease and stroke)
- Chronic obstructive pulmonary disease (COPD)
- Diabetes
- Mental health conditions.

Digital technologies to assist elderly people with these chronic diseases were identified with some other basic digital devices to support daily living. The costs of the technologies were collected from both refereed and non-refereed literature and online sources. Per capita cost of technological intervention in the FCW region were estimated from the average cost of the fixed and variable costs over a 10 year

period. This study found, for the low-cost device users, the per capita cost will be AUD 4,169 per year while the figure could be as high as AUD 7,551 year for the digital devices with average range price; however this study did not include the high or very high cost models of the same technologies that can be purchased at a low or average¹ price range. For the elderly people with no chronic diseases, per capita costs for technological intervention is AUD 2,289 with low priced devices and AUD 5,206 for average price devices. Comorbidity² has a big impact on the per capita technological intervention cost, as discovered through this study. For instance, with the average priced devices and for the elderly people with three or more chronic diseases, the per capita costs reach to AUD 8,858.

An extensive literature review was conducted to identify the current practice of estimating health benefits in monetary value. One of the key components of benefit estimation is measuring quality adjusted life years (QALY). For the current study, the benefits of technological intervention were estimated using the available information in the literature and with a set of basic assumptions. Four key factors were considered in the current study to estimate the benefits:

- Retention of the elderly people in the home care package (HCP) and basic home support (BHS)
- Reduction in aged care service hours
- Increase in QALY of the elderly people
- Reduction in hospital admission.

Residential care costs are higher than HCP and BHS, which implies any retention in HCP and BHS with the adoption of digital technologies could lead to substantial savings. Results indicate that up to 11 million dollars could be saved by 2026 with a 25% retention rate (i.e., one of the retention scenarios developed in this study). However, this study considered the elderly people in the FCW region who need assistance for daily activities. Costs of various types of services provided to the elderly people were collected from secondary sources. The reduction of service hours with technological intervention is supported by the literature, hence potential saving may occur. Based on 25 percent reduction in hospital admission (i.e., one of the reduction scenarios developed in this study) in services, about 10 million dollars could be saved by 2026.

Quantifying QALY is generally done by calculating willingness to pay by the clients to achieve QALY. This study used information available in the Australian context to estimate the average WTP per QALY gained. The results indicate that with a 5% QALY gained (i.e., one of the QALY gain scenarios adopted in this study) by adopting digital assistive technologies could potentially save AUD 31 million in 2016, however these savings could be as high as AUD 229 million by the year 2026. Adopting digital technologies can also reduce the hospital inpatient hours and hence save money. Approximately AUD 30 million can be saved by 2026 under the 25 percent reduction in hospital admission scenario.

The net benefits of technological intervention were calculated by adding all benefits and subtracting the costs for technologies. The net benefit analysis suggests that technological intervention may not be cost

¹ Average range price is a price between the lowest and highest price of the same technology.

² Comorbidity is defined as the co-occurrences of one or more diseases or disorder of the same person.

effective if the combined level of benefit is below 10%. However, with a combined 25% of benefit level, AUD 160 million can be saved by 2026.

As a part of the study a stakeholders workshop was organised with the participation of local and state government people, service providers, RDA-FCW, nurses and allied health practitioners. The participants have expressed their concern about the barriers to adopt and access digital technologies for the elderly people. A few technologies were suggested during the discussion which were not included during the cost analysis. Telehealth has a large impact on the wellbeing of the elderly people ageing in place. However, this study only considered the devices to support telehealth and the entire impact of telehealth was not considered. Unproductive travel time is a barrier for the service providers and it reduces the actual service hours. Technological intervention could lead to a better communication system and may reduce the travel time of health providers

This study identified the importance of digital technologies for the wellbeing of the elderly people of the FCW region. However, one of the limitations of this study was not collecting primary data for analysis. The stakeholders and the study team identified the following research needs for further research:

- Randomised control trial (RCT) study to measure the improvement of the quality of life (QoL) with technological intervention, particularly focusing on the mobility aid with digital technology and fall prevention.
- Case study/individual personal story of home care benefits (e.g. Dorothy suffers from xxx chronic disease...).
- Understanding how home care options with digital technologies reduces travel cost for patients and reduces other measurable impacts on patient families.
- Improving cost efficiency of provider services: Looking at the travel and other costs of current services and how this can be reduced and improved with home care and other options.
- Focusing on more specific estimates about changes to QoL to update existing or previous research on QoL measures.

1. OVERVIEW OF THE PROJECT

1.1. Introduction

Under the Commonwealth Government initiatives, Regional Development Australia (RDA) was established to enhance the development of Australia's regions. Fitzroy and Central West (FCW) is one of those RDA regions. Providing better quality services to the elderly people under the home-care packages in the FCW region has been a strategic priority of the RDA-FCW committee and the local governments within this region. The current proposal for estimating the costs and benefits in adopting technologies that improves quality of life for elderly people in RD-AFCW region is one of the nine key recommendations made by the RDA-FCW (2017) study on aged care and allied health services within the FCW region.

Australian government initiatives and scholarly studies acknowledged the need for technological innovation and adoption in the aged care system (Buntin et al., 2011; Productivity Commission, 2013; Aged Care Sector Committee, 2015) to improve the aged care quality, safety and wellbeing of the elderly people. Technological innovation and adoption have been happening rapidly since the beginning of the 21st century, especially in the six domains of aged care services: communication technology, technology to support therapy and rehabilitation, telecare and environmental sensors, telehealth, telemedicine and technologies for securities. RDA-FCW (2017) also recognised that technological improvement and adoption are required in these domains of aged care services.

Several studies have been carried out in the past to evaluate the health technologies in favour of elderly people. In general, three types of methods were used to do the economic evaluation of health technologies: cost effectiveness analysis (CEA), cost-utility analysis (CUA) and cost benefit analysis (CBA) (Drummond et al., 2015). Under all three methods of economic analysis for health intervention evaluation, the measurement units for cost analysis is always in the monetary form. However, the measurement of consequences or benefit analysis vary amongst these methods. Under CEA and CUA, the measures are generally in the natural units, specifically in disability adjusted life years (DALY) and quality adjusted life years (QALY) respectively. Unlike the other two evaluations, CBA estimated the benefits in the monetary form (Drummond et al., 2015). Therefore the current study has chosen CBA because nature of the study is based on available data and literature but not a direct intervention study.

1.2. Scope of the project

This study was conducted via a desktop review of existing material with additional analysis and extrapolation where required. A five-step model was developed to estimate the net cost for the adoption of digital assistive technologies for the elderly people of FCW who choose aging in place. The resultant benefits were estimated based on a few assumptions due to the shortage of resources and time for the project. In addition, the study conducted a stakeholder workshop to understand needs related to technological adoption in in-home aged care services within the FCW region. The stakeholders included the service providers, RDA-FCW committee members, state and local government representatives. The research team with the assistance of the RDA-FCW made the initial contact with the expert panel stakeholders.

1.3. Aim of the project

The aim of this study was to provide an estimate of costs and benefits of adopting digital technologies that can improve the quality of life of the elderly people within the FCW region and where possible, recommended some strategic guidelines to improve the services for the elderly people who lives in their own home within the FCW region.

1.4 Rationale of the Study

Economic evaluation is essential to justify any public spending that come from overall tax-payers money. Culyer and Chalkidou (2018) argued the appropriateness of CBA and CEA to evaluate the health related investment in low and middle income countries (LMICs). They have identified a few issues and challenges regarding the implication of CBA and CEA in the prospect of LMICs. Akiyama and Abraham (2017) studied a comparative CBA of tele-homecare for two different groups of elderly people with government supported funding and without it. They identified that the benefit to cost ratio is higher in the case of non-government support funding model. In their study a few key parameters, including system cost, device costs, number of users and medical expenditure saved, were considered for sensitivity analysis. Dang et al. (2009) focused on the impact of tele-health remote monitoring on the wellbeing of heart failure patients. They had analysed the relevant literature to develop an evidence based conclusion on the benefits of telehealth technologies for the targeted cohort.

Caley & Sidhu (2010) have conducted a cost analysis study for the healthcare expenses for the ageing population in the UK. They noted that the estimated health care costs could be under or over-estimated due to the uncertainty of the morbidity pattern and the incapability to measure the cost burden towards the end of the life.

Cost benefit analysis on adopting different technologies are available in the literature. For instance, Kulvik et al. (2015) have developed an economic model to assess the cost benefits of applying boron neutron capture therapy (BNCT) to cancer patients. They have identified different benefits including non-monetary value of avoiding death, non-monetary value of an early recovery and spill over effects from novel technologies. Lehoux and Grimard (2018) have investigated the public perception on using robot technologies to assist older adults for independent living. They have identified several potential benefits in form of opportunities on using assistive robot along with some limitations as well. This study focused mostly on the basic assistive technologies along with some health care technologies to assist elderly people with chronic diseases. More advanced technologies like robot and nanotechnologies are not considered for the current study.

Ageing in place can be defined as the ability to live in one's own home safely, comfortably and with some level of independency regardless of age, income or ability level (Benefeld and Holtzclaw, 2014; Schorr and Khalaila, 2018). Age in place is one of the most common desires expressed by older Australians and the percentage is even higher for the outright owner of the home because of the satisfaction level with their housing (AIHW, 2013; Rioux & Werner, 2011). A recent study (AIHW, 2016) indicated that in 2014-15 more than 11 million Australians suffered from at least one of the eight most common chronic diseases. Meanwhile, about 60% of elderly Australians (aged 65 years and over) have two or more chronic diseases. The comorbidity of the elderly people is the most common reasons

for shifting them from their own home to some cared facilities. To enable the ageing in place researchers have investigated the adoption of digital technologies and their impacts on the elderly people with or without chronic diseases (Queirós et al., 2017; Kim et al., 2017, Rantz et al., 2013).

Hoof et al. (2011) investigated the ambient intelligence Unattended Autonomous Surveillance system (UAS) and their impact on the lifestyle of the older people living in their own home. They concluded that, though the new technologies could increase the sense of safety and security among the sample of elderly people, the ambient intelligence technology alone is not sufficient to age-in-place. Smart home concepts with health monitoring devices and assistive technologies were also studied to identify the benefits and supports for ageing in place (Cook, 2006). Kok et al. (2015) compared the cost benefit for the elderly people living in the home care and residential care. They have identified the additional expenses that need to be borne by elderly people living in the residential care facilities. Though, their study revealed that the respondents living in the residential care were happier than the same living under the home care.

Systematic reviews on the smart home and health monitoring systems are also available in the literature (Liu et al., 2016), which indicate that there is inadequacy in the readiness level of smart home and health monitoring system. They have also indicated that conflicting evidence were available on the benefits of smart home and health monitoring systems for the patients of Chronic Obstructive Pulmonary Diseases (COPD). Meanwhile, Wilson et al. (2017) have investigated the benefits and risks of smart home technologies from different perspectives. One of the key features of smart homes are developed communication technologies available at home to connect elderly people with the health practitioners and service providers. Magnusson & Hanson (2015) conducted a cost analysis on the information and communication technologies (ICT) for the elderly people and their carer living in their own home. Their study reveals that ICT based support could potentially empower ageing in place with cost savings in the community care services. Recent studies also highlights the importance of mobile and wearable technologies for the elderly people with chronic diseases and living in their own home (Malwade et al. 2018; Schaffer et al., 2018; Queirós et al., 2017; Kuo et al., 2016).

In the Australian context, no study has been identified on the cost benefit analysis of adopting digital assistive technologies. Khosravi and Ghapanchi (2016) have conducted a systematic review on the effectiveness of technologies to assist seniors and they have also pointed out the shortage of studies conducted on the ageing population of Australia. Literature also suggested that the number of studies conducted in the regional areas are lower than for urban areas. This study was targeted to identify the appropriate digital technologies to assist elderly people of FCW region and to estimate the associated costs on adopting those technologies. Moreover, this study has examined the potential benefits in monetary form that could be achieved by adopting digital assistive technologies. The authors identified this study as a pioneer in this research arena and indicated some way forwards in advancement of research and practice in the allied health sector.

In summary, this study focuses on cost benefit analysis for the adoption of available technologies that can bring better services and quality of life for elderly people who are seeking age care services at their own home.

1.5. Organisation of the report

This introduction forms Section One of this report. Section Two contains a detailed description of the methodology of the research project. This is followed in Section Three by background information on the Commonwealth and State governments' policies and key packages of aged care system. Section three also highlights the demographic profile of FCW region and provides a review on the digital assistive technologies. Section Four provides findings and analysis of both predicted elderly population as well as costs and benefits of adopting digitally assisted technologies. This study concludes in Section Five with some strategic guidelines regarding how to improve the services for the elderly people who lives in their own home within the FCW region.

2. METHODOLOGY

This section provides a detailed description of the methodology applied to collect data and assess and analyse various costs and benefits. A quantitative approach was undertaken to estimate potential costs and associated benefits in monetary terms. As a part of the study, a combination of expert panel and representative stakeholder's workshop was conducted to validate the study findings and prioritise the future action studies. Secondary data on the ageing population and the expenditure in the allied health sector were collected from Australian Bureau of Statistics (ABS), Australian Institute of Health and Welfare (AIHW) and Aged Care Financing Authority (ACFA). The assistive digital technologies have been identified from the available literature, medical catalogues, online resources and current usage by the health practitioners and service providers. The price of the identified technologies were mostly collected from online sources and by sourcing quotes from the retailer and suppliers.

2.1 Identification of relevant technologies, relevant cost and total cost estimation

A five step hybrid model has been developed in this study that includes a progressive forecasting and direct cost estimation method to estimate the total costs of adopting digital technologies for the elderly population. First, the project identified the number of elderly people under both home care and aged care services. The progressive forecasting method predicted the elderly population over the next 10 years period; here entry and death rates of specific age groups and migration rates for both overseas and interstate population are included.

Secondly, this study investigated the comorbidity pattern of the elderly people living in the FCW region; with the elderly population grouped into four categories based on the number of chronic diseases they have. Since individual data are not available in the secondary sources due to the sensitive nature of the data, this study estimated the number of people of each categories with possible combination of chronic diseases using normalisation ratio and combinatorial methods. This estimation is vital for the cost estimation as the different categories of elderly people needs different sets of technologies.

Finally, all direct costs related with technological adoption such as initial purchasing, set-up and maintenance costs have been estimated based on the prices available in the open access online sources. Then this study conducted a literature review to understand the needs for the technologies that require adoption by the elderly people who choose to live in their own home. The forecasting and cost estimation models have been set for a 10 year period because the accuracy and validity of the findings from cross-sectional data is better in the short to medium term compared to long-term predictions. Total costs have been estimated based on the key eight chronic diseases of the RDA-FCW population aged 65 years and over. All costs (fixed and variable costs) are estimated in the 2016 base year value. The five steps hybrid model for cost estimation is presented in Figure 2.1.

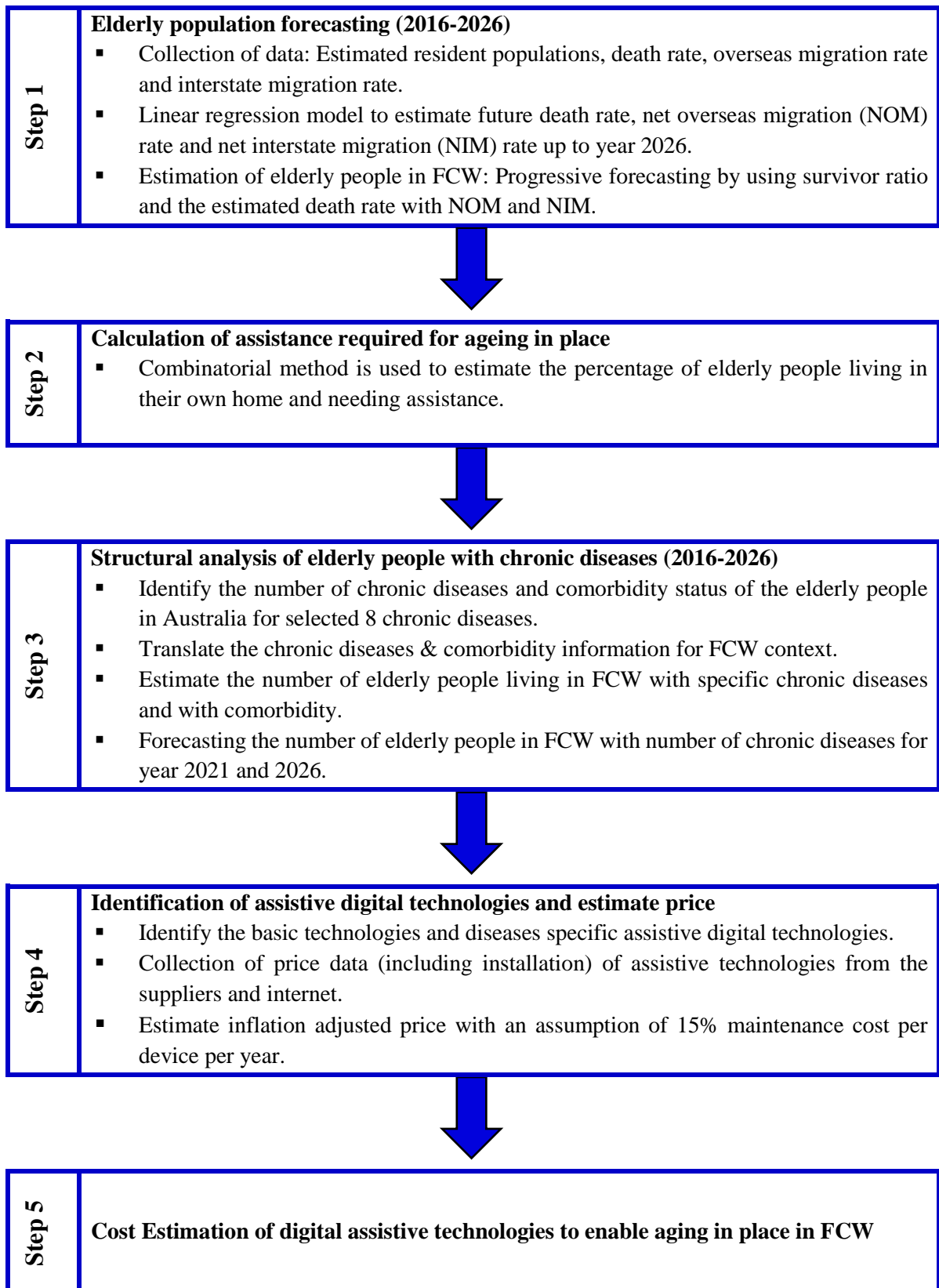


Figure 2.1: Framework of cost estimation.

The operational model with the data flow direction are presented in Figure 2.2. The model has been built in a Microsoft Excel file with multiple worksheet. Worksheets are connected by formulas and it is a macro enable workbook.

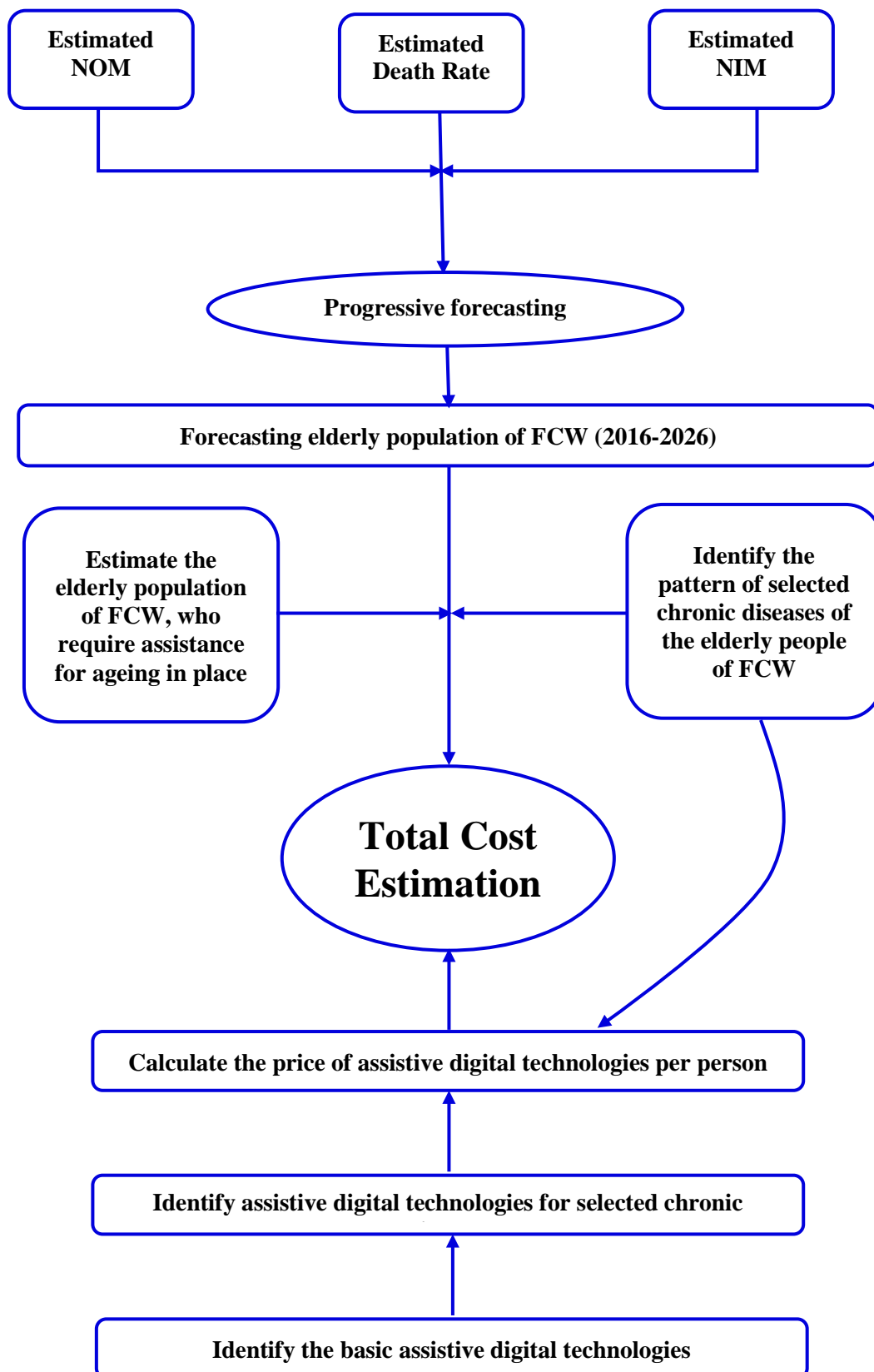


Figure 2.2: Operational model for cost estimation for technological adoption

2.2 Estimation of benefits in monetary value.

The provision of technological innovation and adoption is likely to generate improved aged care services. The net effects of those improved services are likely to be expressed as time savings for employees. Therefore the providers either can expand their services without increasing allocated time or save money within the current capacity of services. Improved access to technological facilities helps improve public health in general. Here the benefits were assessed from marginal changes to the quality of life (QoL). These values were taken from a desktop review, and transferred to the case study. Since the residential care facilities are more expensive than the home care packages (HCP), any potential retention to the HCP due to the technological intervention could lead to monetary benefits. Also this study captured the benefits that came from potential reduction in the number of hospital admissions. However, this benefit estimation from the improved health condition could not be based on a randomised control trial (RCT) method because of current scope of the study but based on available similar studies.

The estimation of benefits were conducted in four different categories. The first were benefits estimated as cost savings from the retention of elderly people in their own home. Federal and state government are providing home care packages (HCP) and basic home support (BHS). It is worthy to mention that the BHS includes Commonwealth Home Support Program (CHSP) and Home and Community Care (HACC). Staying at home with technological intervention may potentially lead to savings on additional expenses associated with entering into a residential care. We assumed a range of retention rate (5% to 25%) to calculate the potential savings. Relevant data was collected from the Aged Care Financing Authority (ACFC, 2017) report.

In the basic home support the recipient can access different services to utilise the government support. The services include mobility, communication, allied health care, nursing care, personal care, transport, household chores, property maintenance and meal preparation. Any reduction on the service hours will lead to monetary savings as the cost per hour services is very high in the allied health sector. Again a range (5%-25%) of reduction was consider to calculate the benefits.

Quality of life is one of the key wellbeing expectations of the elderly people. Digital assistive technology enhances QoL of the elderly people (Siegel and Dorner, 2017). This study conducted a desktop review to estimate the monetary value of QoL based on the willingness to pay by the elderly people per Quality adjusted life years (QALY) gained. Benefits on increasing QALY due to technological intervention were calculated under several scenarios.

Lastly, this study considers the possible reduction of hospital admission of elderly people with at least two chronic diseases (more likely to visit hospital due to health condition). Literature suggests that about 20% reduction in hospital admission could result because of assistive digital technologies adoption (Benetar et al. 2003, Kashem et al., 2008). This study considered the fact and calculated potential savings on that ground with a selection of reduction percentages. Overall per capita net benefits were calculated by adding all potential savings and by subtracting the technology adoption costs.

2.3 CBA Result Validation Workshop

The cost benefit analysis of adopting existing and new technologies in aged care system is essential to justify further investment in technological innovation and integration in the aged care sector in the FCW region. The financial costs and returns depend on several factors such as number of technological adoptions, installation costs, fixed capital (purchase of technology) cost, depreciation, interest rates, and market price of the provider's services. To identify the appropriateness and validity of the CBA methods and findings respectively, the study team conducted a workshop with a combination of expert and representative stakeholders including federal and state government people, service providers and academic experts. A systematic four-stage discussion was conducted to obtain field level and expert views on the findings and to determine the priorities for future action.

3. POLICY INITIATIVES AND SERVICES FOR ELDERLY POPULATION

This section provides a brief account of Australian and Queensland government aged care related initiatives based on the published literature and policy documents.

The world population is ageing, which is one of the most significant social transformation for this century. Population ageing implies the increase of the share of older persons in the entire population (UN, 2015). It was projected that the world population of older persons over 60 years of age will be about 1.4 billion in 2030 with an growth percentage of 56% from the year 2015 (UN, 2015). Australia is also following the similar trend with increasing numbers of older people. In 2016 approximately 3.7 million people are older Australians (15% of the total population) and by 2031 the number will be between 5.7 to 5.8 million (ABS, 2013).

An increasing older population will require additional care and services. The health and age care system of Australia is complex due to different types of service providers and funding mechanisms. The service and care to the elderly population of Australia are delivered in residential and community based settings. Community based aged care can be categorised in two groups: home care package (HCP) program and basic home support (BHS). BHS includes Commonwealth home support program (CHSP) and Home and community care (HACC). To obtain a government supported age care service, the elderly people need to undergo an assessment provided by the Aged Care Assessment Team (ACAT). The path way for home care packages are given in the Figure 3.1.

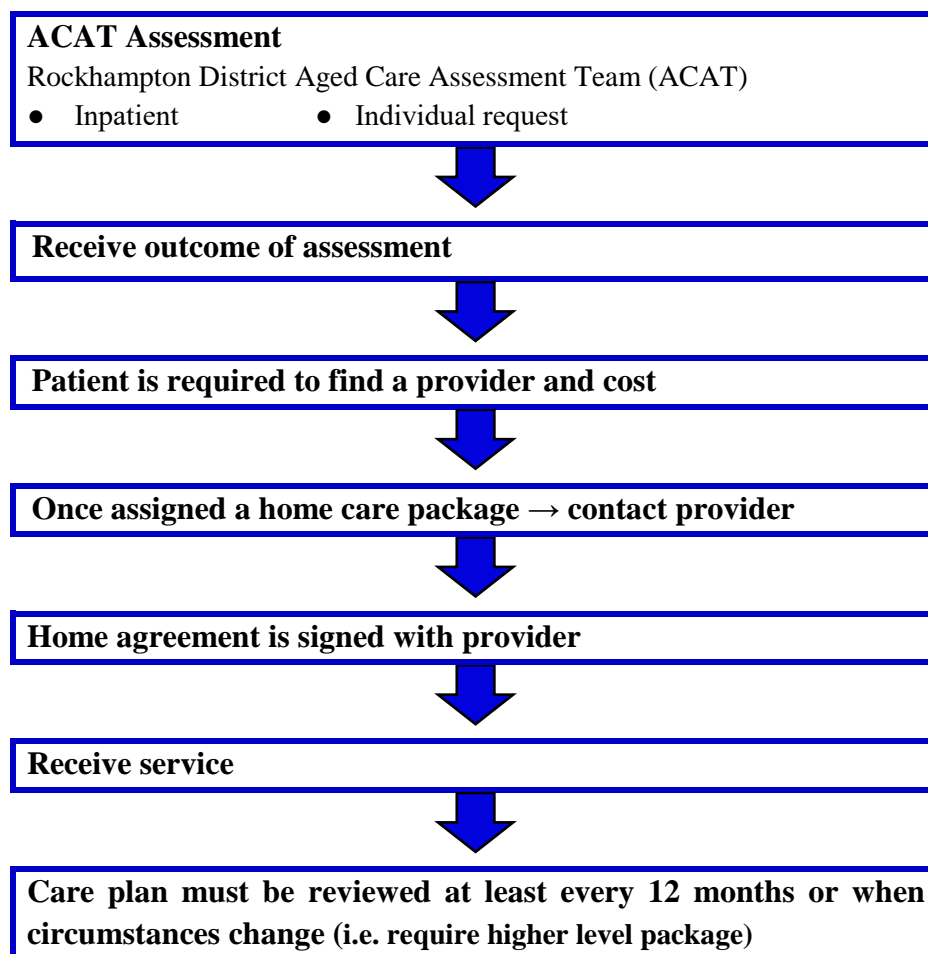


Figure 3.1: Home care package pathway

Under the current system, “My Aged Care” is the first point of contact for any consumer wanting government funded aged care services. In a second stage consumers may be redirected to the Regional Assessment Services or to an age care assessment team (ACAT). Based on the assistance required by the consumers and overall circumstances of the consumers, the assessment team refers them to potential service providers. The aged care provider can also investigate the requirement of the consumer to develop a care plan. Funding level is fixed based on the assessment provided by the team and the associated age care plan provided by the providers.

Australian government expenditure for aged care is expected to reach to \$18.6 billion for the year 2017-18. The majority of this expenditure is to support residential care (67.6%) followed by home support (16.2%) and home care (10.6%) (ACFA, 2017). Figure 3.2 illustrates the share of budget for the aged care sector for the financial year 2017-2018. So reducing the number of people who are in the pathway to enter into the residential care would be one of the mechanisms for reducing government expenditure.

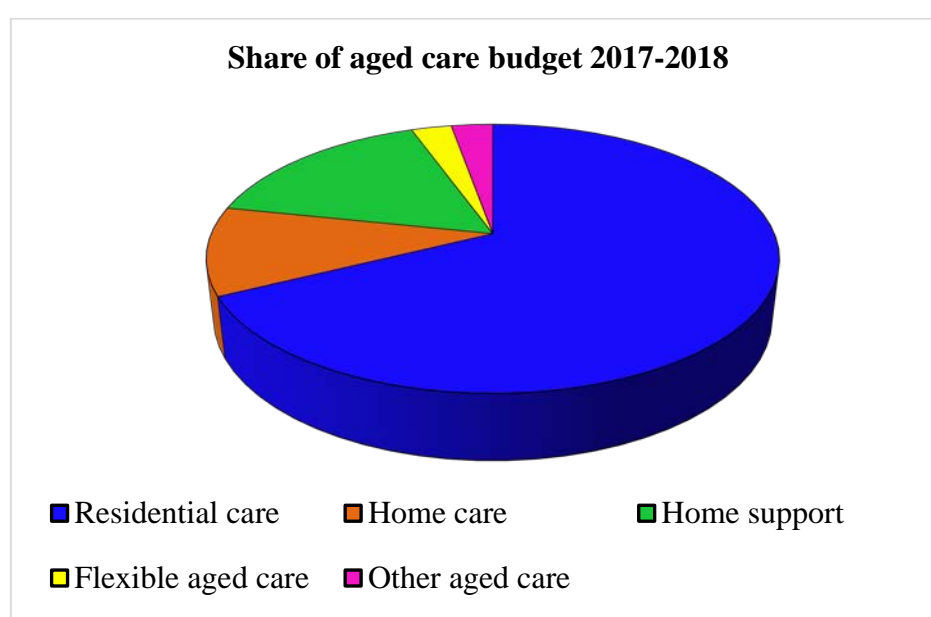


Figure 3.2: Percentage of budget share for different aged care sector

According to ACFA (2017), there are 2,022 service providers for aged care in Australia. Most service providers offer a single type of age care service, but some provide two or all three types of services.

3.1 Chronic diseases and assistive technology for different group

Different illness and health conditions are frequently referred as chronic disease, even though the specific definition of the term chronic disease is not available in the literature. National Health Survey (NHS) (ABS, 2015) reported that most of the elderly people (age over 65 years) are suffering with one or more of the following eight chronic diseases:

- Arthritis
- Asthma
- Back pain and problems
- Cancer (such as lung and colorectal cancer)
- Cardiovascular disease (CVD) (such as coronary heart disease and stroke)

- Chronic obstructive pulmonary disease (COPD)
- Diabetes
- Mental health conditions.

Types of care and assistive technologies needed by a consumer differ from person to person based on the number of chronic diseases suffered.. According to the national health survey (ABS, 2015), about 14% of elderly people living in Australia do not have any chronic diseases. However, this cohort might still need some basic technologies to support their ageing in place and they are categorised as basic care level category. The second category is comprised of the elderly people with single chronic diseases and 26.6% of elderly people of Australia fall in this category. The next two categories are comprised of elderly people with two chronic diseases and three or more chronic diseases respectively. Table 3.1 illustrates the different categories of technologies that might be required by people aged over 65 years with no chronic disease or some chronic diseases.

Table 3.1: Care Needs Categories

Basic Nil chronic diseases	Basic technology: <ul style="list-style-type: none"> ▪ Hearing aid and/or Vision aid ▪ Lamps ▪ ICT ▪ Monitors
Low Care At least one of the eight selected chronic diseases <ul style="list-style-type: none"> ▪ 87% of People aged 65 years and over (AIHW, 2016). Needs: <ul style="list-style-type: none"> ▪ Lives alone or with family/carer ▪ Needs fortnightly cleaning and community access 	Low care technology: <ul style="list-style-type: none"> ▪ Basic technology ▪ Technologies to assist with home cleaning ▪ Tablet reminder device
Intermediate Care Two or more of the eight selected chronic diseases <ul style="list-style-type: none"> ▪ 60% of People aged 65 and over (AIHW, 2016). Needs: <ul style="list-style-type: none"> ▪ Lives alone or with family/carer ▪ Needs fortnightly cleaning and community access ▪ Requires medication monitoring and/or administration of medication ▪ Mobility difficulties ▪ Activity daily living difficulties ▪ Increase falls risk 	Intermediate care technology: <ul style="list-style-type: none"> ▪ Basic technology ▪ Technologies to assist with home cleaning ▪ Specific chronic disease monitoring machines ▪ Mobility aid ▪ Electric chairs ▪ Pressure injury management ▪ Motion sensors ▪ Alarms

High Care Three or more chronic diseases <ul style="list-style-type: none"> ▪ 29% of People aged 65 years and over (AIHW, 2016). Needs: <ul style="list-style-type: none"> ▪ Lives alone or with family/carer ▪ Requires medication monitoring and/or administration of medication ▪ Needs weekly visit with alternating house work ▪ Mobility difficulties ▪ Continence difficulties ▪ Activity daily living difficulties ▪ Require community access for shopping ▪ High falls risk 	High care technology: <ul style="list-style-type: none"> ▪ Basic technology ▪ Technologies to assist with home cleaning ▪ Specific chronic disease monitoring machines ▪ Mobility aid ▪ Electric chairs ▪ Hoist ▪ Pressure injury management ▪ May require advanced health monitoring machines ▪ Motion sensors ▪ Alarms
--	--

The concept of assistive technologies refers to the process of integrating technologies within the residence to achieve improved functional health, safety, security and quality of life (Yusif et al., 2016). A wide range of assistive technologies are currently available and being used by the elderly people in Australia. To date no extensive research has been conducted to identify the types of technologies for the different phases of the elderly people. Identifying appropriate technologies is vital for services required for various groups of elderly people. Here technologies are categorised based on the type and number of chronic diseases suffered by the elderly people. This include a range of assistive technologies but the list is not exhaustive. Table 3.2 summarises the potential digital assistive technologies for the elderly people, which have been identified through an extensive literature review.

Table 3.2: Technologies for Chronic Diseases

Nil Chronic disease/Low care		
Function	Mobility	<ul style="list-style-type: none"> ▪ Cane/sticks (non-digital) or crutches (non-digital) ▪ Walking frames i.e. 2 wheels, 4 wheels (non-digital) ▪ Chairs for shower/bath/toilet (non-digital)
	Vision	<ul style="list-style-type: none"> ▪ Lighting i.e. lamps, touch lamps ▪ Magnification/Magnifiers (digital and hand-held) ▪ Audio player with DAISY capability Watch (digital) ▪ Big button phone
	Hearing	<ul style="list-style-type: none"> ▪ Alarm signallers with light/sound vibration ▪ Hearing aids (digital) and batteries ▪ Sound amplifier ▪ Amplified phone ▪ Pocket talker ▪ Audio books ▪ Hearing aids

	Communication	<ul style="list-style-type: none"> ▪ Communication software ▪ Deaf/blind communicators ▪ Keyboard and mouse emulation software ▪ Personal digital assistant (i.e. iPad) ▪ Video communication devices i.e. phone with screen ▪ Mobile devices- phones/smartphones ▪ Simplified phones ▪ Computers ▪ Large format keyboards
	Environment/Home safety	<ul style="list-style-type: none"> ▪ Power failure alarm with flashlight
	Exercise and Fitness	<ul style="list-style-type: none"> ▪ Pedal exercisers/pedal bike ▪ Treadmill ▪ Exercise bike
Particular Chronic disease		
Arthritis		
Function	Basic needs	Same as Nil chronic diseases category
	Environment/Home safety	<ul style="list-style-type: none"> ▪ Kitchen tools- food processor ▪ Electric jar/can opener ▪ Electric toothbrush ▪ Robot vacuum
	Exercise and fitness	<ul style="list-style-type: none"> ▪ Exercise bike
Asthma		
Function	Basic needs	Same as Nil chronic diseases category
	Health monitoring devices/chronic disease related	<ul style="list-style-type: none"> ▪ Spirometer ▪ Pulse oximeter ▪ Electronic asthma monitoring ▪ Nebuliser system ▪ Air purifier
Back Pain		
Function	Basic needs	Same as Nil chronic diseases category
	Health monitoring devices/chronic disease related	<ul style="list-style-type: none"> ▪ Thermal belt ▪ TENS machine
	Environment/Home safety	<ul style="list-style-type: none"> ▪ Hoist/lifter ▪ Robot vacuum
	Mobility	<ul style="list-style-type: none"> ▪ Recliner Chairs
	Exercise and Fitness	<ul style="list-style-type: none"> ▪ Pedal exercisers/pedal bike
Cancer		
Function	Basic needs	Same as Nil chronic diseases category
	Health monitoring devices/chronic disease related	<ul style="list-style-type: none"> ▪ Nebuliser ▪ Air purifier
	Cognition	<ul style="list-style-type: none"> ▪ Pill organisers and reminder ▪ Personal emergency alarm system

	Mobility	<ul style="list-style-type: none"> Recliner Chairs Electric motorised wheel chair Electric scooter (*assumption- wheelchair or scooter)
	Environment/Home safety	<ul style="list-style-type: none"> Falls detectors/Motion sensors/Falls monitor Personal emergency alarm system Pressure care mattress (*assumption-may require temporarily) Hospital bed (*may require temporarily) Hoist/lifter Medical Alert system with risk of falls/duress alarm
Cardiovascular Disease		
Function	Basic needs	Same as Nil chronic diseases category
	Health monitoring devices/chronic disease related	<ul style="list-style-type: none"> Blood pressure monitoring INR monitoring tester Heart rate monitor ECG self-monitoring Medication tablet reminder Home monitoring devices for vital signs Thermometer
	Mobility	<ul style="list-style-type: none"> Recliner Chairs Electric motorised wheel chair Electric scooter (*assumption- wheelchair or scooter)
	Cognition	<ul style="list-style-type: none"> Pill/Medication organisers and reminder Personal emergency alarm system
	Environment/Home safety	<ul style="list-style-type: none"> Falls detectors/Motion sensors/Falls monitor Personal emergency alarm system Hoist/lifter Robot vacuum Medical Alert system with risk of falls/duress alarm
Chronic Obstructive Pulmonary Disease		
Function	Basic needs	Same as Nil chronic diseases category
	Health monitoring devices/chronic disease related	<ul style="list-style-type: none"> Heart rate monitor Asthma monitoring Spirometer Pulse oximeter Oxygen therapy Medication tablet reminder Nebuliser system Air purifier
	Mobility	<ul style="list-style-type: none"> Recliner Chairs Electric motorised wheel chair Electric scooter (*assumption- wheelchair or scooter)
	Cognition	<ul style="list-style-type: none"> Pill/Medication organisers and reminder Personal emergency alarm system
	Environment/Home safety	<ul style="list-style-type: none"> Falls detectors/Motion sensors/Falls monitor Hospital bed/electric bed Hoist/lifter

		<ul style="list-style-type: none"> ▪ Robot vacuum ▪ Medical Alert system with risk of falls/duress alarm
Diabetes mellitus		
Function	Basic needs	Same as Nil chronic diseases category
	Health monitoring devices/chronic disease related	<ul style="list-style-type: none"> ▪ Blood glucose monitoring ▪ Medication tablet reminder ▪ Home monitoring devices for vital signs
	Mobility	<ul style="list-style-type: none"> ▪ Recliner chairs
	Cognition	<ul style="list-style-type: none"> ▪ Pill/Medication organisers and reminder ▪ Personal emergency alarm system
	Environment/Home safety	<ul style="list-style-type: none"> ▪ Fall detectors/Motion sensors/Fall monitor ▪ Robot vacuum ▪ Medical Alert system with risk of falls/duress alarm
	Exercise and Fitness	<ul style="list-style-type: none"> ▪ Exercise bike
Mental Health Conditions		
Function	Basic needs	Same as Nil chronic diseases category
	Cognition	<ul style="list-style-type: none"> ▪ Pill organisers and reminder
	Environment/Home safety	<ul style="list-style-type: none"> ▪ Global positioning system (GPS) (to locate patient if required) ▪ Personal emergency alarm system ▪ Door alarm ▪ Cordless bed alarm ▪ Medical Alert system with risk of falls/duress alarm

Along the listed technologies in Table 3.2, any individual may need additional assistive technologies if they have comorbidities. A basic assumption for this cohort is that they are at an increased risk of falls and experience polypharmacy. Digital technologies included for this cohort included pill/medication organisers and reminders, falls detectors/motion sensors/falls monitor and home monitoring devices for vital signs.

The costs of the technologies may vary from company to company because of the functionality, reliability and servicing costs. The cost data for the technologies were collected mostly from the online sources, medical catalogues and by personal communication. A complete list of the technologies with price and source of the price is given in the appendix. Because of the wide range of prices, this study considered two scenarios with the lowest price and average price of each technologies. In addition, an assumption was made that the life span of these technologies would be approximately five years and after five years the devices would need to be replaced by new sets. The maintenance cost of the technologies may vary from device to device and company to company. For the simplicity of the cost estimation, a 15% maintenance cost for each technologies per annum was considered. An initial installation cost was considered and was assumed to be 5% of the fixed costs.

4. DEMOGRAPHY OF FCW REGION

Fitzroy and Central West (FCW) one of the largest RDA region of Queensland, with total land area of 452,454.2 km², approximately 26% of Queensland (QGSO, 2018). The FCW region has 12 Local Government Areas (LGA) with the estimated resident population of 236,134 on 30th June 2017 (QGSO, 2018). Among the entire population of FCW, about 87% live in four LGAs, namely, Rockhampton, Gladstone, Livingstone and Central Highland.

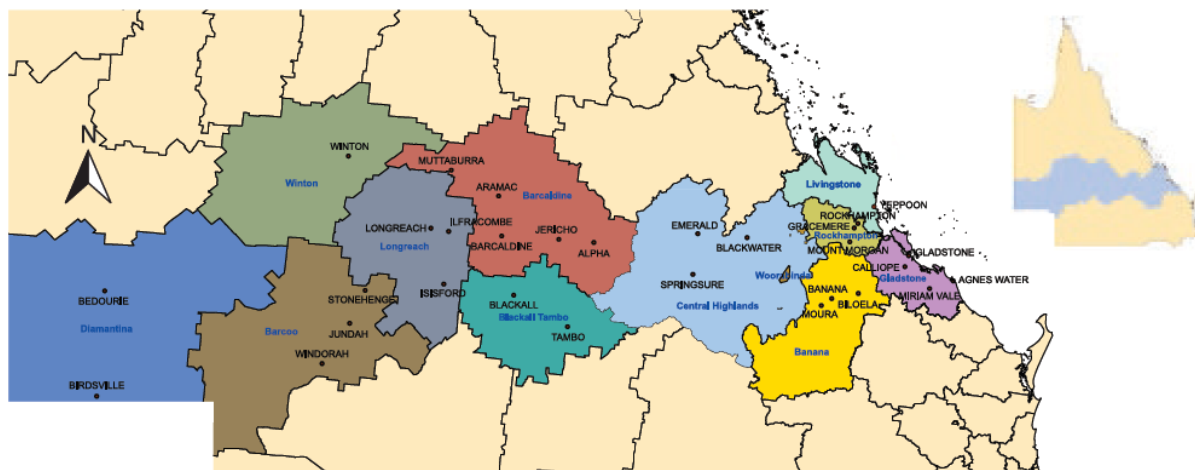


Figure 4.1: Map and location of FCW region (RDAFCW, 2015)

The median age of the population of FCW is 36 years as at 30th June 2016, while the same for Queensland is 37 years. In 2016, among the Australian population 15% were aged over 65 years and the same percentage of elderly people also lived in Queensland. In contrast, among the FCW region residents only 13% are aged over 65 years. The summary of the population data are presented in Table 4.1.

Table 4.1 Estimated resident population, by age group at 30th June 2016

Age (years)	Australia	% of AUS	Queensland	% of QLD	FCW	% of FCW
65–69	1,194,248	4.93%	241,437	4.98%	10410	4.40%
70–74	890,221	3.68%	179,601	3.70%	7536	3.19%
75–79	651,134	2.69%	125,049	2.58%	5495	2.32%
80–84	455,177	1.88%	82,629	1.70%	3615	1.53%
85 and over	482,731	1.99%	84,937	1.75%	3258	1.38%
All ages	24,210,809		4,848,877		236,599	

Source: ABS, 2018, Australian Demographic Statistics

The growth of the elderly population in FCW region is consistent over the last decade. Apart from the Diamantina Shire Council, all the LGA of FCW have seen positive growth of the people 65 years and over within the period of 2011 to 2016. The following figure indicates the comparison of percentage of elderly people living in the LGAs of the FCW region (Figure 4.2).

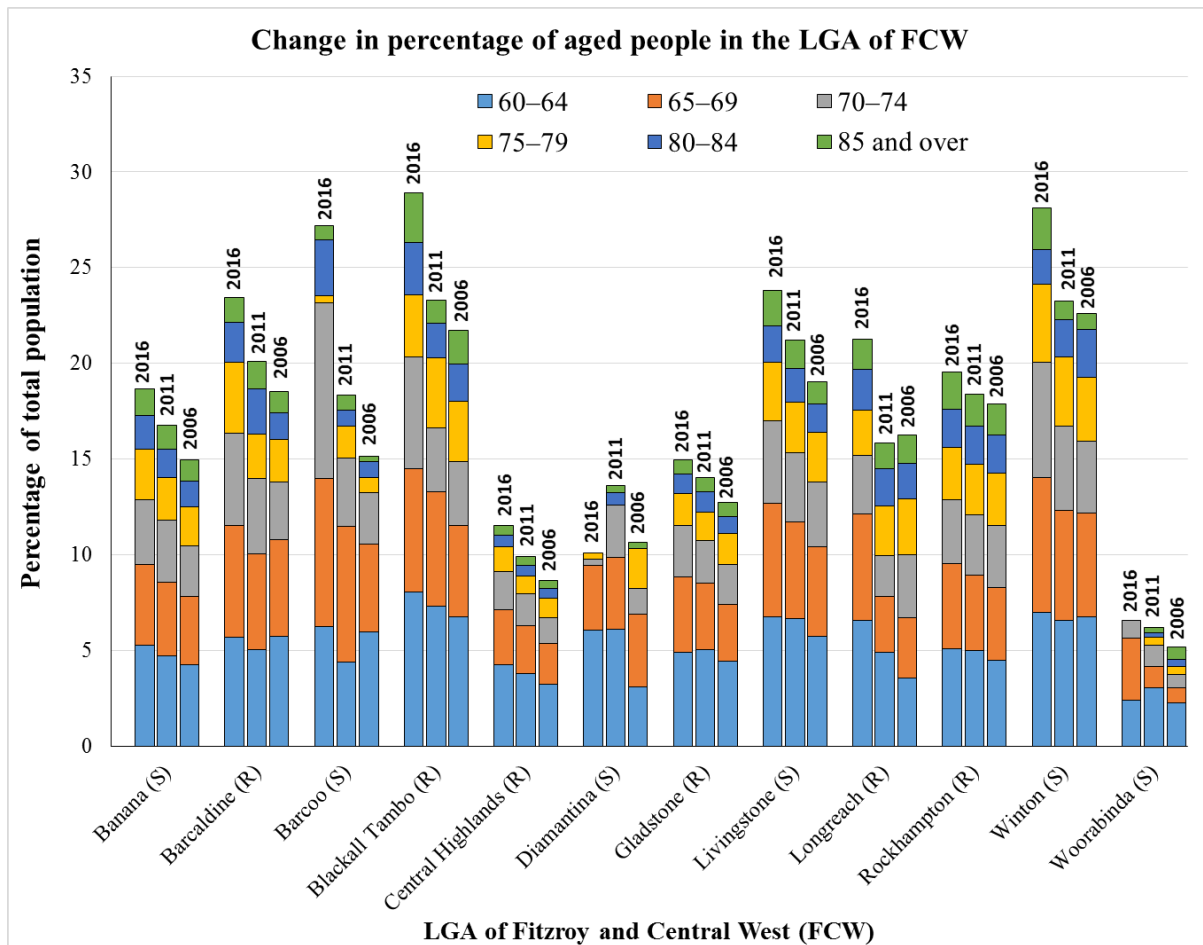


Figure 4.2: Change of percentage of elderly people in FCW during the last decade.

Recent data indicates that currently there are 76 age care service providers in the FCW region which provide different types of care including residential care, home care and transition care (AIHW, 2018).

5. COST ANALYSIS

This section presents findings of the study and analysis of the findings in terms of estimated costs for adopting digital assisted technology to improve the quality of life of the elderly people who choose to stay in their own home.

5.1. Elderly population forecasting for RDA FCW region

This study predicted the elderly population for 2016 to 2026. Initially the estimated population and forecasted death rates of elderly aged group people is determined by using a regression model. The population data from 2006, 2011 and 2016 censuses were used to estimate population growth and death rate. The results are summarised in Table 5.1. The results indicate that the total population of FCW will decrease by 7% by the year 2026 but the same for Queensland will increase by 20%. The death rate of the 65+ aged group are likely to decrease for the next 10 years. Net overseas migration (NOM) and net interstate migration (NIM) rate were used to calculate future trends.

Table 5.1: Death Rate - Qld

Year	2006	2011	2016	2021	2026	Changes from 2016 to 2026
Population QLD	4007992	4476778	4848877	5191483	5835658	20.3%
Population FCW	210637	229056	236599	235440	220131	- 6.9%
Age Group	Death Rate					
55 - 59	4.40	4.20	4.10	4.02	3.69	-10.0%
60 - 64	7.00	6.60	6.00	5.42	4.84	-19.3%
65 - 69	11.80	10.30	9.60	8.54	6.38	-33.5%
70 - 74	19.00	17.70	15.50	12.30	12.17	-21.5%
75 - 79	33.10	29.50	27.10	24.54	20.20	-25.5%
80 - 84	59.70	54.90	49.80	42.96	40.55	-18.6%
85 - 89	104.00	103.90	94.50	84.46	85.83	-9.2%
90 - 94	186.90	183.40	167.50	154.74	154.88	-7.5%
NOM for FCW				-14	-13	
NIM for FCW				137	128	

Assumption: NOM and NIM are distributed evenly among the age groups

Net overseas migration (NOM) rate=-0.006%
Assumed as constant for the forecasting period
Net interstate migration(NIM) rate=0.058%
Assumed as constant for the forecasting period

To estimate the population in the different age groups for next 10 years, a progressive forecasting method was used with survivor ratio and estimated death rate. NOM and NIM are also considered during the estimation and the results are summarised in Table 5.2.

Table 5.2: Elderly Population of FCW (progressive forecasting)

Age Group	Year				
	2006	2011	2016	2021	2026
55 - 59	12154	14281	15432		
60 - 64	9481	11703	12475	15014	
65 - 69	7371	8720	10410	11967	14558
70 - 74	5645	6387	7536	9794	11262
75 - 79	4527	4762	5495	6636	8828
80 - 84	2948	3432	3615	4339	5313
85+	2349	2698	3258	3423	3863
total 65+	22840	25999	30314	36159	43824
Total	210637	229056	236599	235440	220131
%	11%	11%	13%	15%	20%

According to the estimated results, there will be a 20% increase of the people aged over 65 years by 2026 which is a 13% increase from 2011 to 2016 (table 5.2). The total increase between 2016 and 2026 in the number of people over 65 years of age will be 44.5%.

5.2: Elderly people need assistance for aging in place

Among the Australian elderly residents about 39% need assistance with their day to day activities. Assistance might be required for activities like self-care, mobility, communication, cognitive or emotional tasks, health care, reading or writing tasks, transport, household chores, property maintenance, and meal preparation. The data also indicate that 94.8% of the elderly people are living in households in contrast to only 5.2% who are living in cared-accommodation. The summary of findings are included in Table 5.3. The results of combinatorial analysis indicate 36.61% of Australian elderly population requires assistance with at least one activity while they are living in their own home.

Table 5.3: Percentage of Australian population aged 65 years and over living in household and need assistance

	Age group (years)						Total
	65–69	70–74	75–79	80–84	85–89	90 and over	
All needing assistance with at least one activity	22.2%	29.1%	39.4%	56.8%	72.5%	88.5%	38.6%
Assistance not needed	77.8%	71.0%	60.6%	43.0%	27.5%	11.8%	61.4%
Living in cared-accommodation	0.8%	1.4%	3.2%	7.7%	17.0%	37.0%	5.2%
Living in households	99.2%	98.6%	96.8%	92.3%	83.0%	63.0%	94.8%
Living in households and need assistance	22.03%	28.72%	38.20%	52.43%	60.18%	55.78%	36.61%
Total (in thousands)	1,149.7	859.6	630.2	444.0	297.8	165.7	3,546.2

Source: ABS, 2016, Disability, Ageing and Carers, Australia: Summary of Findings, Table: 28.1 & 28.3

Note: Assistance needed for activities including self-care, mobility, communication, cognitive or emotional tasks, health care, reading or writing tasks, transport, household chores, property maintenance, and meal preparation

5.3. Number of diseases of people aged 65 years and over

Many Australian people aged over 65 years are suffering eight most common chronic diseases and many of them are suffering with comorbidity. Table 5.4 indicates the number of Australian population aged 65 years and over with one or more chronic diseases. Among the cohort 13.6% don't have any chronic diseases but they might need some basic technologies to assist them. 26.6% of Australian population aged 65 years and over have only one primary chronic diseases and they require assistive technologies relevant to their primary disease along with some other basic technologies. The figure presented in Table 5.4 exhibits that 30.6% of the selected cohort have two chronic diseases while another 29.3% have three or more chronic diseases. Additional technological assistance may be required for the elderly people who have 2 or more chronic diseases.

Table 5.4: Number of chronic diseases of Australian population aged 65 years and over (in 1000)

	0 (no chronic diseases)	1 (primary chronic disease only)	2	3 or more	Total
Arthritis	..	237.8	653.4	772.9	1,665.1
Asthma	..	28.4	69.9	236.1	339.7
Back problems (dorsopathies)	..	95.6	204.7	550.0	853.7
Cancer (malignant neoplasms)	..	15.9	53.1	121.8	191.9
Chronic obstructive pulmonary disease (COPD)	..	8.9	37.8	216.7	257.5
Diabetes mellitus	..	57.3	146.5	373.1	573.0
Diseases of the circulatory system	..	389.1	701.6	834.9	1,920.5
Mental and behavioural problems	..	43.0	134.1	402.4	584.4
Total persons aged 65 years and over	447.2	872.6	1,004.3	962.4	3,285.6
Percentage	13.6%	26.6%	30.6%	29.3%	

Source: ABS, 2015 National Health Survey: First Results, 2014–15 — Australia

The comorbidity pattern of the Australian population aged 65 years and over are also available in the literature. The following table illustrates the comorbidity matrix for the selected eight chronic diseases. Table 5.5 indicate that the most common comorbidities are Arthritis and CVD; Arthritis and Back pain; and CVD and Back pain (Refer to appendices).

Table 5.5 Comorbidity matrix of chronic diseases Australian population aged 65 years and over (in 1000)

Primary chronic disease	Arthritis	Asthma	Back problems	Cancer	COPD	Diabetes	Diseases of the circulatory system	Mental and behavioural problems
Arthritis	..	202.5	553.6	89.8	174.5	299.1	1,059.1	368.0
Asthma	202.5	..	126.8	23.8	91.9	80.3	215.2	82.1
Back problems	553.6	126.8	..	55.3	106.0	184.3	533.3	209.9
Cancer	89.8	23.8	55.3	..	18.2	39.5	128.6	54.2
COPD	174.5	91.9	106.0	18.2	..	62.3	188.7	84.8
Diabetes	299.1	80.3	184.3	39.5	62.3	..	421.6	131.7
CVD	1,059.1	215.2	533.3	128.6	188.7	421.6	..	378.1
Mental and behavioural problems	368.0	82.1	209.9	54.2	84.8	131.7	378.1	..
Total persons aged 65 years and over	1,665.1	339.7	853.7	191.9	257.5	573.0	1,920.5	584.4

Source: ABS, 2015, National Health Survey: First Results, 2014–15 - Australia

The estimated results for the elderly population with no to multiple chronic diseases in 2016, 2021 and 2026 are presented in Table 5.6. The number of individuals in FCW with specific chronic diseases and with different comorbidities has also been determined for cost estimation purpose.

Table 5.6: Estimated population of FCW with different number of chronic diseases

	Year			%	Ref
	2016	2021	2026		
Estimated Population of FCW	30314	36159	43824		Table 5.2
Living in household and need assistance	11098	13238	16044	36.61%	Table 5.3
no chronic diseases	1511	1802	2184	13.6%	Table 5.4
One primary chronic disease only	2947	3516	4261	26.6%	Table 5.4
Two chronic disease	3392	4046	4904	30.6%	Table 5.4
Three or more chronic disease	3251	3878	4699	29.3%	Table 5.4

5.4. Costs estimation

The cost estimation task is carried out in two phases. Information regarding the prices of different assistive technologies was collected based on extensive literature review and by collecting quotes from the providers. The complete price list is included in the appendices. The number of elderly people with one chronic disease was identified and estimated (Table 5.7). However, detailed data for the elderly people with all types of comorbidity patterns were not found and some assumptions were made to calculate the costs.

Table 5.7: Breakdown of FCW elderly population with one chronic disease

	Year			
	2016	2021	2026	
FCW population with one chronic disease	2947	3516	4261	% (Ref Table 4.4)
Arthritis	805	960	1163	27.3%
Asthma	97	116	141	3.3%
Back problems (dorsopathies)	324	387	469	11.0%
Cancer (malignant neoplasms)	53	63	77	1.8%
Chronic obstructive pulmonary disease (COPD)	29	35	43	1.0%
Diabetes mellitus	195	232	281	6.6%
Diseases of the circulatory system	1314	1568	1900	44.6%
Mental and behavioural problems	144	172	209	4.9%

The total cost for the assistive technologies are calculated by multiplying the size of the estimated population with one chronic disease with the costs associated with their potential need based on their primary disease. For the population with two chronic diseases, some overlapped (same individual is counted in different categories) data are available in the ABS databank. Individual data are not available in the literature and was not collected due to the time limitation of the project. Most common combinations of diseases are

- Arthritis & CVD
- Arthritis & Back Problem

- CVD & Back Problem
- CVD & Diabetes
- CVD & Mental Health
- Mental Health & Arthritis

The following assumptions were made to calculate the total cost for this cohort:

- 28 possible combinations are for the eight most common diseases.
- For cost calculation, all combinations were considered and population percentage is determined by using normalised ratio.

Similar scenarios were considered for the population with three or more chronic diseases. Again, individual data was not available and was not collected due to the time limitation of the project. Most common combinations of diseases are

- Arthritis, CVD and Back Problem
- Arthritis, CVD and Mental Health
- Arthritis, CVD and Diabetes
- CVD, Mental health and Back Problem
- CVD, Mental health and Diabetes
- Arthritis, Back Problem and mental health
- Arthritis, Back Problem and Diabetes
- Mental health, Back Problem and Diabetes

Some assumption are made to facilitate the cost estimation.

- 219 possible combinations were considered in this study for three or more common diseases among the selected eight diseases.
- For cost calculation the most common combinations were considered and population percentages were estimated using combinatorial methods.
- The rest was calculated by using weighted average methods.

Table 5.8: Cost estimation for assistive technologies

	Cost unit	2016		2021		2026	
		low	Average	low	Average	low	Average
No chronic diseases	AUD	3,458,063	7,864,246	4,124,789	9,380,500	4,999,183	11,369,026
One primary chronic disease only	AUD	11,508,369	20,045,598	13,730,378	23,915,956	16,639,688	28,983,473
Two chronic disease	AUD	15,052,611	27,092,848	17,954,805	32,316,440	21,760,956	39,167,043
Three or more chronic disease	AUD	16,244,548	28,795,217	19,376,552	34,347,032	23,484,092	41,628,090
Total	AUD	46,263,591	83,797,909	55,186,525	99,959,928	66,883,918	121,147,631
Annual Per capita cost	AUD	4,169	7,551	4,169	7,551	4,169	7,551

The costs estimation results are presented in the Table 5.8. The figures for the year 2016 are adjusted by using inflation rate and rest of the figures are based on the 2016 base value. An inflation rate was

not applied on the estimated figure for the years 2021 and 2026. As the range of price of assistive technologies is very wide (refer to appendices), hence two sets of costing are presented in the table, namely low and average. Per capita cost for adoption of assistive technologies are also presented in the results. Per capita costs was estimated for the 10 year period and per annum 15% maintenance costs were assumed for the calculation. The life cycle of the technologies were assumed to be 5 years and the replacement costs was also included during the per capita cost calculation. The results indicate that per annum and per capita costs for the 10 years period could be AUD 4,169 for low cost scenario and AUD 7,551 for the average one. Due to the increasing elderly population in FCW, total cost could increase from AUD 46.2 million to AUD 66.8 million (low cost case) respectively from year 2016 to year 2026. Per capita costs vary over amongst the elderly people by number of chronic diseases that an individual has. Figure 5.1 illustrates the variation of per capita cost on adopting assistive technologies with different groups of people.

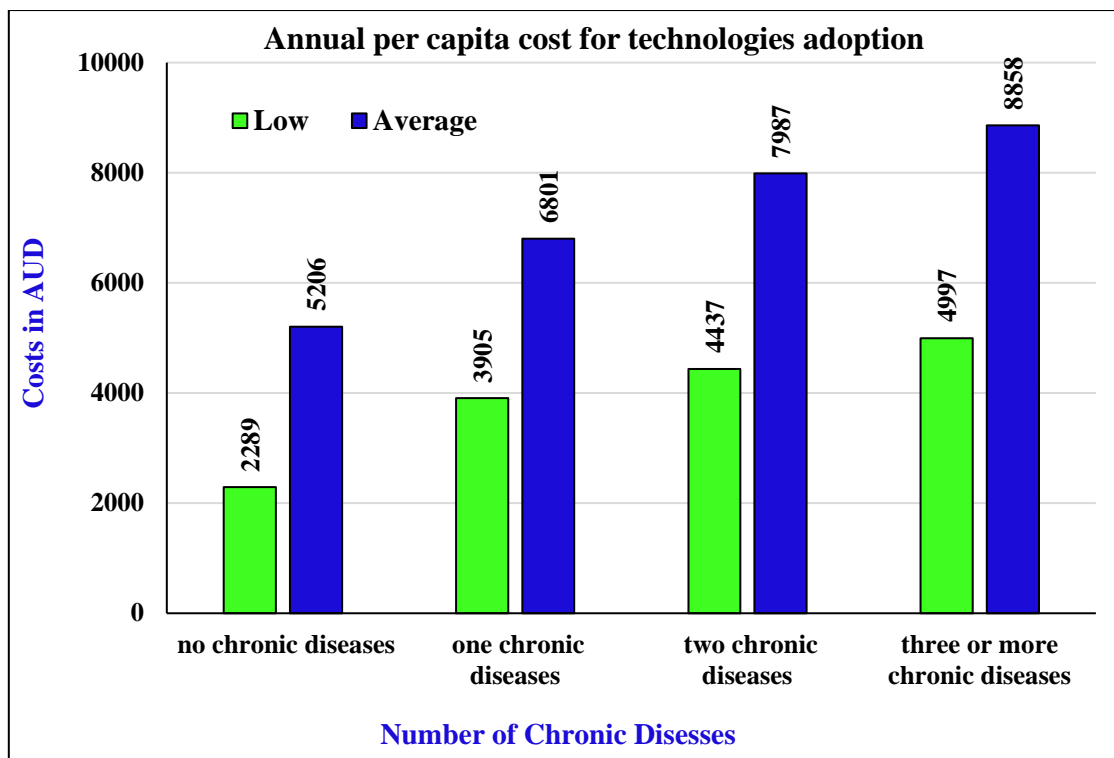


Figure 5.1: Per capita cost for technologies adoption for different group

6. BENEFITS ESTIMATION

Technological intervention has a positive impact on the daily life of the elderly people. However, measuring the benefits of adopting technologies in monetary form is difficult due to lack of appropriate methods to measure the wellbeing of the elderly people. A study identified that the assistive technologies has the most prominent contribution towards the care service (ACIITC, 2017). A desktop review reveals that a limited literature is available on the cost benefit analysis (CBA) form and none of them are in the context of regional aged care system of Australia. This study reviewed some most relevant literature and used some of the coefficients or information to estimate the benefits.

Table 6.1: Summary of literature review

Title, Author, Year	Methods	Results
Wilson et al., 2017, Benefits and risks of smart home technologies.	Online Survey on the benefits and risks of smart home technologies (SHT). User perception was measurer for: <ul style="list-style-type: none"> • The potential benefits of SHTs • The potential risks of SHTs Among the sample only 23% are over 64 years of age.	Respondents perceive the potential benefits of SHTs to be saving energy, time, and money, as well as making domestic life less difficult.
Malwade et al., 2018, Mobile and wearable technologies in healthcare for the ageing Population.	Discussion and review article. Key points are: <ul style="list-style-type: none"> • Wearable devices and sensors • Telemedicine • Ambient assisted living (AAL) • Technologies for stress level management • Benefits of using the technologies. 	Mobile and wearable technologies can improve health outcomes, reduce health care costs, increase quality of life and decrease medical appointments (evidence form literature).
Kulvik et al., 2015, An economic model to assess the cost-benefit of BNCT.	<ul style="list-style-type: none"> • The cost benefit analysis on two technologies in the acute care system following by long term care options. • Economic model was developed used to assess the benefits. • Budget and budget share allocation was also included in the model to calculate the effective cost per technology. 	<p>The benefits from adoption of new technology can be purely humanitarian or they might involve economic impacts. Benefits (in non-monetary terms) are</p> <ul style="list-style-type: none"> • The non-monetary value of avoiding deaths • The non-monetary value of an early recovery, leading to a better quality of life, • Spill over effects from supporting a novel technology

Culyer & Chalkidou, 2018, Economic Evaluation for Health Investments en Route to Universal Health Coverage: Cost-Benefit Analysis or Cost-Effectiveness Analysis?	Discussion and review on the preference of CBA and CEA be an improvement in appraising health and health-related investments in low- and middle- income countries (LMICs)	Identified a few issues and challenges in applying CBA or CEA in the LMICs context.
Hoof et al., 2011, Ageing-in-place with the use of ambient intelligence technology: Perspectives of older users,	<ul style="list-style-type: none"> • Interpretative research approach with qualitative interviews. • Investigate the Ambient intelligence: the Unattended Autonomous Surveillance system (UAS) and their impact. 	<p>Following benefits are identified by the respondent</p> <ul style="list-style-type: none"> • Assistance during an emergency can reach to them faster. • Increase sense of safety and security. • The number of devices and cables used should be minimised. • The cost of installing UAS could be up to €13,500 (2011 value). • For The Netherlands, €6000 to €16,000 (2004 price level) could be saved per person for not being institutionalised. • Ambient intelligence technology alone is not sufficient to age-in-place.
Akiyama & Abraham, 2017, Comparative cost-benefit analysis of tele-homecare for community-dwelling elderly in Japan: Non-Government versus Government Supported Funding Models.	<ul style="list-style-type: none"> • Two model of tele home care consumers in Rural Municipalities in Japan were investigated. • A probabilistic analysis was conducted by using Monte Carlo simulation. 	<ul style="list-style-type: none"> • Benefit cost ratio (BCR) of models are 1.84 and 1.46 (Simulation results). • Net benefits for models are \$451.33 and \$280.12 respectively per person per year (Probabilistic analysis). <p>Model 1 will be a cost saving option for the society if:</p> <ul style="list-style-type: none"> • Per-patient per-year device costs is less than \$560, • Per-patient per-year labour costs is less than \$558. • Per-patient per-year operational (non-labour) costs is less than \$373.

<p>Kok et al. 2015, Costs and benefits of home care for the elderly versus residential care: a comparison using propensity scores.</p>	<ul style="list-style-type: none"> • Investigate and compare the cost benefits analysis of home care and residential care for the elderly people of Netherland. • Data was collected through two surveys and 1,717 respondent data was included for analysis. • Probit (Probability unit) model was used to identify the probability of living at home or in residential care. • Propensity score matching method was used for comparison. 	<ul style="list-style-type: none"> • Residential care is €1,350 more expensive than home care per person per year (2009 price). • Total costs per person per year in residential care was €39,690. <p>For home care the total cost breakdown is</p> <ul style="list-style-type: none"> • Care at home (including cleaning, care, nursing and social assistance): €14,900. • Cost of household (food, electricity, gas, phone and others): €7,390. • Cost of housing (rent & house adaptations): €5,780. • Medicine, practitioners and hospital: €4,640. and, • Mobility aids: €630. <p>The number of hours care required per year per person by professionals are 180 hours for cleaning, 247 hours for personal care and 175 hours for nursing care.</p>
--	--	--

Key points identified from literature review:

- Technological intervention could improve health outcomes, reduce health care costs, increase quality of life and decrease medical appointments (Malwade et al., 2018).
- Technological intervention can increase the non-monetary value of avoiding deaths and quality of life (Kulvik et al., 2015).
- Quality-Adjusted Life-Year (QALY) or Disability-Adjusted Life-Year (DALY) are key variables to measure benefits by using cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA) respectively (Culyer & Chalkidou, 2018).
- Unattended Autonomous Surveillance system (UAS) can improve the sense of safety and security for the elderly people living in their own home. Associated cost could be AUD 21,095 (2018 value, using inflation calculator). Though, ambient intelligence technology alone is not sufficient to age-in-place. Benefits can be achieved if elderly people continue to age-in-place instead of being institutionalised (Hoof et al., 2011).
- Adopting technologies could be cost saving option if device costs, labour costs, operational costs are kept within a certain range (Akiyama & Abraham, 2017).
- In Netherlands aging in place could potentially save AUD 17,735 (2018 value, using inflation calculator) compared to residential care for elderly people.

The literature review indicates that the benefits of digital assistive technology adoption for the elderly people are significant.

Four types of benefits were considered in the current study to estimate the monetary values of the benefits:

- Retention of the elderly people in the home care package (HCP) and basic home support (BHS)
- Reduction in aged care service hours
- Increase in QALY of the elderly people
- Reduction in hospital admission

The current project is a short term project, hence it was not possible to conduct a survey on the aged care consumers to identify the extent of wellbeing that could be gained through a technological intervention. We have calculated all the benefits in monetary value by using the information available in the literature under a set of assumptions.

6.1 Retention in HCP and BHS with the assistance of assistive technologies

In 2013-14, about 61,300 Australian elderly people entered in the permanent residential age care (PRAC) for first time and there were 1,007 different pathways through the different community based aged care facilities (AIHW, 2017). Figures 6.1 indicates the 15 most common pathways to enter in the PRAC. In the figure all the pathways are through the care facilities including home and community care (HACC), aged care packages, transition care program (TCP) and respite residential aged care (RRAC).

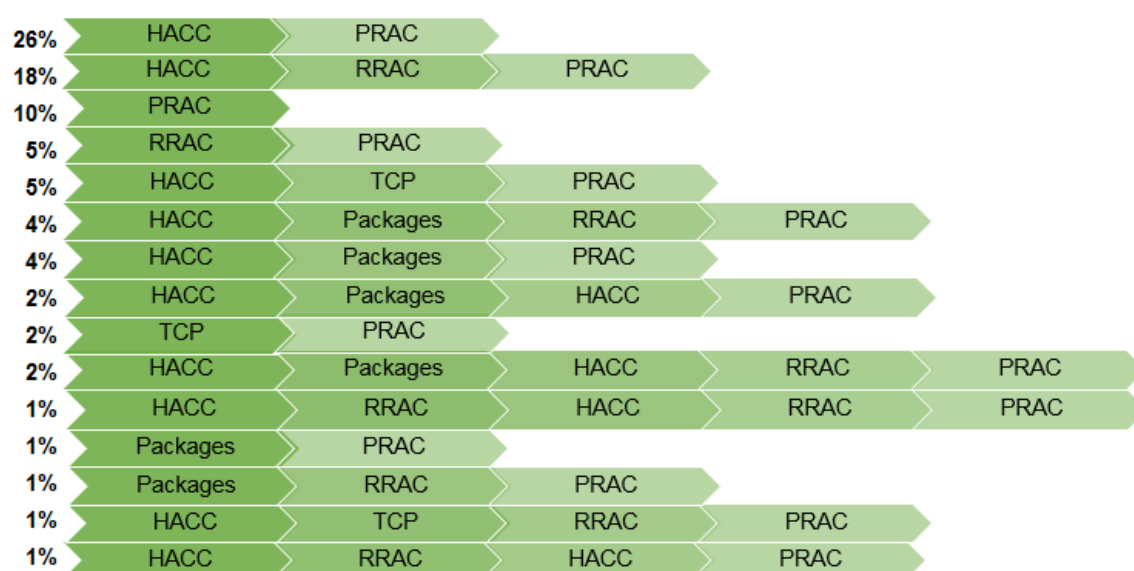


Figure 6.1: Patterns of aged care service use before first entry to PRAC in 2013–14 (AIHW, 2017)

About 49% of elderly people living in the residential care entered into the facilities from the basic home support program (HACC) while another 2% entered directly from the home care packages program (HCP) (Figure 6.1). In 2016, 951 elderly people entered in the residential care and transition care in the FCW region (AIHW, 2018a). Consistent to the pattern of residential care admission 466 people would have been transferred from BHS and other 19 people would have been transferred from HCP. Any amount of retention will save substantial amount since the cost of residential care is much higher than BHS and HCP.

In the summary of aged care data published by Department of Health (GEN, 2017), all relevant information regarding all types of age care services, clients summary and expenditure have been listed. The data indicate that in QLD, in 2016, 33,580 clients were received services from residential care and

96% of them are aged over 65 years. The number of clients in HCP and BHS are 13,293 and 170,320 with the share of elderly clients 96% and 98% correspondingly. The following table summarised total costs and per capita cost for accessing different types of aged care services.

Table 6.2: Expenditure on aged care services QLD (2016-17)

Care type	All clients	Age 65+ (%)	total costs	Per capita costs
Residential care	33,580	96.2%	2,263,448,842	67,405
Home care packages	13,293	96.1%	311,071	23,401
Basic support at home	170,320	98.3%	519,523,948	3,050

The figures in the above table indicate that the potential saving due to retaining people in the HCP and BHS program and not transferring to the residential care (and/or transition care) are AUD 44,004 and AUD 64,354 respectively. For the current analysis we assumed a range from 5% to 25% of potential retention with the technological intervention to the HCP and BHS clients. The associated savings in dollar values are illustrated in Figure 6.2 with the estimation for 2016, 2021 and 2026.

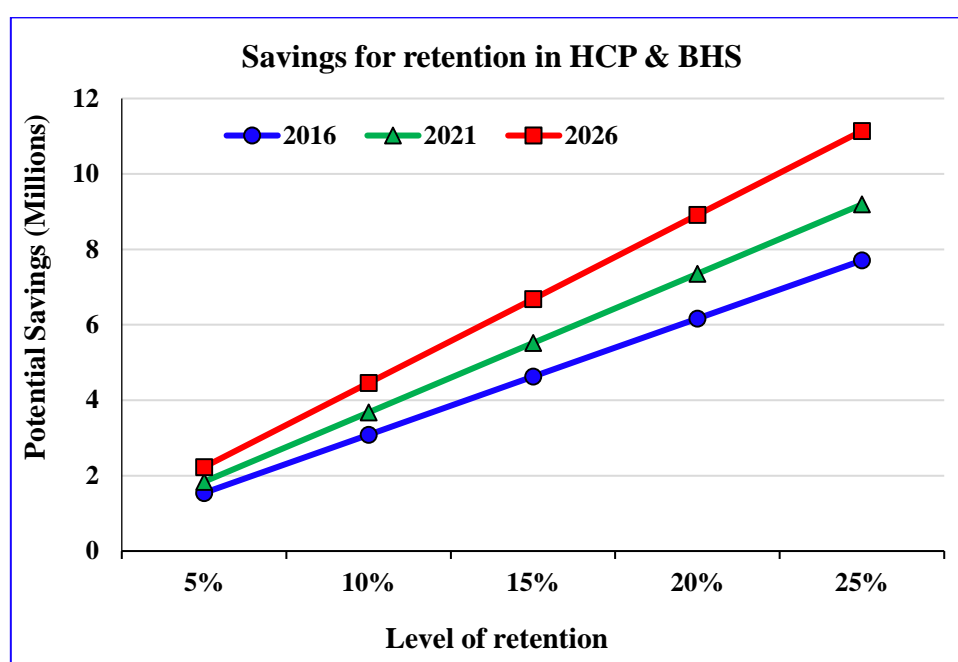


Figure 6.2: potential savings for retaining in HCP and BHS

The results indicate that about 7.7 million dollars could potentially be saved in 2016 with the appropriate level of technology adoption by the HCP and BHS clients. The number could reach up to 11.1 million dollars in 2026 with 25% of retention.

6.2 Reduction in aged care services

The elderly people who are in the HCP and BHS program require different services from the services providers. The services include allied health support, housing, domestic assistance, nursing care, personal care, social support and transport. Table 6.3 summarised the percentage of clients, total services hours required and expenditure with per capita costs.

Table 6.3: Services in QLD for aging in place

Service type	Percentage of Clients	Amount of services (Hours)	Expenditure (\$'000)	Per capita costs (AUD)	Per Hour costs (AUD)
Allied health	27.5%	480,713	54,498	1165	113.37
Assistance with care and housing	0.2%	9,619	911	2811	94.69
Domestic assistance	46.3%	2,234,790	103,600	1313	46.36
Goods and equipment	2.4%	41,639	1,698	409	40.77
Home maintenance	27.5%	319,041	25,243	539	79.12
Nursing care	17.0%	419,904	55,472	1911	132.11
Personal care	10.0%	523,152	30,689	1811	58.66
Social support—group	11%	2,113,075	61,497	3392	29.10
Social support—individual	18%	762,181	40,964	1351	53.75
Specialised support services	7.6%	126,107	12,428	964	98.55
Transport	24.4%	1,221,427 (Number)	38,372	925	31.42 (Costs per service)

Source: Aged care snapshot data 2017 (GEN, 2017)

For the analysis we assumed that the amount of services will be reduced with the adoption of technologies, which is supported by the existing literature (Malwade et al., 2018, Akiyama & Abraham, 2017). For the homogeneity of the analysis the range of service amount reduction was set to be varied from 5% to 25%. Associated cost savings are shown in Figure 6.3. Estimated savings could be up to 10 million as revealed by the analysis.

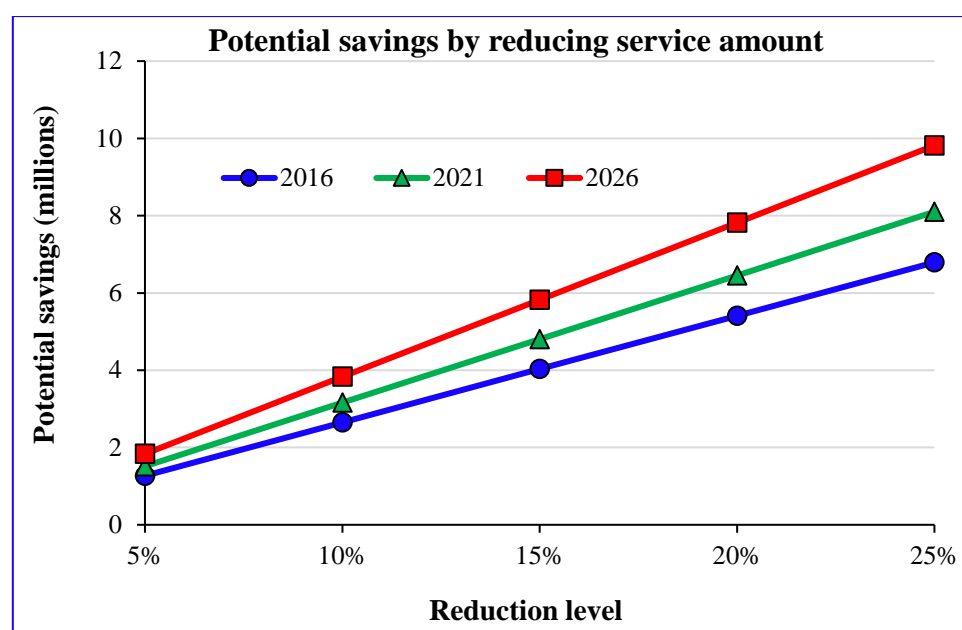


Figure 6.3: Savings for service hours reduction

6.3 Increase in quality adjusted life years (QALY)

Quality adjusted life years (QALY) is a method which was developed to measure the cost effectiveness of a particular treatment. The effectiveness of QALY makes it an important assessment instrument to measure the wellbeing of elderly people (MacKillop and Sheard, 2018). According to National Institute for Health and Care Excellence of UK, the QALY can be defined as “a measure of the state of health

of a person or group in which the benefits, in terms of length of life, are adjusted to reflect the quality of life” (NICS, 2016). In chronic disease related definition QALY is defined as “a state of wellbeing that is a composite of two components: the ability to perform everyday activities and patient satisfaction with level of functioning and the control of disease (Hacker, 2010). Literatures indicate the technological intervention has great influence on the quality of life (QoL) of elderly people and ensued increase in QALYs (Siegel, Thomas Ernst Dorner, 2017). Numerous researchers have attempted to quantify the QALYs in term of willingness to pay (WTP), however we have concentrated only on the published articles in Australian context. Recently Huang et al (2018) used an instrumental variable approach to estimate the WTP per QALY gained. Back in 2015, Farag et al. (2015) have performed economic modelling to identify the monetary value of QALY using the reduction of fall of elderly people through a public health program. A similar study was conducted earlier by Church et al (2011) to the elderly people of NSW living in community and residential aged care under some fall prevention strategies. The findings of these articles are listed in Table 6.4 in terms of WTP for each QALY gained.

Table 6.4: Monetary values of QALY

Measurement	AUD	Ref
Based on willingness to pay \$/QALY gained	42,000	Huang et al. 2018
Based on willingness to pay threshold \$/QALY gained	50,000	Farag et al., 2014
Base case cost per QALY gained	72,765	Church et al., 2011

This study used an average value of QALY based on the available literature with an inflation adjusted rate of 3%. The average value of QALY in terms of WTP is AUD 57,215.40 in 2016 base price. Based on the literature cited above, technological intervention could result in up to 25% QALY gained (ranges from 5%) per elderly person, who choose to stay at his/her own home. The potential benefits are illustrated in Figure 6.4. The results indicated that with a 5% QALY gained by adopting assistive technologies could potentially save 31 million dollars in 2016. Total savings could be as high as 229 million dollars by the year 2026.

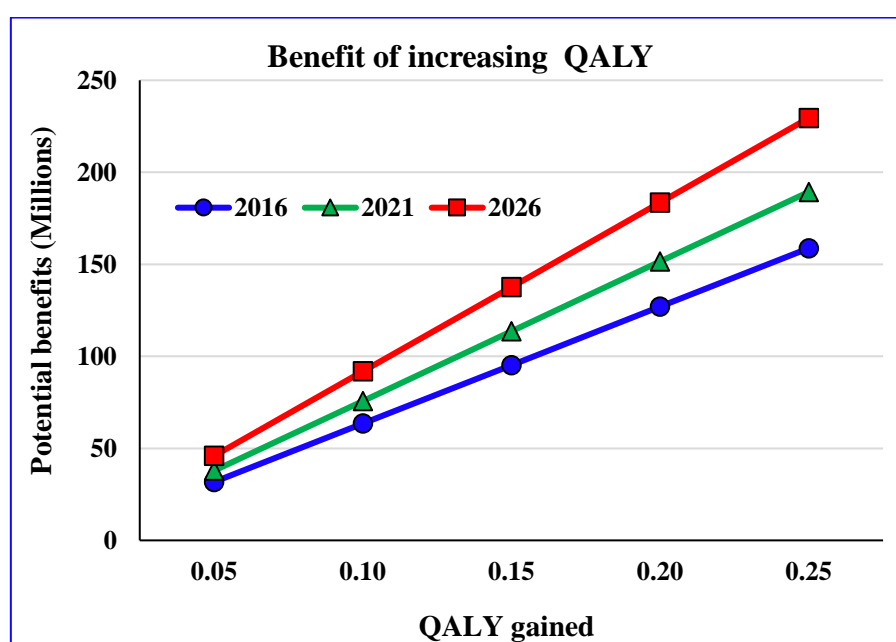


Figure 6.4: Monetary value on increasing QALY

6.4. Reduction in hospital admission

Inpatient hospital care is highly effective for the elderly people with some chronic diseases but could be likewise expensive (Wittenberg et al. 2017). Wittenberg et al. (2017) suggested that the number of emergency admissions for elderly people have been increasing since 2001 at a rate of 3.5% per year in England. Technological intervention may lead to a reduced number of hospital admission, as suggested by Dang et al (2017) through their evidence based investigation on the impact of telehealth remote monitoring. One past study indicated that a telehealth care and home monitoring system reduced the hospital readmission numbers and costs (up to 20% for a 12 month study) for the heart failure patients (Benetar et al. 2003, Kashem et al, 2008).

In our estimation, we assumed that the elderly people who have at least two chronic diseases are more likely to require admission in hospital during ageing in place. The potential saving was estimated for the reduction in hospital admission for the same cohort. The reduction level was set to 5% to 25%. The estimated benefits are shown in the Figure 6.5. The results indicate that savings could vary from 4 million to 20 million dollar for the year 2016 and in the year 2026 apparently 30 million dollar could be saved.

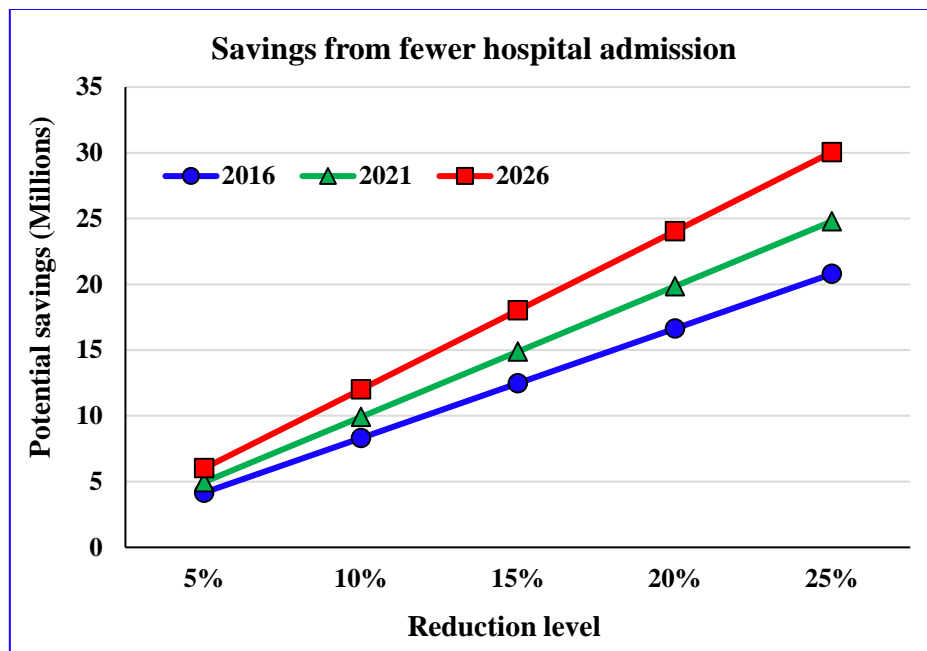


Figure 6.5: Benefits for less hospital admission

6.5 Net Benefits

The net benefit that can be achieved through a technological intervention has been calculated by deducting costs from the all potential savings. Level of benefits were kept at the same range (5% to 25%) that were used for the individual benefit analysis. The results are presented in Figure 6.6 for the three different years which was considered for the study.

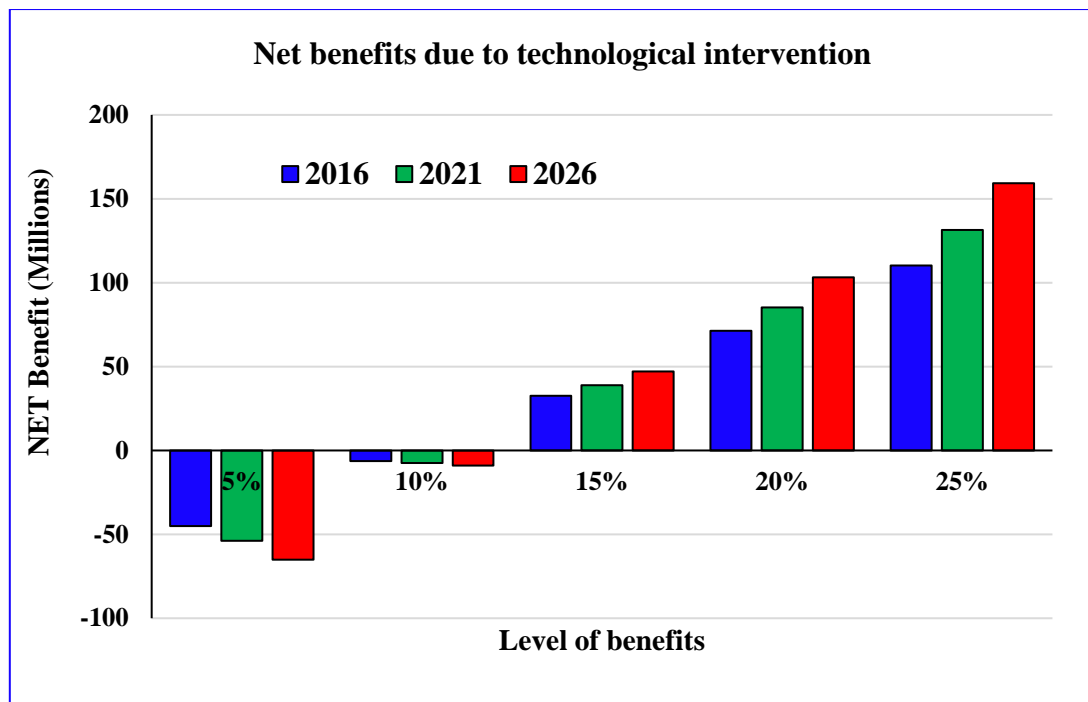


Figure 6.6: Net benefit analysis

For the current study we have considered four different aspects to estimate potential benefits. The net benefit analysis demonstrate that the technological intervention may not be cost effective under 5% and 10% savings scenarios but under 25% savings scenario, about AUD 160 million can be saved by 2026.

7. CONCLUSION

Ageing in their own home is one of the greatest desires of elderly people, which is sometimes not possible due to the presence of chronic diseases and health condition at the later stage of life. Research suggests that assistive digital technologies could potentially delay the institutionalisation of the elderly people and allow them aging in place. Digital technologies have a multitude of benefits including improvement in the safety and security of elderly people, increasing connectivity with health practitioners, reducing social isolation, increasing functionality and increasing mobility. The aim of this study was to provide an estimate of costs and benefits of adopting digital technologies that can improve the quality of life of elderly people within the FCW region. A stakeholder workshop was organised to understand the perceptions of the participants in technological intervention as well as to determine the future priorities.

The study team developed a five-stage hybrid model, which comprised of progressive forecasting and direct cost estimation methods. The forecasting and cost estimation models have been set for a 10 year period because the accuracy and validity of the findings from cross-sectional data is better in the short to medium term compared to long-term predictions. Therefore, we used progressive forecasting, which is appropriate for a short-term population projection. The elderly population (aged 65 years or over) in the FCW region was 30,314 in 2016. Our forecasting model predicted that number of elderly people will be 43,824 by 2026, about a 45 percent increase. The analysis also revealed that amongst this cohort, about 11,098 people lived in their own home in 2016 and needed assistance with at least one core activity; and this number will be 16,044 by 2026 (i.e., about a 46 percent increase).

The identification of required assistive technologies with life-cycle cost is a vital component for accurate cost estimation. The literature review revealed that elderly people likely to suffer from eight chronic diseases, which are:

- Arthritis
- Asthma
- Back pain and problems
- Cancer (such as lung and colorectal cancer)
- Cardiovascular disease (CVD) (such as coronary heart disease and stroke)
- Chronic obstructive pulmonary disease (COPD)
- Diabetes
- Mental health conditions.

Digital technologies to assist elderly people with these chronic diseases were identified with some other basic digital devices to support daily living. The costs of the technologies were collected from both refereed and non-refereed literature and online sources. Per capita cost of technological intervention in the FCW region were estimated from the average cost of the fixed and variable costs over a 10 year period. This study found, for the low-cost device users, the per capita cost will be AUD 4,169 per year while the figure could be as high as AUD 7,551 per year for the digital devices with average range price; however this study did not include the high or very high cost models of the same technologies. For the elderly people with no chronic diseases, per capita costs for technological intervention is AUD 2,289

with low priced devices and AUD 5,206 for average price devices. Comorbidity³ has a big impact on the per capita technological intervention cost, as discovered through this study. For instance, with the average priced devices and for the elderly people with three or more chronic diseases, the per capita costs reach to AUD 8,858.

An extensive literature review was conducted to identify the current practice of estimating health benefits in monetary value. One of the key components of benefit estimation is measuring quality adjusted life years (QALY). For the current study, the benefits of technological intervention were estimated using the available information in the literature and with a set of basic assumptions. Four types of benefits were considered in the current study to estimate the monetary values of the benefits:

- Retention of the elderly people in the home care package (HCP) and basic home support (BHS)
- Reduction in aged care service hours
- Increase in QALY of the elderly people
- Reduction in hospital admission

Residential care costs are higher than HCP and BHS, which implies any retention in HCP and BHS with the adoption of digital technologies could lead to substantial savings. Results indicate that up to 11 million dollars could be saved by 2026 with a 25% retention rate (i.e., one of the retention scenarios developed in this study). However, this study considered the elderly people in the FCW region who need assistance for daily activities. Costs of various types of services provided to the elderly people were collected from secondary sources. The reduction of service hours with technological intervention is supported by the literature, hence potential savings may occur. Based on 25 percent reduction in hospital admission (i.e., one of the reduction scenarios developed in this study) in services, about 10 million dollars could be saved by 2026.

Quantifying QALY is generally done by calculating willingness to pay by the clients to achieve QALY. This study used information available in the Australian context to estimate the average WTP per QALY gained. The results indicate that with a 5% QALY gained (i.e., one of the QALY gain scenarios adopted in this study) by adopting digital assistive technologies could potentially save AUD 31 million in 2016, however these savings could be as high as AUD 229 million by the year 2026. Adopting digital technologies can also reduce the hospital inpatient hours and hence save money. Approximately AUD 30 million dollars can be saved by 2026 under the 25 percent reduction in hospital admission scenario.

The net benefits of technological intervention were calculated by adding all benefits and subtracting the costs for technologies. The net benefit analysis suggests that technological intervention may not be cost effective if the combined level of benefit is below 10%. However, with a combined 25% of benefit level, AUD 160 million can be saved by 2026.

As a part of the study, a stakeholders workshop was organised with the participation of local and state government people, service providers, RDAFCW, nurses and allied health practitioners. The participants have expressed their concern about the barriers to adopt and access digital technologies for the elderly people. A few technologies were suggested during the discussion which were not included

³ Comorbidity is defined as the co-occurrences of one or more diseases or disorder of the same person.

during the cost analysis. Telehealth has a big impact on the wellbeing of the elderly people ageing in place. However, this study only considered the devices to support telehealth and the entire impact of telehealth was not considered. Unproductive travel time is a barrier for the service providers and it reduces the actual service hours. Technological intervention could lead to a better communication system and may reduce the travel time of health providers

This study identified the importance of digital technologies for the wellbeing of the elderly people of the FCW region. However, one of the limitations of this study was not collecting primary data for analysis. The stakeholders and the study team identified the following priorities for further research:

- Randomised control trial (RCT) study to measure the improvement of the quality of life (QoL) with technological intervention, particularly focusing on the mobility aids with digital technology and fall prevention.
- Case study/individual personal story of home care benefits (e.g. Dorothy suffers from xxx chronic disease...).
- Understanding how home care options with digital technologies reduces travel cost for patients and reduces other measurable impacts on patient families.
- Improving cost efficiency of provider services: Looking at the travel and other costs of current services and how this can be reduced and improved with home care and other options.
- Focusing on more specific estimates about changes to QoL to update/existing or previous research on QoL measures.

So far, this is the first study of its kind in Australia and the cost estimation framework developed in this study would be an important tool for service providers and policy makers. The benefit analysis were established under several scenarios, which require a further study such as randomised control trial (RCT) on digital technology intervention.

REFERENCES

- Aged Care Financing Authority (ACFA). (2017). *Fifth report on the Funding and Financing of the Aged Care Sector*, July 2017
- Akiyama, M., Abraham, C. (2017). Comparative cost-benefit analysis of tele-homecare for community-dwelling elderly in Japan: Non-government versus government supported funding models, *International Journal of Medical Informatics*, 104, 1–9.
- Australian Bureau of Statistics (ABS). (2013). *Population projections, Australia, 2012 (base) to 2101*. ABS cat. no. 3222.0. Canberra: ABS.
- Australian Bureau of Statistics (ABS). (2015). *National Health Survey: First results, 2014–15*. ABS cat. no. 4364.0.55.001. Canberra: ABS, Ref: 4364055001DO019_20142015.
- Australian Bureau of Statistics (ABS). (2016). *Disability, Ageing and Carers, Australia: Summary of Findings, 2015*, Ref: 44300DO030_2015, Released at 11.30am (Canberra time) Tues 18 Oct 2016
- Australian Bureau of Statistics (ABS). (2018). *Australian Demographic Statistics*, Sep 2017, Ref: 31010DO002_201709, Released at 11:30 am (Canberra time) Thurs 22 Mar 2018.
- Australian Institute of Health and Welfare (AIHW). (2013). *The desire to age in place among older Australians*. Bulletin no. 114. Cat. no. AUS 169. Canberra: AIHW.
- Australian Institute of Health and Welfare (AIHW). (2016). *Australia's health 2016*. Australia's health series no. 15. Cat. no. AUS 199. Canberra: AIHW
- Australian Institute of Health and Welfare (AIHW). (2017). *Pathways to permanent residential aged care in Australia: A Pathways in Aged Care (PIAC) analysis of people's aged care program use before first entry to permanent residential aged care in 2013–14*. Cat. no. AGE 81. Canberra: AIHW.
- Australian Institute of Health and Welfare (AIHW). (2018). *Aged care service list 30th June 2018*, available at: <https://www.gen-agedcaredata.gov.au/Resources/Access-data/2018/September/Aged-care-service-list-30-June-2018>.
- Australian Institute of Health and Welfare (AIHW). (2018a). *GEN data: Admissions into aged care*, available at: <https://gen-agedcaredata.gov.au/Resources/Access-data/2018/June/GEN-data-Admissions-into-aged-care>.
- Benatar, D., Bondmass, M., Ghitelman, J., Avitall, B. (2003). Outcomes of chronic heart failure. *Archives of Internal Medicine*, 163, 347–352.
- Benefield, L.E., Holtzclaw, B.J. (2014). Aging in place: Merging desire with reality, *Nursing Clinics of North America*, 49(2), 123–131.
- Caley, M., Sidhu, K. (2011). Estimating the future healthcare costs of an aging population in the UK: Expansion of morbidity and the need for preventative care, *Journal of Public Health*, 33(1), 117–122, doi:10.1093/pubmed/fdq044.
- Church, J., Goodall, S., Norman, R., Haas, M. (2011). An economic evaluation of community and residential aged care falls prevention strategies in NSW, *NSW Public Health Bulletin*, 22, 3–4.
- Culyer, A.J., Chalkidou, K. (2018). Economic evaluation for health investments en route to universal health coverage: Cost-benefit analysis or cost-effectiveness analysis? *Value in Health*, article in press, Available online 26 July 2018, DOI: <https://doi.org/10.1016/j.jval.2018.06.005>.

- Dang, S., Dimmick, S., Kelkar, G. (2009). Evaluating the evidence base for the use of home telehealth remote monitoring in elderly with heart failure, *Telemedicine and e-Health*, 15(8), 783-796.
- Diane J. Cook, D.J. (2006). Health monitoring and assistance to support aging in place, *Journal of Universal Computer Science*, 12(1), 15-29.
- Drummond, M.F., Sculpher, M.J., Claxton, K., Stoddart, G.L., Torrance. G.W. (2015). Methods for the economic evaluation of health care programmes (4th edition), Oxford: Oxford University Press.
- Farag, I., Howard, K., Ferreira, M.L., Sherrington, C. (2015). Economic modelling of a public health programme for fall prevention, *Age and Ageing*, 44, 409–414.
- GEN Aged care data. (2017). *Aged care data snapshot—2017*, available at: <https://www.gen-agedcaredata.gov.au/Resources/Access-data/2018/January/Aged-care-data-snapshot%E2%80%942017>.
- Hacker, E.D. (2010). Technology and quality of life outcomes, *Seminars in Oncology Nursing*, 26(1) (February), 47-58.
- Hoof, J., Kort, H.S.M., Rutten, P.G.S., Duijnste, M.S.H. (2011). Ageing-in-place with the use of ambient intelligence technology: Perspectives of older users, *International Journal of Medical Informatics*, 80, 310–331,
- Huang, L., Frijters, P., Dalziel, K., Clarke, P. (2018), Life satisfaction, QALYs, and the monetary value of health, *Social Science & Medicine*, 211, 131–136.
- Kashem, A., Droogan, M.T., Santamore, W.P., Wald, J.W., Bove, A.A. (2008). Managing heart failure care using an Internet-based telemedicine system. *Journal of Cardiac Failure*, 14(2), 121–126.
- Khosravi, P., Ghapanchi, A.H. (2016). Investigating the effectiveness of technologies applied to assist seniors: A systematic literature review, *International Journal of Medical Informatics*, 85, 17–26.
- Kim, K., Gollamudi, S.S., Steinhubl, S. (2017). Digital technology to enable aging in place, *Experimental Gerontology*, 88, 25–31.
- Kok, L., Berden, C., Sadiraj, K. (2015). Costs and benefits of home care for the elderly versus residential care: a comparison using propensity scores, *European Journal of Health Economics*, 16, 119–131.
- Kulvik, M., Hermans, R., Linnosmaa, I., Shalowitz, J. (2015). An economic model to assess the cost-benefit of BNCT, *Applied Radiation and Isotopes*, 106, 3–9.
- Kuo, M., Wang, S., Chen, W. (2016) Using information and mobile technology improved elderly home care services, *Health Policy and Technology*, 5, 131–142.
- Lehoux, P., Grimard, D. (2018). When robots care: Public deliberations on how technology and humans may support independent living for older adults, *Social Science & Medicine*, 211, 330–337.
- Liu, L., Stroulia, E., Nikolaidis, I., Miguel-Cruz, A., Rincon, A.R. (2016). Smart homes and home health monitoring technologies for older adults: A systematic review, *International Journal of Medical Informatics*, 91, 44–59.
- MacKillop, E., Sheard, S. (2018). Quantifying life: Understanding the history of Quality-Adjusted Life-Years (QALYs), *Social Science & Medicine*, 211, 359–366.

- Magnusson L., Hanson E. (2005). Supporting frail older people and their family carers at home using information and communication technology: cost analysis, *Journal of Advanced Nursing*, 51(6), 645–657.
- Malwade, S., Abdul, S.S., Uddin, M., Nursetyo, A.A., Fernandez-Luque, L., Zhu, X., Cilliers, L., Wong, C., Bamidis, P., Li, Y. (2018). Mobile and wearable technologies in healthcare for the ageing population, *Computer Methods and Programs in Biomedicine*, 161, 233–237.
- Queensland Government Statistician's Office (QGSO), (2018). *Queensland Treasury, Queensland Regional Profiles*, 2018.
- Queirós, A., Cerqueira, M., Santos, M., Rocha, N.P. (2017). Mobile health to support ageing in place: A synoptic overview. *Procedia Computer Science*, 121, 206–211.
- Rantz, M.J., Skubic, M., Miller, S.J., Galambos, C., Alexander, G., Keller, J., Popescu, M. (2013). Sensor technology to support aging in place, *Journal of the American Medical Directors Association*, 14(6), 386-391.
- Regional Development Australia Fitzroy and Central West Inc (RDAFCW) (2015), *Central Queensland Snapshot*, 2015.
- Rioux, L., Werner, C. (2011). Residential satisfaction among aging people living in place, *Journal of Environmental Psychology* 31, 158-169.
- Schaffer, J.L., Rasmussen, P.A., Faiman, M.R. (2018). The emergence of distance health technologies, *The Journal of Arthroplasty*, 33, 2345-2351.
- Schorr, A.V., Khalaila, R., (2018). Aging in place and quality of life among the elderly in Europe: A moderated mediation model. *Archives of Gerontology and Geriatrics*, 77, 196–204.
- Siegel, C., Dorner, T.E. (2017). Information technologies for active and assisted living—Influences to the quality of life of an ageing society, *International Journal of Medical Informatics*, 100, 32–45.
- The Aged Care Industry IT Council (ACIITC) (2017). *A technology roadmap for the Australian aged care sector*, Medical Device Research Institute, Flinders University.
- The National Institute for Health and Care Excellence (NICE), 2016. Glossary. Available at: <https://www.nice.org.uk/glossary?letter=q>.
- United Nations (UN), 2015, Department of Economic and Social Affairs, Population Division (2015). *World Population Ageing, 2015* (ST/ESA/SER.A/390).
- Wilson, C., Hargreaves, T., Hauxwell-Baldwin, R. (2017) Benefits and risks of smart home technologies, *Energy Policy*, 103, 72–83.
- Wittenberg, R., Sharpin, L., McCormick, B., Hurst, J. (2017). The ageing society and emergency hospital admissions, *Health Policy*, 121, 923–928.
- Yusif, S., Soar, J., Hafeez-Baig, A. (2016). Older people, assistive technologies, and the barriers to adoption: A systematic review, *International Journal of Medical Informatics*, 9, 112–116.

APPENDICES

Data from AIHW, 2016

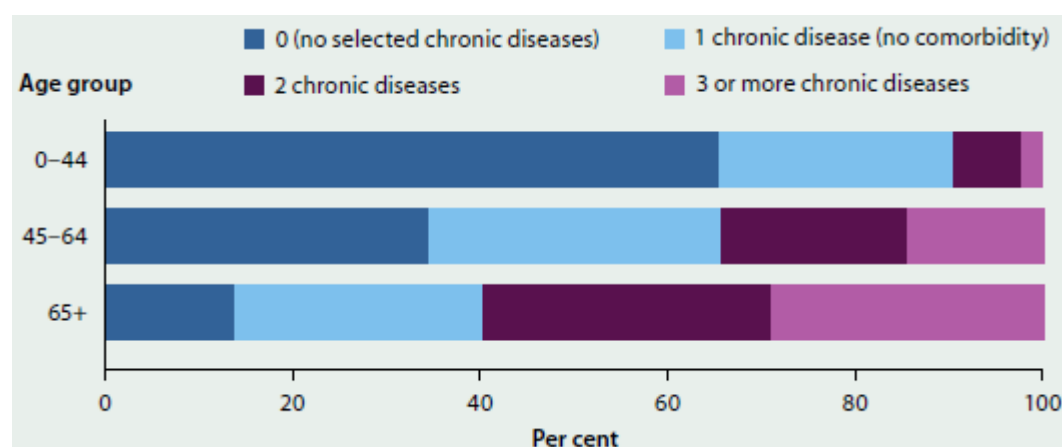
Figure 3.3.1: Most common selected chronic diseases, by age and sex, 2014–15

	Age group			Sex		
	0–44	45–64	64+	Males	Females	People
1	Mental health conditions	Cardiovascular disease	Cardiovascular disease	Cardiovascular disease	Mental health conditions	Cardiovascular disease
2	Asthma	Arthritis	Arthritis	Back pain and problems	Cardiovascular disease	Mental health conditions
3	Back pain and problems	Back pain and problems	Back pain and problems	Mental health conditions	Arthritis	Back pain and problems
4	Cardiovascular disease	Mental health conditions	Mental health conditions	Arthritis	Back pain and problems	Arthritis
5	Arthritis	Asthma	Diabetes	Asthma	Asthma	Asthma

Note: The selected chronic diseases are: arthritis, asthma, back pain and problems, cancer, cardiovascular disease, chronic obstructive pulmonary disease, diabetes, and mental health conditions.

Sources: ABS 2015 (Table 19.1); Table S3.3.1.

Of the eight selected chronic diseases, cancer (1.6%) was the least prevalent, based on self-reported data. Some people diagnosed with cancer may consider it to be a one-off event rather than a 'long-term' condition. However, cancers can recur multiple times in a person and over an extended time. As treatments and survival rates improve, cancer is increasingly viewed as a chronic disease that may not be cured, but can often be managed for months or even years (American Cancer Society, 2015).



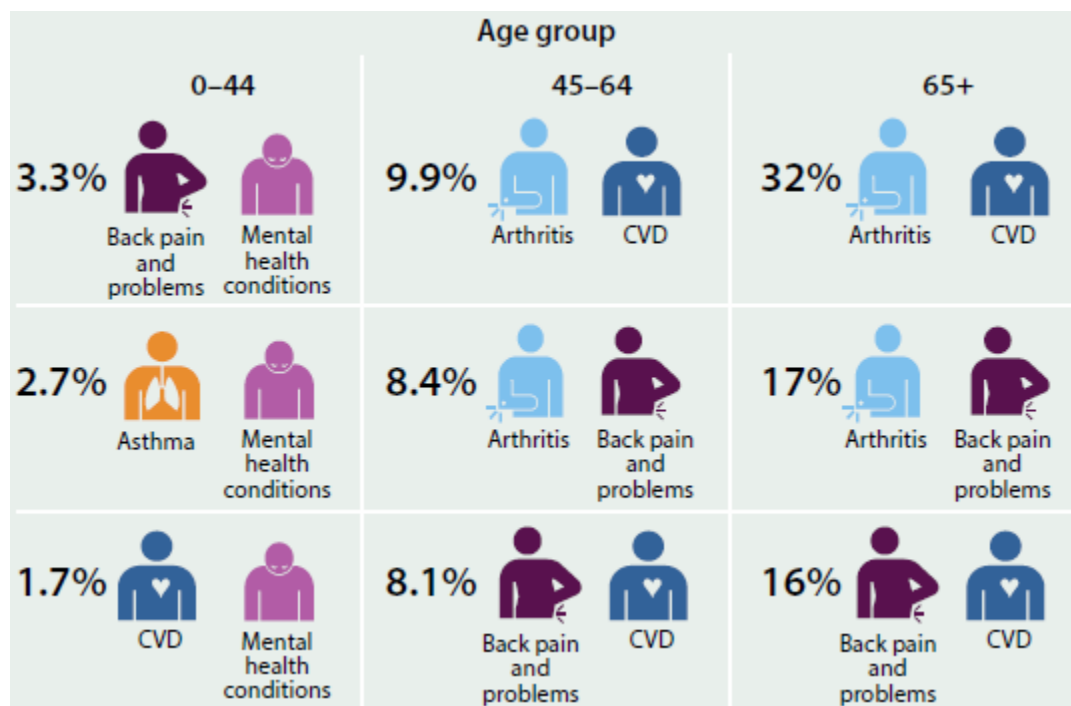


Table A1: List of price of digital assistive technologies for elderly people.

Technology					
Security, Safety and Falls					
Item	Chronic disease	Price/Price Range \$AUD	Description	Stockist	Website
Household/Environment/Safety					
Door alarm- Vitalcom Victoria (formerly Marker Engineering) (Boronia)	0 - 8	89- 95	This compact, attractive door alarm is perfect for the wandering Alzheimer's patient.	Independent Living Centres Australia	https://ilcaustralia.org.au/products/5110?search_tree=636
		89		Health Saver	https://www.healthsaver.com.au/healthsaver-online-store/Anti-Wandering-Stop-Alarm-p88767070
Cordless bed alarm/ personal alarm			Alerts a caregiver when their patient gets up, up to 100' away from the patient's room. Cordless operation allows greater caregiver freedom and provides a calmer environment for the patient.		
Motion sensor	0 - 8	130	Detects falls by censoring motion.	Health Saver	https://www.healthsaver.com.au/healthsaver-online-store/Motion-Sensor-Fall-Alarm-p88767090
Loud power failure alarm with flashlight	0 - 8		Loud alarm when there is a power failure, flashlight available for senior to navigate around while there is a power outage to prevent falls.		
Medical alert system/ duress alarm/emergency pendants/ fall detection/Push button personal emergency response system	0 - 8	300-497	Pendant operates on the 3, 4 and 5G mobile networks. Can alert up to 5 pre-programmed contacts when the SOS button is pushed. Verbal communication is possible via the speaker and microphone in the pendant, once a contact has answered the call. The pendant also sends a text message giving GPS location via a link to Google Maps. It has a built in falls detector which automatically sends an alert.	Independent Living Centres Australia	https://ilcaustralia.org.au/products/21394?search_tree=632
					https://www.healthsaver.com.au/healthsaver-online-store/Smart-Caregiver-Fall-Alarms-c24229107
AbleNet Mini Beamer Wireless Switch	0 - 8	192-355	A small rectangular wireless switch that is activated within 10mm of the sensor. (Actual contact with the device is not required).	Independent Living Centres Australia	

Fall Monitor	0 - 8	148-237	A portable wireless audible and visual alarm that provides up to 100 metres monitoring range with a variety of sensors including Smart Caregiver sensor pads and mats, Smart Caregiver motion sensors, and nurse call systems. The portable alarm can be paired with up to six wireless sensors. The device is battery operated or has an optional 12 v DC power adapter.		
		148	Smart Caregiver Economy Cordless Fall Monitor.	Independent Living Centres Australia	
		237	Quiet Wireless Fall Alarm Monitor (Pager Not Included).	Health Saver	https://www.healthsaver.com.au/healthsaver-online-store/Quiet-Wireless-Fall-Alarm-Monitor-Pager-Not-Included-p89327296
Malem Wireless Bedwetting Alarm		220	A wireless enuresis alarm which uses a small magnetic transmitter attached the waistband of the user's underwear and a receiver which can be positioned up to approximately 25 metres from the transmitter. A second receiver can be purchased to be placed in the parent's room. A clip on sensor is attached to user's close fitting underwear which is connected to the transmitter. Ideal for those who prefer not to wear a pyjama top to bed.	Independent Living Centres Australia	
Robot Vacuum	0 - 8	589.00-1499.00	Robotic vacuum cleaner.	Good Guys	https://www.thegoodguys.com.au/vacuums-and-cleaners/vacuum-cleaners/robot-vacuums
Touch Lamp	0 - 8	15.00-21.89	Lamp activated by touch.		https://www.bunnings.com.au/our-range/lighting-electrical/lighting/lamps/table?gclid=EAlaIqObChMIId-fzPi52wIVmyQrCh1cRA00EAAYASAAEgITCfD_BwE&sort=PriceAscending http://www.kmart.com.au/category/home-&-entertainment/home-by-category/home-decor/lighting/lamps/251205
Lamp switch turners	0 - 8		Not digital; helps when turning on lamps		
Adaptive switches	0 - 8	80-129	Switches that enables individuals with a physical disability to independently activate assistive technology devices.		https://ilcaustralia.org.au/products/5534
Automatic door opener	0 - 8		for those with mobility issues		
Talking thermostat	0 - 8		Announces day, date, time and temperature.		
ICT					

Mobile devices i.e. phones, iPad, smart watches	0. Nil Chronic disease		medical consultation wth specialists		
ipad	0. Nil Chronic disease	439-1919		Harvey Norman	https://www.harveynorman.com.au/catalogsearch/result/index/?dir=asc&order=price&q=ipad+#toolbar-top
TV Toshiba 32-inch HD LED LCD Smart TV	0. Nil Chronic disease	395	Video link appointment.	Harvey Norman	
Computer	0 - 8	298-1698		Harvey Norman	https://www.harveynorman.com.au/catalogsearch/result/?af=producttype%3Alaptops&q=laptop+computer
Vision & Hearing Products					
Talking Rx	0 - 8	24.95	Seniors with poor vision can take their medications correctly with the Talking Rx's talking directions.		https://www.afb.org/prodProfile.asp?ProdID=799
Telephone amplifier/door bell and telephone ring amplifier	0 - 8	79.95- 199	Portable phone amplifier; amplifies sounds- rings and flash.	Independent Living Centres Australia	https://ilcaustralia.org.au/products/21490 https://ilcaustralia.org.au/products/17129
Sound amplifier	0 - 8	225-603.95	Pocketalker Ultra System amplifies sounds closest to the listener while reducing background noise.		https://ilcaustralia.org.au/products/20184 https://ilcaustralia.org.au/products/20183 https://ilcaustralia.org.au/products/4884 https://www.aldsaustralia.com.au/categories/personal-sound-amplifiers/page/3/
Big button phone	0. Nil Chronic disease	129	This picture phone is absolutely fantastic for those that have sight issues.		https://ilcaustralia.org.au/products/13918
Audio books	0. Nil Chronic disease	?	For individuals with a vision impairment.		
Amplified phone	0 - 8	182.95-237.95	For individuals with a hearing impairment.		https://www.aldsaustralia.com.au/categories/personal-sound-amplifiers/
Pocket talker	0 - 8	284.95-338.95	Personal sound amplifier.		https://www.aldsaustralia.com.au/categories/personal-sound-amplifiers/
Hearing Aids	0 - 8	3340-14000	Costing obtained from internet.	CHOICE	https://www.choice.com.au/health-and-body/optical-and-hearing/hearing/buying-guides/hearing-aids
Exercise & Fitness Products					
<u>Power Plate Exercise Machine</u>	0 - 8	-	Uses whole body vibration and acceleration training to help heal injuries and provide a low impact workout.		
Pedal exercisers/pedal bike	0 - 8	165-278.30	Fully automatic electronic exercise pedal.	DJO Global	https://ilcaustralia.org.au/products/11026

Treadmill	0 - 8	995-2999.00		Rebel Sports	http://search.rebelsport.com.au/search?isort=price&lbc=rebelsport&method=and&p=Q&ts=custom&uid=106041558&w=treadmill&cnt=100
Exercise bike	0 - 8	149.99-1999.99		Rebel Sports	http://search.rebelsport.com.au/search?p=Q&srid=S1-2SYDP&lbc=rebelsport&ts=custom&w=exercise%20bikes&uid=106041558&method=and&isort=price&view=grid&srt=12
Bedroom & Sleeping Products					
Hospital bed/electric bed		1890-2400	Offers the greatest convenience for the patient and caregiver.	Mobility Aid	
				Assistive Technology Australia	http://at-aust.org/items/13724
Hoist/lifter		3275	Used to transfer individuals who are not mobile.	Mobility Aid	
Nursing bed/ Princess bed		2500	Specialised bed with remote to adjust bed.	Mobility Aid	
Health & Medical Supplies Products					
Portable oxygen	6. Chronic Obstructive Pulmonary Disease	*\$174	You can now take off on a moment's notice, without having to watch the clock or guess how long your oxygen will last. Oxygen travel made, easy-airline approved.		
			\$89 to start up + \$46 monthly hire + \$39 oxygen (price for 3 bottle 2L each bottle last for 3 hours -->depends on what the prescription is)	Heeson Medical	http://www.heesonmedical.com.au/?page_id=660732625506
		\$34	\$11.22 per month for hire and \$17.65 for refill and \$5 admin fee	Air Liquide Healthcare	https://www.airliquidehealthcare.com.au/1300360202
Blood glucose meter/ continuous glucose monitoring	7. Diabetes mellitus	\$29-65.25	Range. Test blood glucose levels	Vital Medical	http://www.vitalmed.com.au/images/pdf/catalogue/2018_19/vms_diagnostic-reagents.pdf
		65.25	Accu chek	Independence Australia	https://store.independenceaustralia.com/accu-chek-blood-glucose-meter.html
		45	Accucheck Performa Blood Glucose Meter - ROC51551	Zone Medical	http://zonemedical.com.au/medical-equipment/Blood-Monitoring/Accucheck-Performa-Blood-Glucose-Meter-ROC51551_2.html
Medication tablet reminder	0 - 8	51.04-79.75	Alarm to remind patients to take their tablets	Independence Australia	
			TabTimer Pill Box Reminder TT4-3	Independent Living Centres Australia	
INR measurement tester	5. Cardiovascular Disease	595	Alere INRatio 2 PATIENT/INR Monitoring system	Vital Medical	
Blood pressure monitor/sphygmo manometer	5. Cardiovascular Disease	49- 749	Range. Test blood pressure		
		749	Omron HEM907 Digital Blood Pressure Monitor - JADHEM907	Zone Medical	http://zonemedical.com.au/medical-equipment/Blood-Pressure-Monitors/Omron-HEM907-Digital-Blood-Pressure-Monitor-JADHEM907_2.html

Blood pressure monitor/sphygmo manometer	5. Cardiovascular Disease	\$115	HEM7121 Standard Automatic Blood Pressure Monitor	Vital Medical	
		\$49	Honsun LD578 Automatic Digital Blood Pressure Monitor - HONLD578	Zone Medical	http://zonemedical.com.au/medical-equipment/Blood-Pressure-Monitors/Honsun-LD578-Automatic-Digital-Blood-Pressure-Monitor-HONLD578.html
Electronic Asthma Monitoring		\$149	electronic peak flow meter	Vital Medical	-
Hand held device to measure cholesterol, glucose, lactate and triglycerides Accutrend Plus	0 - 8	\$295		Vital Medical	http://www.vitalmed.com.au/images/pdf/catalogue/2018_19/vms_diagnostic-reagents.pdf
Thermometer	0 - 8	9.45-59.62	Range		
		\$9.45	Monitor temperature	Vital Medical	
		\$59.62	Tympanic with covers	Independence Australia	https://store.independenciaustralia.com/thermometer-tympanic-with-covers.html
Air mattress	7. Diabetes mellitus	1100-4700	To prevent pressure injuries		https://ilcaustralia.org.au/products/12383 https://ilcaustralia.org.au/products/9308 https://ilcaustralia.org.au/products/21408 https://ilcaustralia.org.au/products/21856 https://ilcaustralia.org.au/products/9304 https://ilcaustralia.org.au/products/9309
Carilex Dual Alternating Pressure Mattress Replacement	7. Diabetes mellitus	4996		Assistive Technology Australia	http://at-aust.org/items/10248
Nebuliser System - 2.4MHz Ultrasonic Nebulizer	6. Chronic Obstructive Pulmonary Disease	45		Caremax	https://www.caremax.com.au/ultrasonic-nebulizer.html?gclid=EAIaIQobChMiv6Xi7pGW2wIVRB0rCh1jnAGREAYYASABEgJ8rvD_BwE
	6. Chronic Obstructive Pulmonary Disease	109-225	Machine used to change liquid medication into vapour for inhalation	Vital Medical	http://www.vitalmed.com.au/images/pdf/catalogue/2018_19/vms_diagnostic-reagents.pdf
Nebuliser System	2. Asthma		Purify air for allergy sufferers		
Air purifier	6. Chronic Obstructive Pulmonary Disease				
	5. Cardiovascular Disease		i.e. diabetes mellitus, cardiovascular disease, cardiac arrhythmias, chronic		

			obstructive pulmonary disease, Chronic Kidney Disease		
Home monitoring devices/ vital signs	7. Diabetes mellitus				
	0-8		Alert pts regarding unsafe dose.		
Drug delivery/infusion pump	0-8		Remote monitoring of continence events using a sensor in a disposable continence aid. Helps to aid personalised care plan.		
Smart incontinence system	5. Cardiovascular Disease	79.95-699	Monitor heart rate.	Rebel Sports	http://www.rebelsport.com.au/store/gym-fitness/heart-rate-monitors/412?pageSize=12&sort=ProductVisiblePrice&page=1
Heart rate monitor	5. Cardiovascular Disease 5. Cardiovascular Disease	79.95	Diagnostic and assessment tool that measures and records the electrical activity of the heart using electrodes attached to the skin.	Omron Australia	https://omronhealthcare.com.au/product-category/omron-heart-rate-monitors/
Electrocardiogram (ECG)	5. Cardiovascular Disease	USD \$259	Self-monitoring ECG- The Heart Check Pen Handheld ECG.	The Heart Check	http://www.theheartcheck.com/wheretobuy_ECGPEN.html
			Monitoring system for patients with kidney disease undergoing home haemodialysis.		
Home haemodialysis monitor	6. Chronic Obstructive Pulmonary Disease	99-2495	Measure volume of air inspired and expired by the lungs	Zone Medical	http://zonemedical.com.au/medical-equipment/spirometers/MIR-Smart-One-Personal-Spirometer-Peak-Flow-Meter-MIR9111000D2.html
Spirometer	6. Chronic Obstructive Pulmonary Disease	49-1795	Measuring the pulse oxygen saturation and pulse rate through finger	Zone Medical	http://zonemedical.com.au/medical-equipment/pulse-oximeters/
Pulse Oximeter	6. Chronic Obstructive Pulmonary Disease 3. Back Pain	622.93	Pulse Oximeter	Independence Australia	https://store.independenceaustralia.com/pulse-oximeter-2.html
		129.09	Fingertip pulse oximeter	Independence Australia	https://store.independenceaustralia.com/fingertip-pulse-oximeter.html
		81.99-97.99	Back Belt with Magnetic and Heating Therapy. It uses 2 magnets and USB powered heating pad to warm up strained tendons, muscles and bones to relieve back pain, soreness, tightness and discomfort.	Caremax	https://www.caremax.com.au/pain-relief/supports-braces/pain-management-braces-belts.html
Thermal belt	3. Back Pain	116-198	Transcutaneous electrical nerve stimulation- used for pain relief	Astir	
TENS	3. Back Pain	116-198	Transcutaneous electrical nerve stimulation- used for pain relief	Astir	

Mobility					
Motorised wheel chair	3. Back Pain	1790	Heartway P3D Maxx 20	Mobility Aid	
	1. Arthritis	1699.99-6125.99	Range		
	6. Chronic Obstructive Pulmonary Disease	6125.99	Jazzy Air Wheelchairs electric	Independent Living Specialists	
	4. Cancer	1699.99	Cobalt Travel Power Wheelchair	Independent Living Specialists	
	0. Nil Chronic disease	unable to get quote			
Home elevators	0 - 8	1099.99-10409.99	Range		
Electric Mobility Scooter	1. Arthritis	10409.99	Predator 4-wheel drive mobility scooter	Independent Living Specialists	http://ilsau.com.au/department/mobilityscooters/?gclid=EAlaIQobChMk-z1n9KW2wIVkB0rCh14fAQREAAYASACEgKr5fD_BwE
	3. Back Pain	5555.99	Easy Rider Mobility Scooter	Independent Living Specialists	
	4. Cancer	1099.99	Scout Portable Economy Mobility Scooter	Independent Living Specialists	
	6. Chronic Obstructive Pulmonary Disease	1564	Pride Go-Go LX 3 wheel with CTS suspension	Mobility Aid	
	3. Back Pain	waiting for quote		Acorn	
Stair lifts	1. Arthritis	waiting for quote 795.99-3800.99			
	5. Cardiovascular Disease				
	0 - 8		Range		
Life chair/recliners	0 - 8	1455	Assist to help sit down and stand up	Mobility Aid	
		895.99	Pride C5 Electric recliner lift chair	Independent Living Specialists	
		3800.99	K Care Compact Electric Recliner Lift Chair	Independent Living Specialists	
		795.99	Mayfair Select Electric Lift chair	Independent Living Specialists	
Organisation tools					
Walking cueing device	0 - 8	2199	Clips onto a belt or waistband. It continuously monitors the user's walking motion with a small motion sensor and intelligent software.	Assistive Technology Australia	http://at-aust.org/items/10247