OUR HONG KONG
FOUNDATION
團結香港基金

Gerontechnology Landscape Report

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Executive Summary

INTRODUCTION AND BACKGROUND

1. Hong Kong's population is ageing rapidly. By 2040, it is estimated that approximately 30% of Hong Kong's population will be aged 65 or over, and the elderly dependency ratio will increase dramatically from 198 in 2014 to 494 in 2040.

2. Along with a declining labour force, coupled with rises in anticipated spending on elderly healthcare, welfare and other services, it is expected that tremendous pressure will be exerted on Hong Kong's public finances. Hence, it is imperative for Hong Kong to tackle these challenges head-on, invest in the ageing ecosystem, and turn these challenges into an opportunity instead.

3. Gerontechnology, combining gerontology with technology, is the key to turn this challenge into an opportunity, as it would not only benefit elders and their caregivers, but would also create momentum for the Innovation and Technology sector to develop new products with innovative technology, which in turn would increase productivity for the overall economy.

4. Integrating technology within the elderly healthcare system should be viewed as an investment and not an expense. The application of gerontechnology will reduce the government's expenditure in the long run by revamping Hong Kong's innovation and technology sector, and transforming Hong Kong into a technologically advanced city.

5. The functional capacity of an individual increases in childhood, peaks in adult life, then gradually declines with ageing. The rate of decline is largely accelerated by sedentary lifestyles and the external environment. Hence, compared to Hong Kong's neighbouring countries, we have a relatively high institutionalisation rate. Gerontechnology could fundamentally improve the livelihood of Hong Kong's senior citizens through improving their functional capacity and delaying institutionalisation. Functional decline can be slowed with the use of assistive health technologies, ranging from simple handrails to sophisticated robots. In addition, these technologies may also facilitate caregivers in providing care, increasing efficiency and freeing up valuable time for caregivers to complete more important tasks, hence alleviating the pressure and workload on institutional caregivers and public resources.

GERONTECHNOLOGY PRODUCTS IN HONG KONG

6. In our report, a total of 72 innovative products have been studied, and categorised into four areas: Living (住), Healthcare (醫), Diet (食) and Transport (行). Details of the products can be found in Chapter 2, with a brief description of each of the four categories below:

i. Living (住): The concept of "Ageing in Place" aims to enable the elderly to remain at home in their community and avoid institutional care for as long as possible. "Smart" homes integrate a range of technologies to support the ageing population in the comforts of their own homes, with intelligent sensor networks, information and communication technologies, such as surveillance and emergency assistive systems; daily living products for basic activities, such as products which assist with bathroom usage and personal hygiene; daily living products for instrumental activities, such as products which assist with supplementary tasks e.g. devices which supports communication and reading.

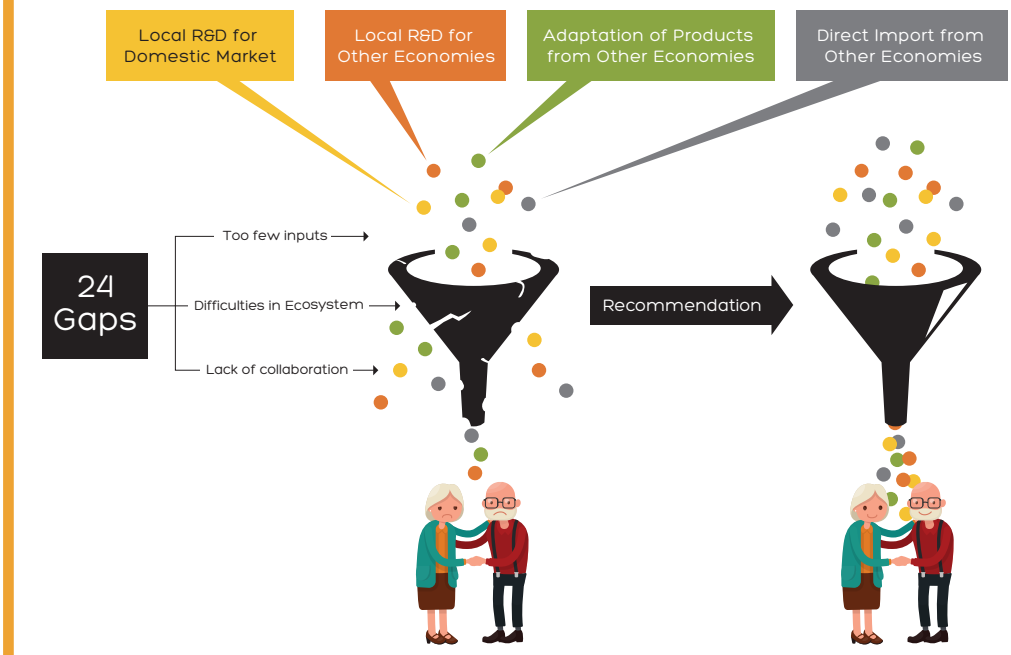
ii. Healthcare (醫): As our study focuses on ageing in place, traditional medical, biotechnology and pharmaceutical methods are outside the scope of our study and are excluded from our coverage of healthcare. The healthcare category will encompass products relating to the maintenance or improvement of physical and mental health through diagnosis, treatment and prevention only. With advanced technology, early diagnosis is made possible to enhance healthcare and enable treatments to be safer, more efficient and reliable. For example, by using robotic innovations, high-tech monitoring and therapeutic devices enhanced with servicing software for physiotherapy procedures, the ageing population will have access to alternative options other than traditional care, with an extra layer of communication between healthcare providers and the elderly.

iii. Diet (食): As seniors grow older, they may face certain difficulties in eating as the ability to bite, chew and swallow food deteriorates. Loss of vision may also limit the ability to shop for food and cook, while loss of teeth and sensitivity to tastes of foods will reduce their appetite and subsequently, the quantity and types of food consumed. This can result in an imbalanced diet and malnutrition, but with the help of dental prosthesis and aesthetically pureed "soft" meals, some of these problems can be alleviated.

iiii. Transport (行): Transportation is essential to ensure access to fundamental services such as medical care and grocery shopping, but it is also crucial for enabling the elderly to stay connected with the outside community. Innovative services and technologies can help elderly stay mobile and live independently, by physically assisting their movement or preventing injuries and accidents. Types of product include wheelchairs and walking canes, transportation services and location devices.

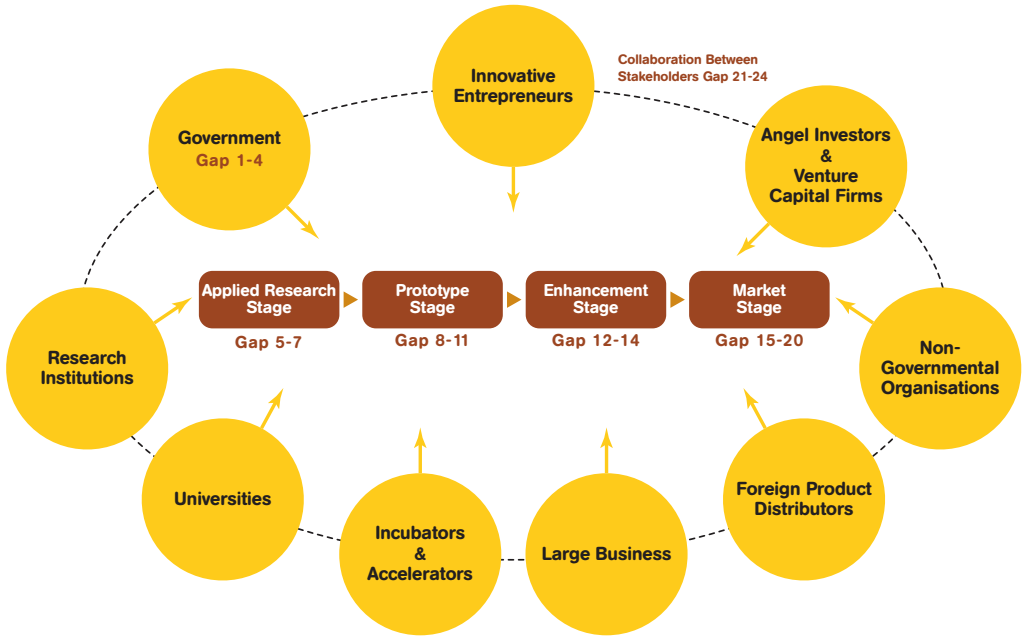
GAPS AND DIFFICULTIES WITHIN THE GERONTECHNOLOGY ECOSYSTEM

Figure a: Illustration of the Problems Faced by the Gerontechnology Ecosystem



7. The funnelling system diagram above is used as an analogy to describe and summarise the problems faced by the gerontechnology ecosystem. The illustration on the left represents the current situation in Hong Kong while the right corresponds to the ideal situation. This report is focused on investigating the various gaps and difficulties within the present gerontechnology ecosystem. Our objective is to raise public awareness and promote more discussions in regards to this topic, and hopefully this would give rise to recommendations for enhancing the system, and ultimately the situation in Hong Kong can shift towards the ideal situation on the right.

Figure b: Stages and Stakeholders of the Gerontechnology Ecosystem



8. The gerontechnology ecosystem in Hong Kong, as illustrated by the above diagram, can be divided into four main product development stages: 1) Applied Research Stage; 2) Prototype Stage; 3) Enhancement Stage; and 4) Gerontechnology Market from both the product developer's and consumer's perspective.

   i. The gerontechnology business process begins with stage 1, where universities and research institutions carry out applied research. The applied research being carried out may inspire an idea for a product or a service. (Gaps 5-7)
   ii. Stage 2 is the prototyping stage, where applied research is transformed into an early-stage model for a commercial product or service by innovative entrepreneurs. (Gaps 8-11)
   iii. Stage 3, the enhancement stage, is where product designs are enhanced and refined to suit the target consumer market. (Gaps 12-14)
   iiii. Stage 4 is the final stage, where products and services enter the gerontechnology market. (Gaps 15-20)

   In this report, a total of 24 gaps and difficulties, involving different stakeholders across various stages of the ecosystem have been identified. These are grouped into six main categories: the four product development stages as mentioned above, the government (Gaps 1-4) and collaboration between stakeholders (Gaps 21-24).

9. Five Key highlights of gaps and difficulties are identified below:

i. Society's Lack of Awareness in the Importance of Technology (Gap 1):

The understanding of the importance of technology within the industry is largely insufficient and should be greatly enhanced to stimulate more focus and solutions to improve elderly care. Gerontechnology in Hong Kong is presently seen as a supplementary product rather than a core functional foundation for improving the elderly healthcare industry.

An example which can illustrate the case of under-appreciation of technology within elderly care is the initial development of protective clothing, which was originally developed as sportswear but then later reapplied to protect seniors from serious injuries due to falls, however the usage of this protective technology is still much higher for sportswear in comparison to the elderly industry. Despite few products are being developed with the silver economy in mind, products that were invented specifically for the elderly industry also has a very low acceptance and usage. On the contrary, such innovations when adopted by other industries, become much more successful, for example, the self-cleaning fabric produced for elderly users was later adopted by the hospitality industry and utilised more widely by top-tier hotels rather than the intended elderly user group.

This is also the case from a government's perspective, as although the Department of Health is issuing vouchers under the Elderly Health Care Voucher Scheme, the vouchers can only be used to purchase medical products or equipment with professional medical permission, such as prescription glasses or walking sticks. The market would allow greater opportunities for entrepreneurs and investors, as more money will be injected into the gerontechnology industry.

ii. Lack of Collaboration (Gap 21-24):

Insufficient collaboration between different stakeholders in the gerontechnology ecosystem has consequences for business development. Engagement between universities, research institutes, non-governmental organisations, government departments and other stakeholders are rare. Although examples of collaborative efforts do exist in Hong Kong, such as the partnership between the Hong Kong Research Institute of Textiles and Apparel (HKRITA) and its host institute, the Hong Kong Polytechnic University (PolyU), but we need more collaboration between other R&D centres and universities in Hong Kong to encourage open dialogues and partnerships between different research groups to facilitate technology development and transfer.

Another typical example is the difficulty in enhancing the drug handling workflow with the assistance of technology, demonstrating insufficient medical-social collaboration. The existing drug handling manual and rules hinder the use of medicine dispensing machines in residential care homes for the elderly (RCHE). To fully implement the machine, it will require the engagement of multiple stakeholders, such as the Social Welfare

Department and Hospital Authority, since it will change the current workflow and cooperation for prescribing, collecting and distributing medicines.

A different technology which also requires the collaboration of different stakeholders to implement is the stairs climber, which is produced by the business sector but requires the NGO sector to conduct the service which connects the technology to the end-user. Very few NGOs in Hong Kong provide this service at the moment. Currently many technologies are put aside due to the lack of collaborations among stakeholders, hence obstructing the advancement of technology products.

iii. Valley of Death (Gap 9):

There is a lack of support for Hong Kong gerontechnology companies to overcome a common issue termed the "Valley of Death". The valley of death is a funding gap that startups often face in the later stages of prototyping and throughout the product enhancement stages because venture capitalists prefer to invest at the later stages of a startup's business development when more information is available and the startup faces a lower risk of failure, hence there is very limited funding input during the initial stages of prototyping from the private sector. As a result, the lack of funding makes it difficult for startups to successfully commercialise their business ideas.

Businesses may overcome the valley of death if they acquire sufficient funding at earlier stages that will last long enough until venture capitals begin investing, or if venture capitals are willing to invest in the earlier stages. In the US, there's a funding scheme called the Small Business Innovation Research (SBIR) programme, which is a competitive awards-based programme that helps early stage small businesses aiming to commercialise technologies cross the valley of death.

In Hong Kong, there is not enough support for startups before they receive funding from venture capital firms. The closest examples of government support which helps startups overcome the Valley of Death is the HKD 2 billion that the government earmarked in 2016 for mid-downstream research but the amount is far from enough. Another example is another HKD 2 billion for Innovation and Technology Venture Fund set up by the government separate from the mid-downstream research programme, which aims to support startups at later stages to encourage more private investment in local startups by co-investing with the government, but startups would still have to struggle to survive the Valley of Death since funding is again too little and too focused on the later stages.

The gerontechnology industry is currently still at a very early stage and the number of start-ups in this field is also relatively small. These characteristics make it difficult for startups to get funding, as the funding might go to startups in more mature and competitive industries. Thus, there is still a lot of room for improvement in providing funding support, especially from the private sector, to gerontechnology startups in Hong Kong.

iv. Cultural Differences and Difficulties in Product Localisation (Gap 14):

There are examples of commercially successful gerontechnology products overseas - they are functional, well-designed with seamless user experience and are well-received by the target consumer market. Theoretically, they should also be successful if introduced in Hong Kong. However, this is not the case due to cultural differences. For instance, bathing is an important ritual in Japanese culture but this is not the case in Hong Kong, where showering is more common. If a commercially successful assistive bathing device from Japan were brought to Hong Kong, it would be unlikely for the device to be as successful due to the lack of a bathing culture in Hong Kong.

In addition to cultural differences, another difficulty in developing gerontechnology products for a different market is product localisation. Differences such as language setting and maintenance service options have to be readjusted for local use and different certifications are required to sell products in different regions. GPS tracking shoes developed in the US were successfully sold to the local American market and could be refined and localised for a Hong Kong market. However, because Hong Kong's gross elderly market is small compared to other markets, such as its mainland neighbour, it would be too costly to localise a product for a smaller market when more lucrative business opportunities are available elsewhere.

v. Lack of Testing Ground for New Products (Gap 13):

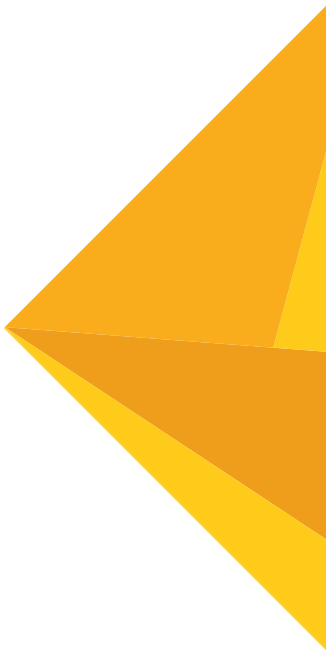
The lack of a testing ground for products and services is a significant gap in the gerontechnology ecosystem. In the later stage of product development, new products require thorough market research and in particular, user feedback from both elderly users and caregivers during the development process to turn a prototype into a final product that is targeted and tailored to elderly consumers. However, Hong Kong currently lacks testing grounds for new gerontechnology products. Care workers in Hong Kong's RCHEs are already facing huge workloads, and adapting to a new assistive device takes time.

Testing new products may increase their workload and lower their efficiency of work at the beginning, as they need to be trained, learn and practise using the products. Some of the test products may fail in the end and not improve their work at all. The adoption of a failed product would end up wasting the care worker's time in the trial period and provide no benefit to the RCHEs. Hence to the RCHEs, new product testing is a speculation with a high cost. Therefore it is not surprising that RCHEs are not keen to test new technologies, but turn to enjoy the mature products with proven quality by their peers, or use the resources to hire extra workers instead. As a result, product developers can hardly find a suitable testing ground for their products.

CONCLUSION

10. The current market for gerontechnology and elderly care products in Hong Kong is relatively small compared to other economies, but is expected to grow substantially. The future elderly population in Hong Kong will not only be more highly-educated, but also wealthier. In 2016, only 25% of people aged 60 and over had attained at least upper secondary or post-secondary education, compared to 51% for those aged 50-59 and 67% for persons aged 40-49. The latter two groups will shift into the 60 or above age group in the next two decades. Future seniors will have accumulated more assets, especially as more women entered the job market and median income also grew in the past years. As a result, it is likely that future seniors will seek a higher quality of living with more independence and autonomy. All this signals greater elderly spending and a significant silver market with many business opportunities.

11. In 2015 for the Asia-Pacific region, the Ageing Asia Silver Economy Index ranks Hong Kong in second-place for the spending power of its ageing population and their supporting children, which includes household savings and GDP per capita. Additionally, if Hong Kong's market is combined with that of Mainland China, then the size of the market will be substantially larger. One must also not forget that the market for elderly products is comprised of both older persons and the formal and informal caregivers that look after them, which increases even more the size of the gerontechnology market. Thus, the potential in this market has yet to be fully realised and we must act now to grasp these significant opportunities.



Content

Chapter 1
Introduction and Background

1.1

HONG KONG'S AGEING POPULATION

Population ageing is the result of declining fertility and rising life expectancy, leading to an increase in the average age of a population (United Nations, 2015). Like numerous other economies across the globe, Hong Kong's population is rapidly growing old. By 2040, there will be 2.5 million people aged 65 or above in Hong Kong, representing approximately 30% of the population (C&SD, 2015a) (Figure 1.1). In comparison to other economies, Hong Kong's elderly population is expected to drastically increase over the next 20 years with a significantly steeper gradient and then slowly plateau but still remain at a comparatively high percentage (Figure 1.2). Our society will witness a demographic shift of a grand scale, with far-reaching social and economic implications for Hong Kong. The elderly dependency ratio[1] will rise from 198 in 2014 to 567 by 2064 (C&SD, 2015a). As this shift occurs, it will undoubtedly create additional pressure for a healthcare system that is struggling to cope with demand - already, we are seeing rising healthcare costs, inefficiencies and long waiting times. According to the Social Welfare Department (SWD), the average waiting time for admission to private residential care homes for the elderly (RCHEs) was 11 months, and was 36 months for publically subsidised RCHEs (Social Welfare Department [SWD], 2017) (Figure 1.3).

As people age, their physical and cognitive functions deteriorate. Elders with limited functional capacity may resort to moving into RCHEs if they cannot support themselves and live independently at home. The institutionalisation rate of elderly in Hong Kong is relatively high compared to other economies - the rate for Hong Kong stood at 5.7% in 2014, which was more than double that of Singapore, South Korea and Japan, and more than three times of Taiwan (Legislative Council, 2015). RCHEs in Hong Kong are already facing a shortage of labour, and with the current ageing population trend, elderly caregivers and institutions will struggle to cope with the large influx of elderly patients in the coming years.

Furthermore, Hong Kong's labour force[2] is expected to shrink from 3.65 million in 2018 to 3.11 million in 2064 (C&SD, 2015b). With a declining labour force and expected rises in spending on elderly healthcare, welfare and other services, Hong Kong's future financial sustainability will be called into question (Chief Secretary for Administration's Office, 2015). The estimated government expenditure related to elderly people in 2064 will be two to four times the current expenditure, assuming no service improvement (Commission on Poverty, 2015). Moreover, the projected long term care costs are estimated to increase from 1.4% of Hong Kong's GDP to in 2004 to 3.0% by 2036 (Chung et al., 2009). Tackling these critical issues will involve a collective effort from all parts of society. Thus, there is a pressing need to address the challenges of an ageing society now in order to ensure a healthy and sustainable future for Hong Kong.

[1] The dependency ratio is defined as the number of people aged 65 and over in relation to a thousand of those aged 15-64.
[2] Synonymous with the economically active population, comprising both the employed and unemployed population.

Figure 1.1: Composition of the Projected Population of Hong Kong, 2017-2064

Source: Census and Statistics Department (2015)

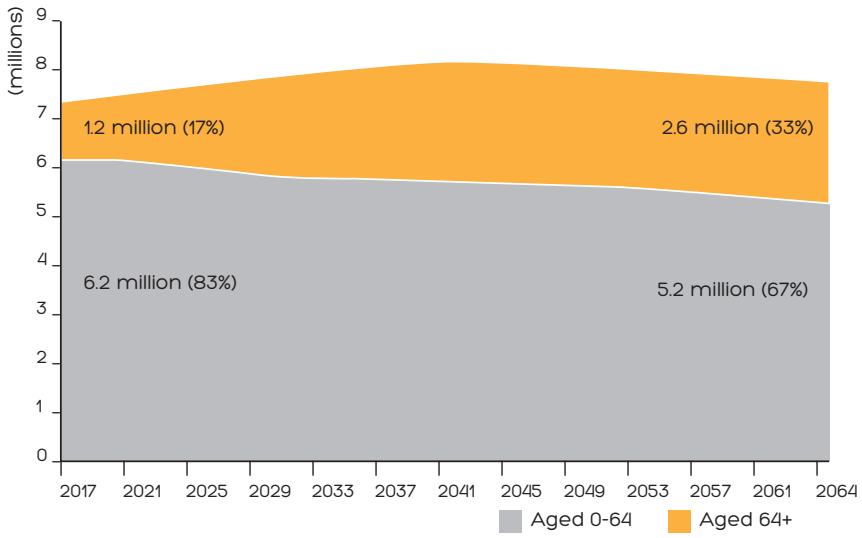
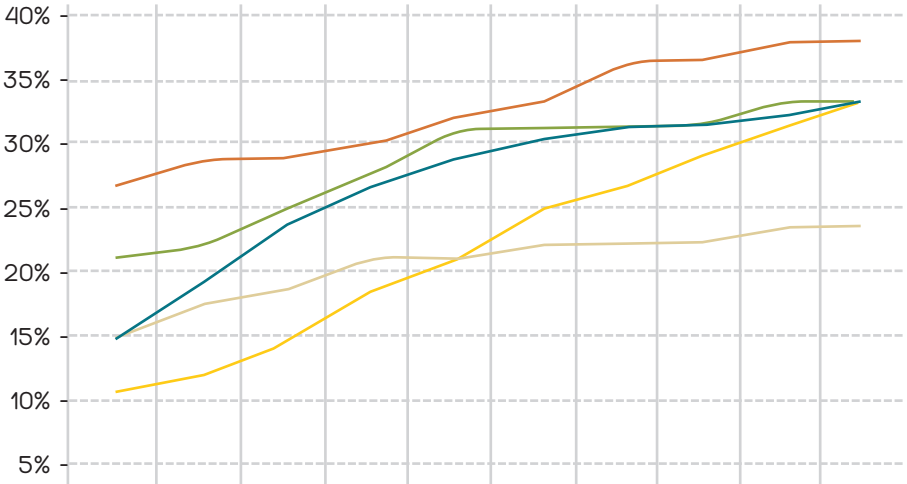


Figure 1.2: Projected Population Aged 65 and Over of Selected Economies, 2015-2060

Source: Census and Statistics Department (2015), United Nations (2015)



	2015	2020	2025	2030	2035	2040	2045	2050	2055	2060
Mainland China	10%	12%	14%	17%	21%	25%	26%	28%	31%	33%
Japan	26%	28%	29%	30%	32%	34%	36%	36%	37%	37%
Germany	21%	23%	25%	28%	31%	31%	31%	32%	33%	33%
USA	15%	17%	19%	21%	21%	22%	22%	22%	23%	23%
Hong Kong	15%	18%	23%	26%	29%	30%	31%	32%	32%	33%

Figure 1.3: Average Waiting Time for Admission to Subsidized RCHEs, 2017

Source: Social Welfare Department, (2017)

1.2

AGEING IN PLACE AND ELEMENTS OF AN AGE-ENABLING CITY

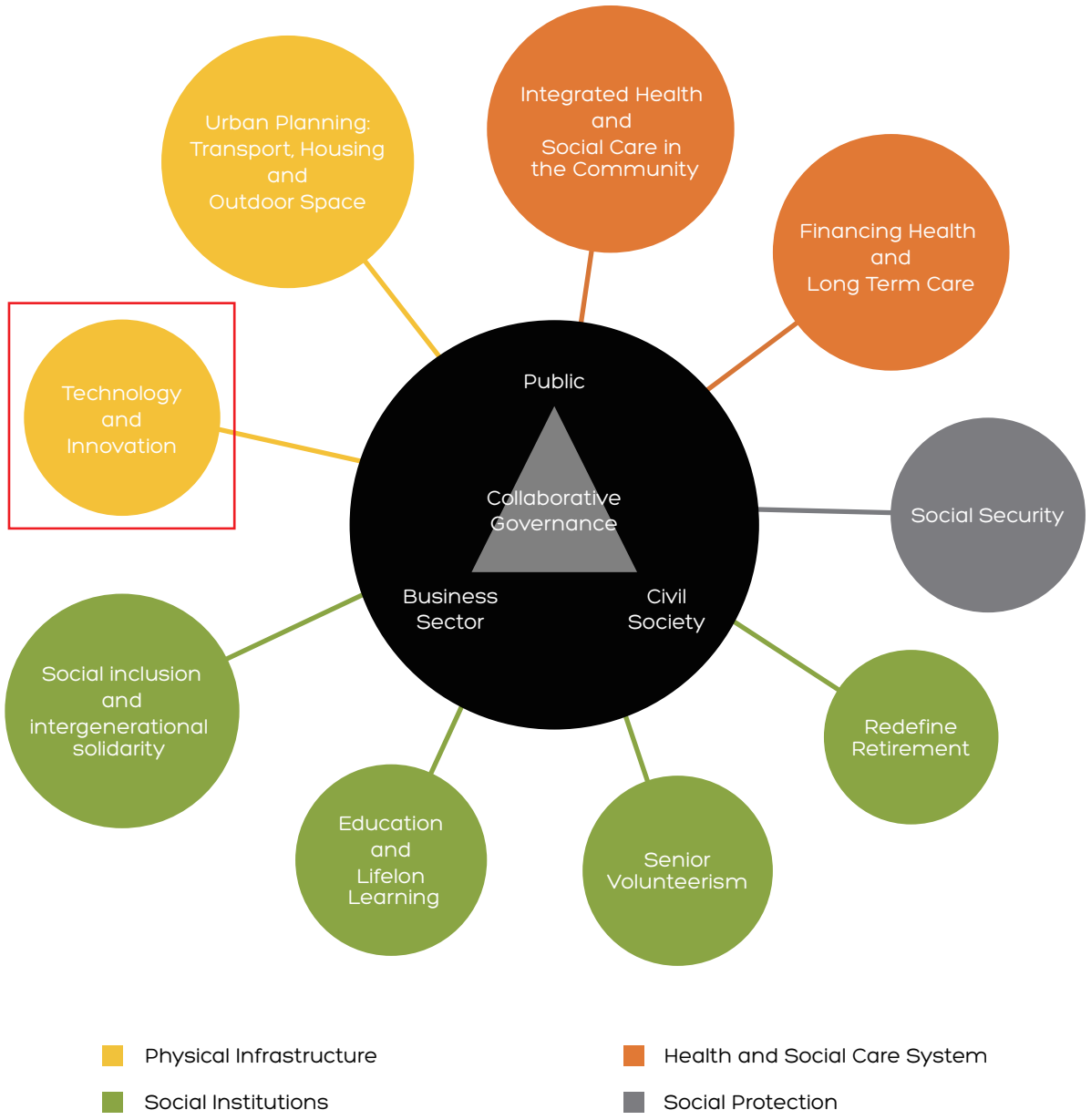
The Hong Kong government's approach to population ageing is "ageing in place at the core, institutional care as back-up" (Legislative Council, 2015). The concept of ageing in place encourages seniors to age at home in a familiar community and physical environment - it promotes independence, participation in society, access to care and provides elders a sense of dignity and self-fulfillment (UN OHCHR, 1991; Chui, 2008). Ageing in place can be brought about by a combination of care provided by family members at home, as well as community care, which refers to care provided within the locality of the older person in question - for example, services provided at community care centres (Chui, 2008). In comparison, institutional care from nursing homes tends to isolate elders and is also more costly than ageing at home (Wiles, Leibing, Guberman, Reeve & Allen, 2011).

Elderly people prefer living and ageing in an environment familiar to them, and this is supported with hard evidence. According to a household survey conducted by the Census and Statistics Department (C&SD) in 2008, over 80% of Hong Kong elders residing in domestic households preferred to remain living at home, even if their health conditions deteriorated, instead of moving into RCHE.

Ageing in place not only benefits the elderly, but also the rest of the community. The Ageing Society Research Report of Our Hong Kong Foundation (OHKF), "An Investment for the Celebration of Aging", details the positive contributions senior citizens can make to the wider community. For example, they can add value by transferring invaluable intangible knowledge to younger generations

Figure 1.4: The World Health Organisation's Elements of an Age-Enabling City

Source: Our Hong Kong Foundation (2016)



in the workplace or through mentoring and participate in volunteering (Our Hong Kong Foundation [OHKF] Ageing Society Report, 2016). Additionally, older generations will contribute to the "silver economy" when they consume products and services, bringing economic growth and prosperity as they age (Senesciencia, 2017).

An important facilitator of ageing in place aside from care provided at home and within the community, is the use of technology. The World Health Organisation (WHO) identified 9 elements that contribute to creating an age-enabling and age-friendly city, where people of all ages can live comfortably in their immediate environment (see Figure 1.4). Gerontechnology, which falls under "Technology and Innovation", is a key age-enabler and has the potential to bring significant benefits to the lives of the elderly and also reduce pressure on public resources. The importance of technology will be discussed further in the following section.

1.3

GERONTECHNOLOGY AND ITS IMPORTANCE

Gerontechnology refers to innovations and technologies customised to the individual needs of seniors to compensate for cognitive and physical decline due to ageing, and are fundamental to helping older persons age independently and comfortably at home (Beard et al., 2011, 2012; Millán-Calenti & Maseda, 2011). Gerontechnology is an interdisciplinary field, requiring collaboration between scholars, engineers, healthcare specialists (Beard et al., 2011). Gerontechnologies can be wearable, implanted, portable or stationary, and can be as simple as motor wheelchairs assisting elderly with impaired mobility or as advanced as social robots, mobile-monitored health (m-health) or smart homes (Beard et al., 2011). Such assistive and age-enabling technologies support relatively frail and fragile older persons, allowing them to continue living within a community they are familiar with, enhancing the well-being of elderly and helps to delay institutionalisation which subsequently reduces the stress on caregivers.

In addition to gerontechnology used by elders, there are also technologies used by caregivers that can assist them in providing better care for elders to help them age in place. The scope of this report will be extended to cover both gerontechnology as well as the field of elderly caregiving.

As we age, it is inevitable that our physical abilities and cognitive functions will deteriorate. The chances of people acquiring a disability or multiple impairments at once increase as we grow older. Figure 1.5 shows that the 70 or above age group has the greatest prevalence rate of people with disabilities, with the highest prevalence of disability being for restricted body movement.

Disabilities cause loss of functional capacity and the ability to perform basic tasks or activities. It may also increase demand for public and private long-term care services. The Our Hong Kong Foundation's ageing society report highlighted the importance of assistive health technologies to the functional ability of elderly people:

"Functional ability refers to health related attributes that enable people to be and to do what they have reason to value. It is made up of the intrinsic capacity of the individual, relevant environmental characteristics and the interactions between the individual and these characteristics (World Health Organisation [WHO], 2015). … If placed in an appropriate environment, the functional ability of an older

Figure 1.5: Prevalence Rate of Disability by Types of Disability and Age, 2013

Source: Census and Statistics Department (2014)

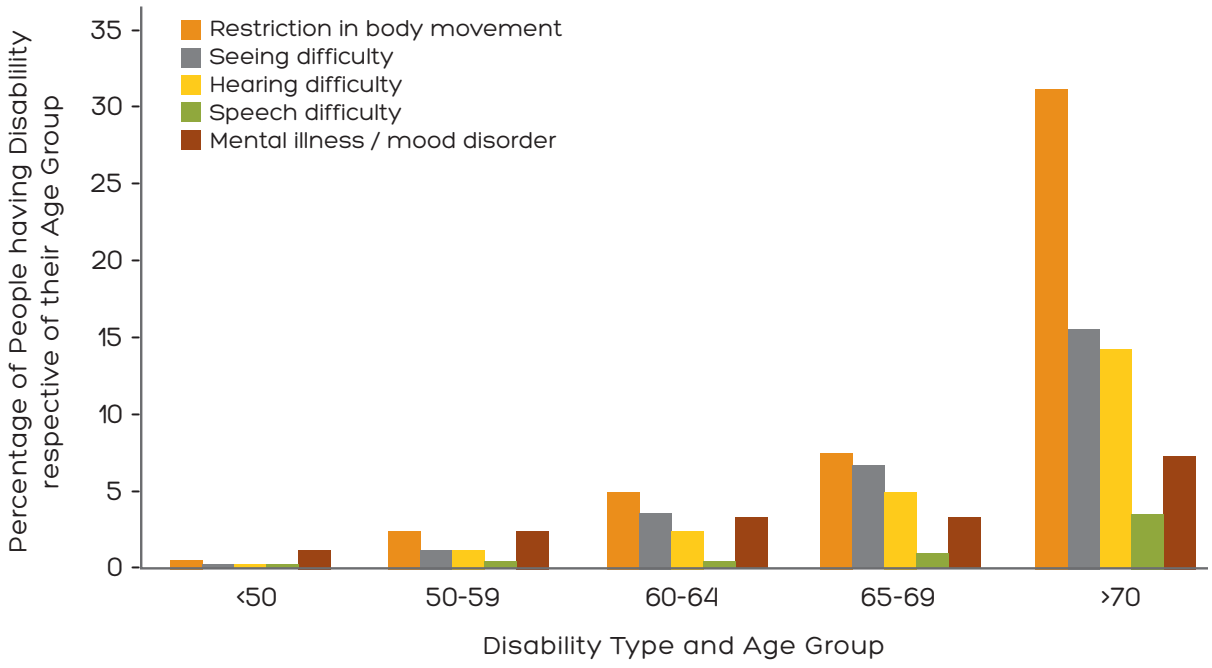
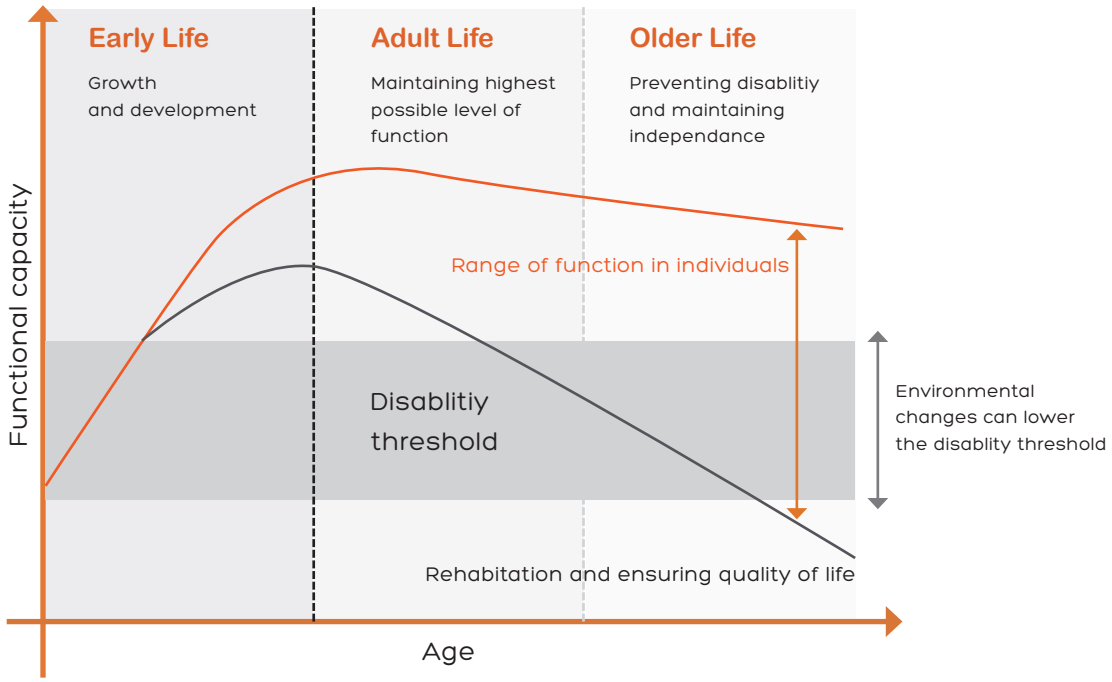


Figure 1.6: A Life Course Perspective for Maintenance of the Highest Possible Level of Functional Capacity

Source: Our Hong Kong Foundation (2016)



person can be maintained. Figure 1.6 shows that the functional capacity of an individual increases in childhood and peaks in adult life, followed by a gradual decline. The rate of decline is largely determined by lifestyles and the external environment. At a given level of intrinsic capacity, functional ability can be enhanced. Appropriate measures can be adopted to ensure that people's external environments will enable them to function better than through their intrinsic capacity alone. These measures may include the use of assistive health technologies, ranging from a simple handrail to sophisticated robots."

While gerontechnology and other assistive elderly care technologies cannot completely replace human care and are by no means, a panacea for solving all the challenges of an ageing society, innovations and technologies can improve the lives of elders by reducing the negative impacts of impaired functional capacity on ageing seniors and also delay institutionalisation, enabling them to live longer and more comfortably within a familiar environment. Other elderly care technologies will facilitate caregivers in providing care, increasing their efficiency and lowering the error rate, increasing the quality of care in the process. These technologies may even be able to replace humans in carrying out routine work, freeing up valuable time for caregivers to complete more important tasks. Furthermore, as elderly technologies and innovation promote ageing in place, allowing elders to live in the comforts of their own homes for longer, they will alleviate pressure on institutional caregivers and public resources, as demand for public services and spending on long term care will be controlled.

There is an urgent need to address the lack of technological support for the elderly. It is a social, commercial and government imperative, as there will be consequences for all if we do not. Hong Kong elders will be victims of rising healthcare costs and inefficiencies in the healthcare system (long waiting times for access to care and elderly facilities), elderly caregivers will face even greater workloads and pressure, and the government will incur substantial economic costs. Integrating technology within the elderly healthcare system should be viewed as an investment and not an expense. The application of gerontechnology will bring numerous benefits to boost both the livelihood of the elderly and the welfare of caregivers (for detail, refer to Chapter 2) as well as reduce government expenditure in future. This is a chance for Hong Kong to turn a challenging situation, whereby the population is ageing rapidly, into a golden opportunity by revamping Hong Kong's technology system and elevate its advancement as a technologically progressive city.

1.4

RESEARCH OBJECTIVES

The overarching aim of this study is to establish a baseline by providing a comprehensive and detailed summary of the gerontechnology industry in Hong Kong and to identify and analyse the gaps and difficulties in the ecosystem. The hope is that policy makers, health professionals, companies, investors, NGOs and other stakeholders will gain a better understanding of the circumstances and begin to address the ecosystem gaps and difficulties to create a better future for senior citizens and their care givers in Hong Kong.

This report will explore the current state of the gerontechnology and innovation industry in Hong Kong. A landscape review of gerontechnology products and services used by both elderly people and their caregivers in Hong Kong will be conducted and compared to other economies in Chapter 2. In Chapter 3, gaps and difficulties faced by the local gerontechnology ecosystem will be identified. Chapter 4 will summarise and conclude our findings.

Chapter 2 Gerontechnology Products in Hong Kong

As population ageing becomes more apparent, shortage of labour, as mentioned in Chapter 1, for elderly care will become even more evident and in order to solve this predicament, technology will become significantly more important. This Chapter will review technologies that currently help with elderly care in Hong Kong. The technologies may either assist caregivers in performing their duties to support the elderly with their daily activities or help seniors maintain autonomy, live independently and remain healthy in the community or residential homes. We will illustrate innovations and products by categorising them into four areas: Living (住), Healthcare (醫), Diet (食) and Transport (行). A key product comparison with other neighbouring and OECD countries will also be made at the end of each area to see the characteristics of products in Hong Kong. Since many of the products featured in the Hong Kong section can also be found in other economies, only some successful and unique cases, which are unavailable in Hong Kong, are selected to be mentioned in the report.

2.1

LIVING (住)

The concept of "Ageing in Place" aims to enable the elderly to remain at home in their community and avoid institutional care for as long as possible. "Smart" homes integrate a range of technologies to support people to grow old in the comfort of their own homes, such as intelligent sensor networks and information and communication technologies[3]. The intention is to allow elderly people to age with dignity, security, autonomy and a reasonable quality of life. Through a variety of installed devices and systems the user's medical status and welfare can be discreetly monitored and support for emergency assistance is possible when an imminent harmful situation occurs. Sections 2.1.1 to 2.1.3 will cover existing Living products within Hong Kong, while Section 2.1.4 will be based on unique successful products in other economies.

Figure 2.1: The Infrared Thermal Sensing Safety Alert System For Elderly
Source: LSCM R&D Centre

[3] The Tanner Hill of Housing Society in North Point is Hong Kong's first quality retirement living initiative specifically tailor-made for seniors, providing assisted living with the support of a wide range of technology products. The estate provides health data monitoring and stationed health care workers which aids the residents to age in place. This kind of assisted living estates is still rare and insufficient in Hong Kong.

2.1.1 SURVEILLANCE AND EMERGENCY ASSISTIVE SYSTEMS

Elderly people are prone to having a variety of accidents in the confines of their homes and as does people from all age groups, however the difference is the elderly typically have a higher risk and the consequences are much more severe. Falls by an elderly can cause serious injuries such as hip fractures, head injuries or even death if immediate assistance is not available. According to the Department of Health, approximately one in five elderly community residents aged 65 and above fall every year in Hong Kong. Among those who fall, around 75% would sustain an injury including head trauma and broken bones and almost half the deaths due to falls for elderly citizens occurred within their own homes. Installing surveillance and emergency assistive systems not only provides the elderly with the care they need but also the peace of mind and comfort for both the user and their family to know these systems are in place in case an emergency situation occurs.

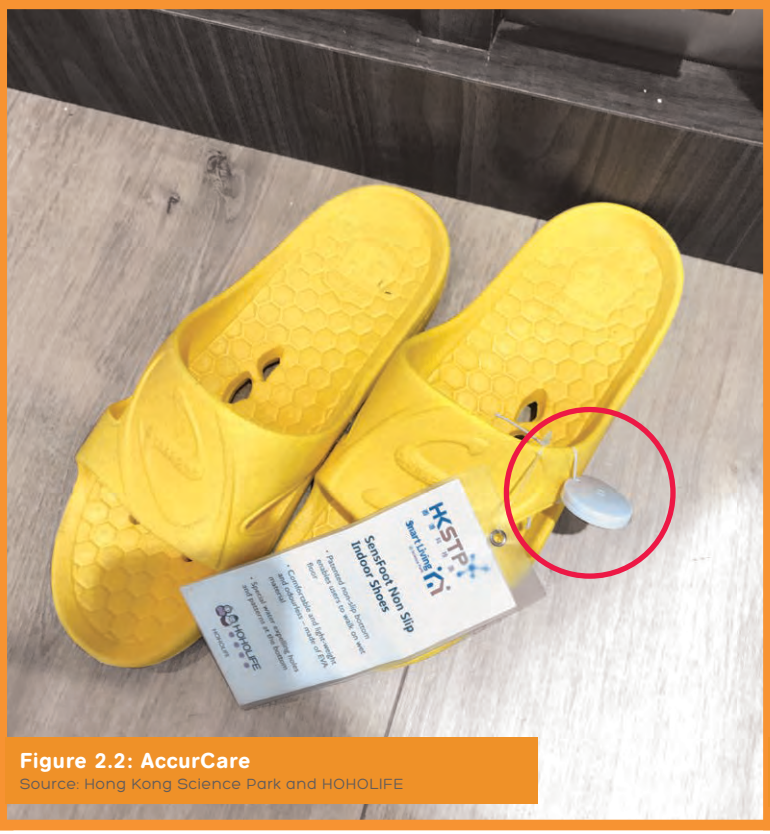


Figure 2.2: AccurCare
Source: Hong Kong Science Park and HOHOLIFE

Figure 2.3 Sensara Senior Care Solution
Source: Qorvo

2.1.1.1 Surveillance Systems

The Telecare System was developed to detect motions from warm objects, such a human body, using infra-red emitter optical sensors. Wireless communication between sensor modules and computer allow for an interpreter software to collect 24-hour data and to identify risky pattern of activities in different areas in the apartment. In the case of a fall, the system will identify this and alert family members for assistance. The Infrared Thermal Sensing Safety Alert System for Elderly was developed and installed in several bathrooms at the Clague Garden Estate in Tsuen Wan, where the system again uses infrared sensor technology

to detect heat from an elderly's body. If the sensor detects a stationary warm body for over a certain period of time the system will set an emergency alarm off informing caregivers and neighbours of an emergency situation. During a focus group session with residents from Clague Garden Estate, the product received positive feedback from both the residents and the caregivers. AccurCare attaches a small tag to the elderly and by installing sensors around the apartment the system is able to detect the elderly's movement and location without breaching the elderly's privacy, and the elderly's real-time location can be accessed by caregivers and family members through the internet. Another system which is less precise with the location of the elderly but allows for their behaviour pattern to be traced is the Sensara Senior Care Solution, the system works for single independent elderly users. A device is installed in every room and detects which room the elderly is currently situated in and registers the elderly's behaviour pattern, if there is sudden changes in behaviour patterns, push notices are forwarded to family members and caregivers.

An alternative type of surveillance devices detects whether the elderly has left from their original location, such as the bed or wheelchair. These products can be extremely useful for alerting family members and caregivers when an elderly has fallen off their bed or wheelchair and require immediate assistance. Both the Smart Elderly Bed Exit monitoring system and the WhizPad are used to detect whether an elderly is absent from their bed using pressure sensors. The former activates an alarm system immediately while the later pushes a notification through a mobile app to alert the caregiver responsible for the elderly. The pressure sensor pad is a small more compact and portable version which can be used on wheelchairs, sofas or chair, again this device immediately activates an alarm when the user removes their weight from the product.

Figure 2.4: The Smart Elderly Bed Exit Monitoring System
Source: Rondish Co. Limited

Figure 2.5: The 24-hour Personal Emergency Link Service
Source: Senior Citizen Home Safety Association

2.1.1.2 Emergency Alert Devices

These devices provide instant send for help in the event of an emergency. The systems work through the senior pressing a transmitter's button which alerts the service's emergency response centre without needing to reach for a telephone. The transmitter is typically worn around their neck, on their wrist or installed around different locations of the home. In addition to alerting the centre, the operator will also contact family members. In the case of a serious accident the system is able to forward the user's electronic patient records of the service user to the relevant A&E department and hence speed up the rescue procedure.

The 24-hour Personal Emergency Link Service caters to elderly citizens living alone in Hong Kong. The services theme is to provide a "peace of mind" and "cross-generation love and care" allowing family members to be rest assured with the elderly's well-being. Besides providing emergency support by pressing the help button on the different devices, such as a pendant worn around the elderly's neck, mobile device, tablet and so on the service also offers optional caring calls, appointment reminders, weather tips, information on everyday life and short-term emotional counselling.

2.1.2 BASIC ACTIVITIES OF DAILY LIVING

Basic daily living activities consists of self-care tasks which are essential for fundamental functioning such as personal hygiene and toilet hygiene. Consequently, for an elderly to be able to live autonomously assistance for performing these activities is crucial. Bathrooms can be the most dangerous place in the apartment, with various environmental hazards such as slippery surfaces and wet floors. Thus, for elderly's who have weak muscles and difficulty in mobility using the bathroom and cleaning oneself becomes a very difficult task. Technology which can improve the independence of bathroom usage will enable the elderly to stay within their own home for a longer period of time.

Figure 2.6 Sit and Shower Device
Source: Sit and Shower

2.1.2.1 Personal Hygene Assistive Devices

Different medical conditions, such as arthritis, gait deficits and balance deficits, as well as gradual muscle weakness can cause increasing difficulties for elderly to clean themselves. However, this is an essential daily-task and therefore independency is highly dependent on whether the elderly is capable of taking care of their own personal hygiene. Even within elderly home centres, taking care of the elderly's hygiene is a difficult task since it is particularly labour intensive and time consuming. Quoted from the Code of Practice for Residential Care Homes by the Social Welfare Department for bathing preparations:

"At least two personal care workers are required for holding and lifting heavy or infirm residents."

And it is common practice to find around three to four caregivers bathing one elderly at a time. Innovative products such as the Sit and Shower device allows for full bathing automation with automatic soaping, temperature control, surrounded water jets for rinsing and partial warm drying. Only one caregiver is needed to assist an elderly on to the device and then they can be left alone to be bathed automatically. This allows several elderly to be bathed at the same time and only need one caregiver to supervise at all time, hence drastically reducing the man powered needed and also giving the elderly more dignity when bathing.

2.1.2.2 Tracking Bathroom Usage

Bathroom usage and habits can give information on the elderly's health, any sudden changes in frequency of use may suggest abnormal actives or conditions with the elderly, such as dehydration, increasing difficulties with mobility and so on. For elderly who live alone, tracking their bathroom usage may allow for their family member to get a better idea of their condition. A toilet monitoring device has been developed to track and store data on the user's bathroom usage, it is simply attached to the side of the toilet water tank and water level changes are recorded. If the water level does not change over a long period of time, which implies the elderly hasn't used the toilet during this time, as well as any other abnormal usage pattern detected, such as unusually frequent toilet trips, then a notification alert is sent to the user's family members. This product is also installed at the Clague Garden Estate in Tsuen Wan and from the focus group session, caregivers have mentioned the product as being an excellent way to ensure elderly residents' well-being. As for dependent seniors who live with family members, the VT Care Real Time Wet Diaper Monitor can be used to detect and alert family members of wet diapers as well as high feverish body temperatures.

Figure 2.7: Toilet Monitoring Device
Source: LSCM R&D Centre

Figure 2.8: VT Care Real Time Wet Diaper Monitor
Source: Hong Kong Science Park and HOHOLIFE

figure 2.9: 3D Smart Textile Materials for Protective Apparel for the Elderly
Source: The Hong Kong Research Institute of Textiles and Apparel

2.1.2.3 Injury Prevention Technology

Preventive measures can be taken to eliminate the possibility of injuries when the inevitable accidents occur, this is an important step for elderly healthcare since injuries become more serious and complicated with age. Innovative technologies used in protective apparels, such as the 3D Smart Textile Materials for Protective Apparel for the Elderly, were designed such that in the case of an accident whereby the elderly falls, injuries and damage can be prevented through the absorption of impact via the apparel. Clothing is layered with special innovative protective material within the lining, different areas of the clothing have different thickness of the protective material depending on the probability of impact and the force caused by the impact. The iShoe protects and prevents seniors from injuring themselves through alerting the elderly user if either too much force is exerted, and hence potentially damaging their feet, or if they are walking with a dangerous posture and therefore increasing the possibility of a fall. Alternatively, fittings within the apartment can be customised to help prevent injuries, such as installing floor tiles with a non-slip finish to reduce the possibility of a fall and is also made with innovative shock absorbing material to decrease the damage caused in the case of a fall.

Figure 2.10: iShoe
Source: The Hong Kong Research Institute of Textiles and Apparel

Figure 2.11: Floor Tiles
Source: SAFE Concept Limited

2.1.3 INSTRUMENTAL ACTIVITIES OF DAILY LIVING

Instrumental activities of daily living are tasks which do not necessarily involve fundamental functioning but are still important for an individual to live independently within a community. These tasks include completing housework, different forms of communications and so on. With age daily household chores and basic tasks become increasingly difficult, and many of these chores can be automated by existing technology to enhance senior citizens capability to live independently within their own community. Products could also be applied within elderly home to reduce caregivers' amount of wearisome and tedious chores enabling them to focus on more primary care for the elderly.

Figure 2.12: Self-Cleaning Fabric
Source: The Hong Kong Research Institute of Textiles and Apparel

Figure 2.13: RFID Reader
Source: LSCM R&D Centre

Figure 2.14 Communication Electronic Cards
Source: LSCM R&D Centre

2.1.3.1 Self-Cleaning Fabric

These fabrics can be used to make leisurewear, footwear, curtains and bedding. The self-cleaning fabric uses nanotechnology, whereby a nano-scaled layer is coated over the original fabric material. The nano-layer acts as a catalyst and breaks down dirt, odour, bacteria and colour, removing these with the help of visible light. Clothing and beddings which would usually involve substantial effort and time to wash can now be cleaned simply by turning the light on and exposing them to visible light.

Figure 2.15: Adlens Adjustables Product
Source: Adlens Ltd

2.1.3.2 Vision and Communication Assistive Devices

Similar to the decrease of physical strength with age, people's eyes also exhibit an age-related decline in performance. In Hong Kong according to the Census and Statistics Department, 84.9% of people with visual impairment are senior citizens over the age of 60, and daily living is affected significantly by ageing eye diseases. Products such as the RFID Reader, which is a light portable device, can be used to assist visually impaired elderly to read notification around the community and instructions on medications by simply placing the reader over RFID barcodes and the device will narrate the text. The same technology can be applied to use Communication Electronic Cards for those who have speech difficulties. Communication cards with simple phrases can be paired with an RFID reader to promote and encourage elderly with speech difficulties to interact more within their community. Helping elderly to main some level of autonomy and stay connected within the community. As the elderly ages their eyesight may change consistently at different rates which it can be both inconvenient and expensive when purchasing prescription spectacles. The Adlens Adjustables product provides an economical and practical solution to this situation by allowing the elderly to adjust the prescription of the spectacles according to their need.

Figure 2.16: Doro Initiative Smartphone
Source: Doro

Figure 2.17: Mobile Link, Safety Phone Service
Source: Senior Citizen Home Safety Association

2.1.3.3 Smartphones for the Elderly

Nowadays smartphones have become a part of people's daily life and in many different ways it is becoming exponentially more essential. One of these reasons is due to the connectivity smartphones provide and in order for elderly to stay connected to other family members and society purchasing a smartphone becomes unavoidable. Social isolation and loneliness is a major issue amongst elderly citizens and being able to communicate and interact with others can significantly improve their psychological well-being. Although Smartphones offer more functions than "traditional" mobile phones, they can be excessively complicated to use, especially for an elderly user. Doro and Mobile Link smartphones have been designed specifically for the elderly, using a simpler, and more user friendly interface. The smartphones are also backed by systems which are linked to hospitals and health institutions for immediate assistance in the case of an emergency situation. Both of which have their own dedicated call centres to support this service.

2.1.4 UNIQUE AND SUCCESSFUL PRODUCTS IN OTHER ECONOMIES

Rapid and progressive development within the companion robot sector can be found within different counties such as France, Belgium, Germany, Japan and so on. These robots functional ability can vary between simply providing comfort and interactions with the elderly or as capable as a highly technically advanced butler who can manage your schedule, give reminders, provide useful information, home security and connect with family members.

With a decline in social interactions due to different variables, loneliness is a significant issue within the elderly community and therefore a product as simple as the PARO robot, available in Japan, and Joy for All Companion Pets, available in the United States, can provide great comfort for shut-in seniors

Figure 2.18: PARO robot
Source: AIST (Japan) through idsMED

Figure 2.19: BUDDY Robot
Source: Blue Frog

who craves for companionship. These products are therapeutic robots which are designed to reduce stress and stimulate interactions between seniors and caregivers. PARO Robot uses several different types of sensors to detect and react to different gestures from the elderly.

More advanced robots include BUDDY Robot, available in France, ZoraBots, available in Germany and Care-O-bot, found in Germany. These are intelligent robots which have been developed to assist with different aspects of the elderly's daily life. They can be personalised to suit the needs of the elderly accordingly and provide reminders such as when to take their medicine, when they have a doctors

appoint or give them information on the weather and news. BUDDY can also provide home security surveillance through patrolling the home and sending alerts for unusual activities, detect falls and inactivity for the elderly as well as social communication options to family members and healthcare providers. ZoraBots is able to assist caregivers with therapy sessions by leading exercise classes and motivating the elderly to move and do simple dance exercises. Care-O-bot is a modular robot capable of supporting a variety of household tasks, from cooking to cleaning, provide different services such as taking orders and support healthcare management to loading and unloading objects from shelves. As a result of the large range of functionalities and capabilities, companion robots could significantly improve the lives of the elderly and extend their competence in living independently. Besides assisting elderly users, these robots could also considerably reduce the workload on caregivers and the pressure in the industry's labour shortage.

Figure 2.20: ZoraBots
Source: QBMT

Figure 2.21: Care-O-bot
Source: Fraunhofer Institute

Another type of product which could significantly reduce a caregiver's workload and reduce the possibility of care accidents due to heavy loads are Robotic Beds. These beds can be transformed from a normal bed to a detachable wheelchair without lifting or removing the elderly from the device. The elderly is shifted onto the correct portion of the bed and by detaching the transportable part of the bed from the fixed frame, the movable part of the bed can be morphed into a wheelchair by simply using a remote control. The level of help required to make this transformation varies with different versions of the Robotic Bed. The most basic Robotic Bed only has the morphing of bed from lateral to vertical electrically powered but the most advance can allow the elderly to complete the whole transformation independently with the end wheelchair being electrically powered too.

Figure 2.22 Robotic Beds
Source: Panasonic

2.2

HEALTHCARE (醫)

Healthcare is the maintenance or improvement of physical and mental health that are outside the scope of the traditional medical, biotech and pharmaceutical. It can be realised through diagnosis, treatment and prevention. Early diagnosis and Technology can enable the enhancement of better healthcare through making it safer, more efficient and reliable, in addition to being able to offer alternative options to traditional care. It could simply be adding an extra layer of communication between healthcare providers and the elderly or it could be as advanced as physically helping with treatments such as physiotherapy procedures using robotic innovations. Technology has transformed many aspects of people's lives from the method of shopping, socialising to the method of payment, and healthcare is no exception. Innovations can ease the pressure on the elderly healthcare industry, which is known for shortage in manpower, extend the physical capacity and prolong the independency of senior citizens. Hence, it is not surprising to find the majority of gerontechnology products to be under the healthcare category. Sections 2.1.1 to 2.1.3 will cover existing healthcare products within Hong Kong, while Section 2.1.4 will be based on unique successful products in other economies.

2.2.1 MONITORING DEVICES

Monitoring devices which use biometric technology to measure and monitor different health parameters, such as heart rate, respiration rate, blood pressure, oxygen level, glucose level, weight, sleeping behaviour and so on, of the user. These biometric measurements can be used to determine an elderly's health condition and may provide an early warning in the initial stages of any abnormality, allowing for prevention measures and treatment before the condition becomes too serious. These are usually small items that can be used at home or within elderly home centres. They are either worn by the elderly all day long and have their health data recorded continuously or require regular check-ups for measurements at an institute. This will not only be informative for the elderly themselves but also valuable for caregivers and family members to have the latest assessment of the elderly's condition.

Different biometric measurements can be used to indicate different medical conditions, the most basic and important measurements are the vital signs, these includes the heart rate[4], respiration rate and blood pressure. The normal resting heart rate ranges from 60 to 100 beats per minute (John Hart, 2015), a significant increase or decrease in resting heart rate for elderly people may indicate a medical problem[5]. Therefore, if abnormal heart rate is identified remedial actions can be taken to improve the situation. Respiration rate is often neglected when tracking vital signs; however, a raised respiratory rate is an easy and strong assessment for critical illness. Advanced warnings can be identified through monitoring the respiration rate, allowing healthcare providers to have access to more accurate and critical data[6]. When an elderly's blood pressure[7] is high the heart works harder and the chances of a stroke, heart attack and kidney problems increases significantly (S. Vasan, 2001) and if the blood pressure is too low it could be a sign of heart failure or dehydration which is a common condition amongst the elderly. Monitoring other biometric signs will also allow for an even better picture of an elderly's health condition. Old age increases the probability of illnesses such as diabetes, cardiovascular diseases and sleep apnea, these conditions can be identified through monitoring the elderly's glucose level, arteriacomml stiffness and sleeping behaviour, respectively (Cardiol, 2003). Early detection can allow the elderly, their healthcare providers, caregivers and family members to take precautionary and corrective measures.

[4] The resting heart rate, the number of heart beats per minute while the person is at rest, is key indicator of good health.

[5] The elderly are prone to bradycardia, the slowing of heart rate, this may mean blood is not circulated properly and organ damage may result. Tachycardia, rapid heart rate, is also most prevalent in the elderly and in some cases may cause cardiac arrest.

[6] Respiratory rate higher than 27 breaths/minute is one of the most important predictor of cardiac arrest (Fieselmann, 1993), lower respiratory tract infection is another potential illnesses that can be indicated with a rise in respiratory rate that is frequently found in elderly citizens (J.P. McFadden, 1982).

[7] Blood Pressure is the force of blood pushing against the walls of the arteries.

Figure 2.23: Smart Respiration Belt
Source: Advanpro

2.2.1.1 Smart Respiration Belt and Apparel

By incorporating fabric strain, pressure and electrode sensors into clothing items; these products allows collection of the users physiological information and activity signals. Fabric sensors fitted inside a belt, allows pressure data to be collected from which the breathing rate can be calculated through the stretching and retracting of the belt using strain gauges. Medical level bioelectricity detectors[8] fixed inside an upper-body garment can give important information regarding the electrical activity that takes place within the body such as user's heart rate and sleeping behaviours. The sensors incorporated in the belt and apparel are not only made comfortable, using "soft" sensors, but also washable, allowing the product to be worn daily for continuous data collection.

2.2.1.2 Health Tracking Wristband Devices

Fitted on the wrist of the user, these devices provides continuous tracking of valuable biometrics such as the step-count, distance travelled, calories burnt, heart-rate and sleeping pattern. Paired with a smartphone App, data is uploaded via Bluetooth or Wi-Fi and synced with the App for storage and reading. More advanced products will analyse the information and give feedback through the smartphone App, incentivising the user to be more active through different motivational games. One of these products is the HeHa Qi Health Manager which include functions such as measuring the user's ECG signals to derive health analysis in just 2 minutes as well as provide 3 minute breathing training to lower high blood pressure and reduce mental stress. Another product, Heartisans wearable, uses innovative technology to provide cuff-less blood pressure measurement[9] allowing immediate reading at any moment making it quicker and more convenient for both the elderly and caregivers to keep track of the user's health.

[8] The bioelectricity detectors sense bioelectricity signals when in contact with skin, these signals which are provoked by electrically active tissue like the heart, muscle and brain.

[9] The cuff-less blood pressure measurement technology involves using ECG and PPG sensors on top of the other biometric measurements. It estimates blood pressure by measuring the speed of a pulse flowing from the heart to the wrist.

Figure 2.24: HeHa Qi
Source: iHeHa

Figure 2.25: Heartisans Wearable
Source: Heartisans

2.2.1.3 Body Fat Analyser and Scale

By simply stepping on the analyser the fat level, the hydration level and weight of the body is measured using electric current. These devices uses bioelectrical impedance to calculate the body's composition[10]. Electrical current flows more quickly through water and muscle than bone or fat, therefore the scale can measure the fat level and hydration level through calculating the speed of the current. Using Bluetooth technology, personal measurements can be stored and read by the user using a smartphone App enabling for a more organised and accessible set of health data to review on.

2.2.1.4 Smart Sleep Monitoring Device

Traditionally to determine whether a patient has any sleeping disorder, the patient must undergo a sleep study at a sleep centre or hospital with a team of sleeping specialists. Various testing equipment is attached to the patient in an unfamiliar environment, thus this can be both an uncomfortable and daunting experience which may produce inaccurate results due to the pressure to fall asleep. Home testing is becoming more common since the patient is at ease within their own homes, and a more accurate overview of the patient's sleeping habit can be seen. These devices monitors users' sleep quality and pattern by gathering heart rate, respiratory rate and sleep stages, the health report containing the data collected is then sent and synced with a smartphone app. Problems are identified and the App can provide and offer tips on how to address them. For a smart mattress the posture of the user can also be monitored and subsequent adjustments can be made.

[10] Galvanised electrodes send a small, painless current of electricity through the user's body, the signal travels through your legs to your waist and back down. This measures the subcutaneous fluid under the skin, which in other words mean the amount of body fat.

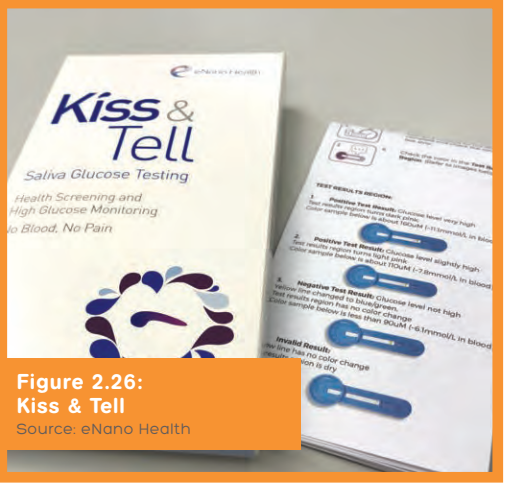


Figure 2.26:
Kiss & Tell
Source: eNano Health

Figure 2.27:
Reflective Pulse Oximeter
Source: ASTRI

Figure 2.28:
The Cardiovascular Monitoring Device
Source: ASTRI

2.2.1.5 Non-Invasive Glucose Monitoring

Traditionally blood glucose monitoring is used to monitor glucose levels, the test requires the skin to be pierced in order to draw blood and assessed. Patients with diabetes, particularly those with type one, often have to test their glucose level multiple times a day, and not only is the traditional test painful but it also increases the chance of infections. These products allow glucose levels to be measured through non-invasive means. Kiss & Tell uses a glucose biosensor which is sensitive specifically to detect glucose level, by placing the test in the user's mouth the product can allow for pre-diabetic and diabetic health screening using the user's saliva. Another product involves the user to only place their thumb over a sensor to determine their glucose level using Near-infrared light emitted through the skin.

2.2.1.6 Institutional Monitoring Devices

These are medical grade monitoring devices which give accurate assessment of the user's health condition. Due to the price and also the requirement of supervised use these products are used within elderly home or community centres, beside they only require occasional assessment and not continuous monitoring. Automatic Retinal Image uses just an ocular fundus photo to accurately assess the risk of a stroke, the image is related through the internet and immediate assessment can be provided. Reflective Pulse Oximeter measures blood oxygen saturation level and heart rate by using the same method as finger sensors but cuffed around the wrist. The Cardiovascular Monitoring Device measures three parameters: arterial stiffness, blood pressure and pulse rate simultaneously by simply using a smart sensor around the wrist and allows for continuous measurement which traditional methods cannot.

2.2.2 THERAPEUTIC DEVICES USING HIGH TECHNOLOGY

These are devices that integrates different technologies into the form of robotics or machinery in order to assist senior citizens with the intake of medication, rehabilitation progress or provide personal-assistance for elderly medical condition. With an increase in age, chances of diseases such as Parkinson's, dementia and the occurrence of strokes increases considerably. The volume of medication required to be taken by the elderly increases as their health deteriorates. However, memory capacity also declines with age and the ability to remember to take large quantities of medication throughout the day reduces. The need for technology to support patients who suffer from these conditions will become progressively more vital, especially with an aging population and a rise in life expectancy.

2.2.2.1 Robotic Assistive Devices

These robotic devices are usually worn by the user to assist with rehabilitation and regaining of movements. The Hand of Hope, a sEMG-driven exoskeleton robotic hand, assists with stroke rehabilitation. Over time the device helps patients relearn and regain hand mobility through therapeutic exercises. The device gives patients more incentives and motivation to train through games connected to the exoskeleton. Based on the principle of neuroplasticity, through repetitive training, a person who suffered a stroke and lost mobility in the hand can regain the ability to perform daily activities such as opening the hand, holding and picking up objects. Another exoskeleton device, called MedEXO Robotics, provides tremor-stabilising assistance to users. Aimed to help users suffering from Parkinson's disease and other patients suffering from tremor problems. The device reduces involuntary movement as well as provide assistive force for voluntary movements, allowing users to perform their daily activities. For lower-body therapy, Rex is a robotic mobility device which is adjustable and helps self-support each user and enables the user to undergo walking, stretching and standing therapy. The device is worn by the user, reducing the physical workload required by therapists and caregivers by supporting the elderly's legs, thus allowing users to perform therapy exercises more frequently.

Figure 2.29: The Hand of Hope
Source: Rehab-Robotics

Figure 2.30: MedExo
Source: MedExo Robotics

Figure 2.31: Rex
Source: Deltason Medical Limited

Figure 2.32: Elderly E-Educational & Infotainment Platform
Source: ASTRI

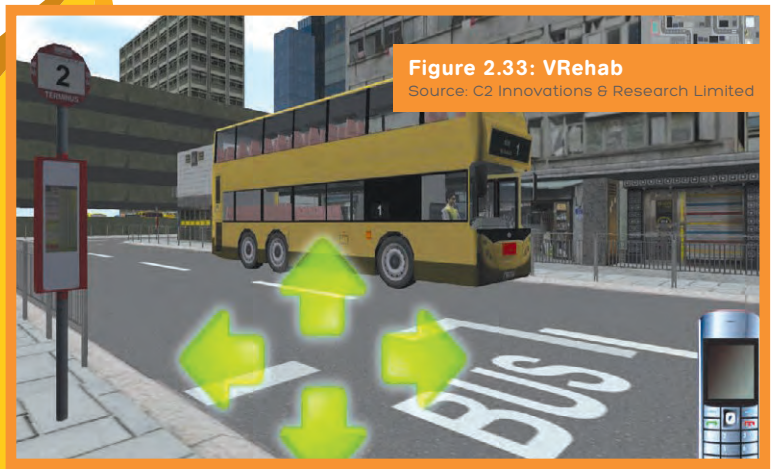


Figure 2.33: VRehab
Source: C2 Innovations & Research Limited

2.2.2.2 Computer Assisted Training Systems

These training systems makes use of computer devices to help seniors with cognitive impairment caused by stroke, mild cognitive impairment, brain degeneration and so on. VRehab, a virtual reality based rehabilitation system, simulate a real training environment for training the elderly to perform a number of tasks using virtual reality technology, such as taking different public transport systems and paying for groceries. These exercises are developed based on the local environment and a variety of relevant cultural tasks. The system mimics everyday functional tasks in real environment to significantly enhance the user's cognitive ability, yet reduce the dangers and uncertainty with practicing outside in real settings. Another system which aims to assist the elderly with regaining confidence and ability to perform functional tasks is Elderly E-Educational & Infotainment Platform, it consists of a touch screen device with a series of games and questionnaires with useful information.

2.2.2.3 Medication Support

Assistance with medication intake is usually provided by caregivers within elderly home centres or family members in the case of seniors who live at home. These devices can reduce the workload and reliance on caregivers. A simple smart medicine box can remind the user to take their medication at the right time with the right dosage, increasing the user's ability to take care of themselves independently and reducing the chances of medication-related errors. A more high technology device is the Automatic Tablet Dispensing and Packaging System which is connected with a computer system of a pharmacy. This device automatically sort, distribute and package medicine based on the specified prescriptions. Traditionally caregivers would accompany seniors to the doctors, collect the medication from the hospital pharmacy, re-organise all medication for the seniors at the elderly home centre and re-distribute according the elderly's schedule. Thus, this device can significantly reduce caregivers' stress since the entire medicine collection and distribution process not only traditionally takes hours to complete but is also tedious. Once permitted by the hospital and pharmaceutical system in the future, further discussion in Section 3.6, the technology is capable of supporting direct collection of prescription medicine from the device, hence reducing the waiting time required at the hospital pharmacy. Each prescription is labelled with the user's information and the specified direction of use and hence reduces the chances of distributing the wrong medication and allowing a more accurate and safer medicine control.

Figure 2.34: Smart Medicine Box
Source: Hong Kong Science Park and HOHOLIFE

Figure 2.35: Automatic Tablet Dispensing Packaging System
Source: Deltason Medical Limited

2.2.3 SOFTWARE AS A SERVICE (SAAS)

Software as a Service (SaaS) is one of three main categories of cloud computing[11], its applications are designed for end-users and delivered over the internet. The technology can be used to store data, simplify administrative tasks, host clinical applications and exchange health information. These applications of SaaS can enhance the delivery and management of care for the elderly both at home and elderly home care centres. Information on the elderly is more readily available, up-to-date and accessible through SaaS.

[11] Cloud computing covers a broad range of internet-based services. The three main categories included in cloud computing is Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).

Figure 2.36: Cloud-based Personal Care Plan eHealth Solution
Source: Acesobee

2.2.3.1 Electronic Health Platform

Traditionally, record systems in elderly home centres require substantial paperwork and admin duties, this in turn causes a reduction in time spent on direct elderly care. Often these paper records are incomplete since they tend to be dispersed across different departments, and retrieving any information become excessively inefficient. Electronic health record platforms have been developed to reduce the redundancies for healthcare providers and allows easily accessible health history files and faster and easier recording and exchanging of information. Individual's records can be retrieved at any time from any location with internet access. Acesobee is an example of an electronic healthcare record platform which simplifies and facilitates the management of personal healthcare information among the user, their family members, healthcare service providers and insurance companies. The App allow information sharing, schedule reminders, viewing of medication and treatment records. Another health platform which is more established is the Electronic Health Record Sharing System (eHRSS). The system provides health records in electronic format that contain health-related data of individuals and allows healthcare providers to upload and access individual's health-related data more efficiently. The platforms aim is to connect public and private hospitals, clinics, laboratories and examinations centre to give a more complete and accurate set of information on the patient.

2.2.3.2 Centralised Monitoring System

Integrating different health devices for real-time service monitoring, these systems allows for immediate alerts and notification when health condition changes. By consolidating all monitoring measurements the efficiency and accuracy of diagnoses and procedures can be increased. Workflow management and task logging becomes easier with a centralized data storage system. These systems can help with reducing paperwork and ease the work load on caregivers, giving them more time to spend on assisting the elderly and more essential tasks. An example of a centralized monitoring system is the A&D Connect, the system collects results and data from different monitoring devices such as blood pressure monitor, weight scale and thermometer through Bluetooth. The result and data is then combined and organised for ease of reference in the future and allows doctors and family members to share across the internet.

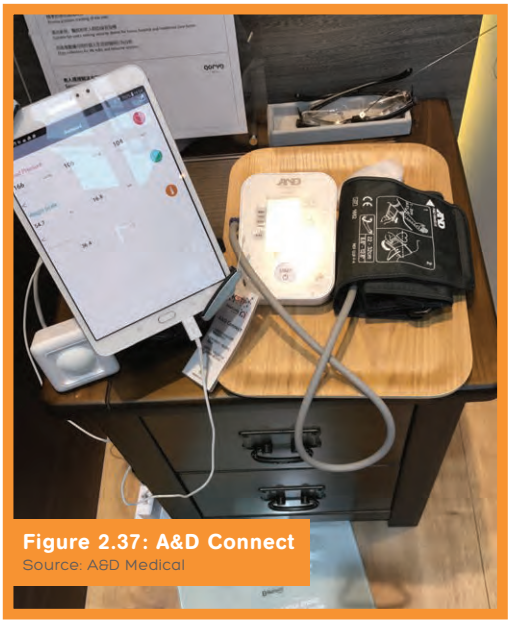


Figure 2.37: A&D Connect
Source: A&D Medical

Figure 2.38: Hong Kong Intelligent Cognitive Assessment Platform
Source: Cognix Limited

2.2.3.3 Diagnostic Assessment Apps

These platforms are used to diagnose and allow for early preventions of diseases such as dementia. Interactive games and quizzes are tailored for a less tedious and more enjoyable assessment experience. Also allows for several participants to complete the assessment at any given time, only one supervisor is required to oversee each assessment session and no special training is required to operate the platform. Thus, improving efficiency in the diagnosis process and reduce labour pressure. Hong Kong Intelligent Cognitive Assessment Platform and Brainastic are both Apps which performs cognitive assessments. Hong Kong Intelligent Cognitive Assessment Platform aims to reduce the burden on professionals, who traditionally carry out a thirty minute one on one monotonous assessment, as well as reduce the waiting time for an assessment which could cause the elderly to miss their golden period for receiving treatment.

2.2.4 UNIQUE AND SUCCESSFUL PRODUCTS IN OTHER ECONOMIES

There are a large number of innovative technology devices within elderly healthcare in other economies, however the one category which Hong Kong undeniably lag behind are assistive devices designed to support caregivers in delivering physical care for the elderly.

Often, when an elderly is no longer capable of looking after themselves they are either admitted into an elderly home centre or their family members will provide care to the elderly and become informal caregivers at home. In these circumstances much of the tasks required to take care of these elderly involve intensive physical labour, such as carrying and lifting fragile seniors with mobility difficulties out of and into bed, wheelchairs, and perform physiotherapy exercises. These tasks can be both strenuous and dangerous for caregivers with negative affects to the caregivers' health. In the United States, nursing homes are among the top 10 industries for musculoskeletal problems from performing different physically taxing activities and working in awkward postures (Trinkoff et al., 2005). Additionally, informal caregivers are often poorly trained and equipped and therefore at risk of injury, typical injuries incurred by caregivers include back pain, other muscular injuries, twisted knees and muscular aches (Brown and Mulley, 1997). In addition to assistive devices for elderly users, assistive technology can also be applied to assist caregivers when performing different healthcare tasks, reducing the load of heavy duty tasks and help prevent physical injuries to the caregivers.

HAL (Lumbar Type), which is available in Japan, was developed to support caregivers and workers who perform heavy work. The device provides reduction in the stress applied on the lower back, hence lighten heavy labour tasks and allows for heavy works to be performed safely and tirelessly, thus reducing the number of labour accidents when taking care of dependent seniors through the use of HAL for Care support. The technology uses bio-electric signals to allow for the device to support the wearer's motion in exact accordance with the wearer's brain signal, the level of assistance can also be adjusted depending on the wearer's preference. Another product which supports caregivers is a highly publicized experimental project in

Figure 2.39: HAL (Lumbar Type)
Source: CYBERDYNE

Japan called ROBEAR, it is a nursing care robot which is capable of performing tasks such as lifting an elderly from a bed into a wheelchair. The technology behind the robot allows for gentle movements enable to ensure power-intensive tasks to be possible whilst also guaranteeing no danger is incurred onto the elderly. With a rapidly increasing elderly population, these assistive devices which are unavailable in Hong Kong could significantly improve the elderly caregiving industry and re-invent its image, which is traditionally viewed as being both labour intensive and tedious.

Figure 2.40: ROBEAR Nursing Care Robot
Source: RIKEN

2.3

FOOD（食）

As seniors grow older, they may face certain difficulties eating as the ability to bite, chew and swallow food deteriorates. Loss of vision may limit ability to shop for food and cook, loss of teeth and sensitivity to tastes of foods will reduce appetite and subsequently, the quantity and types of food consumed (Sugimoto, 2013). This can result in an imbalanced diet and malnutrition, therefore through different innovative technologies eating problems faced by the elderly can be elevated. There are several non-government organisations and charities which provides meal delivery services and food bank schemes. These services aims to provide food and cooked meals for senior citizens from a low-income background or live independently with restricted mobility. However, it can be seen that Hong Kong is lacking considerably in innovation for elderly food. Sections 2.2.1 to 2.2.2 will cover existing food products and services within Hong Kong, while Section 2.1.3 will be based on unique and successful products in other economies.

Figure 2.41: EnvisionTEC's E-Dent
Source: Persona Surgical Modelling Co. Ltd

2.3.1 DENTAL PROSTHESIS

People only has one set of permanent teeth, disease and trauma may cause for adult teeth to decay and die. Damage and tooth loss can cause difficulties with eating normally as well as a loss of appetite due to the reduction in enjoyment of food. In 2001, according to an Oran Health Survey completed by the Department of health the percentage of non-institutionalised older persons in Hong Kong between the ages of 65 to 74 years old with less than 20 teeth left is 40.5%. Additionally, irrespective of the type of dental prostheses used, if was found that 63.2% of non-institutionalised older persons had prostheses in their mouths, which is a total of 284, 900 older persons. Thus, innovations in the dental prosthesis sector can enhance the life of a large portion of the elderly population. Using 3D-Printing technology, the EnvisionTEC's E-Dent temporary dental prosthesis allows for quick rapid production of dental prosthesis for short-term use. During the period when elderly are waiting for their permanent dental prosthesis to be made or altered, this product allows for an affordable and easy option to enable the elderly to continue with their daily life and eat food with a harder texture and not have to rely on pureed meals.

Figure 2.42: Tender Love Cuisine
Source: Sheng Kung Hui Cyril

2.3.2 AESTHETIC PUREED "SOFT" MEALS

Traditionally pureed meals are prepared using a blender or food processor, where by different cooked food with the required nutrition is blended together in to one smooth porridge or soup like meal. These meals tend to be unappealing in appearance and taste, hence cause the elderly to have a loss in appetite and therefore lead to a loss in weight or become malnourished. The Tender Love Cuisine developed by Sheng Kung Hui Welfare Council, and the purchasable packaged version, called Graceful Meals, developed by St. James Settlement are relatively innovative developments, which consists of pureed meals made and presented in the same form as before the food was blended. The packaged version allows elderly to have access to these aesthetically appealing meals at home out of elderly residential care centres. The meals were developed and prepared by a team of nutritionists, speech therapist, cooking chief and healthcare caregivers. The objective is to make the meals nutritional, easy to consume but still appetizing, such that the dignity of the elderly is conserved, and therefore elevate the elderly's enthusiasm for food.

2.3.3 UNIQUE AND SUCCESSFUL PRODUCTS IN OTHER ECONOMIES

Through collaboration between several stakeholders and implementing a more innovative business model, Japan's convenience stores have been made more widely accessible and convenient for the elderly population. Cooperation between a number of convenience store companies and real estate agencies, a hundred convenience stores were opened within vacant apartment units. These convenience stores offers fresh ingredients as well as cooked meals in comparison to solely microwavable and instant noodles which lacks in nutritional value. These stores even provide home delivery services with a simple phone and hence elderly residents do not need to leave their homes.

In contrast to Hong Kong, where meal delivery is the main focus for solving the elderly food consumption problem. Other economies such as Japan[12] and Germany have furthermore developed several innovative technologies and services to assists with feeding the growing older population. It is arguably the birthplace of the functional food trend, food which is enriched with nutrients to have a positive effect on health beyond basic nutrition, with a tradition of fortifying food products to provide health benefits. Kewpie Gentle Menu products can be found in

[12] With one in four of its 130 million population aged over 65, Japan is the world's most rapidly ageing population.

Figure 2.43: Graceful Meals (Beef)
Source: St. James Settlement

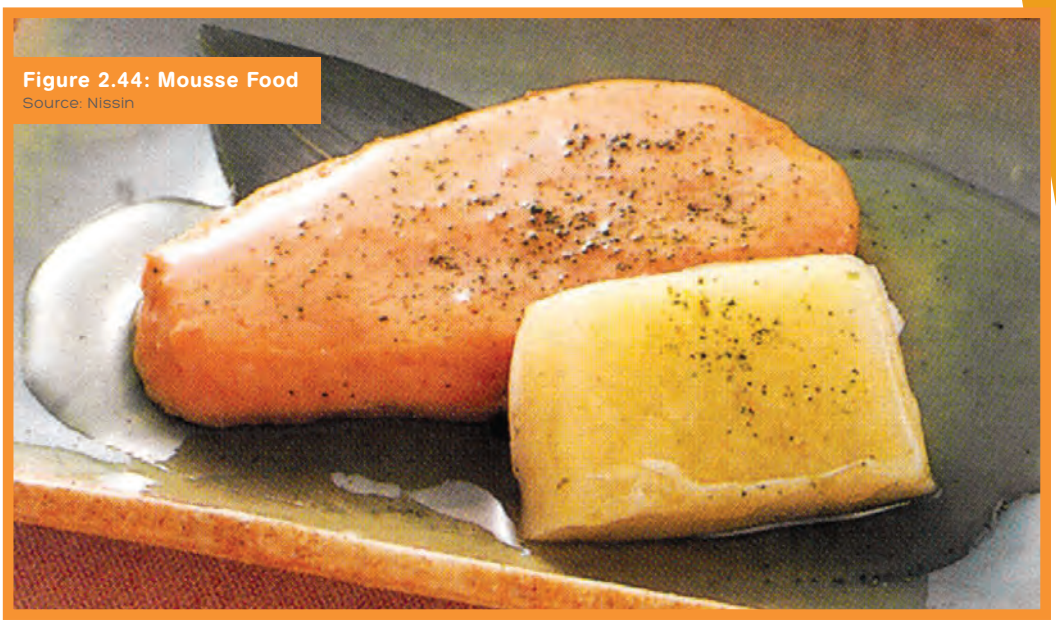


Figure 2.44: Mousse Food
Source: Nissin

local supermarkets and through home deliveries, these menu contains over fifty different items and are vacuum-packed for ease of transportation. The products have various degrees of chewability to choose from, such as no chew, crushed with tongue, crushable with gums and easy to chew. Japan also developed a technology to cook soft foods while maintaining its shape through the use of enzymes, for example this technique will allow shrimps to be cooed and kept in its shape until a small amount of force is applied and it will disintegrate with ease. Other innovative soft textured food products in Japan includes making Mousse Food and Jelly Formed Food, these products take the same appearance as the original food but is in mousse or jelly form for easy consumption, such as salmon mousse which provides high dosage of protein and jelly tomatoes which looks exactly the same as a normal tomatoes. Similarly Germany has also developed several technology to produce soft textured food in the same form as its original appearance. Biozoon and Foodjet both uses 3D printing technology to provide meals with a soft texture but also appetizing and have the same appearance as normal food. The texture of the food produced through 3D printing can be altered depending on the elderly's chewing and swallowing ability. Additional proteins, vitamins and minerals can also be injected into the meals to enrich the elderly's nutritional intake and thus avoid malnutrition and maintain a healthy balanced diet.

Figure 2.45: Jelly Formed Food
Source: Nissin

Figure 2.46: Biozoon
Source: Biozoon

2.4

TRANSPORT (行)

Transportation is essential to ensure access to fundamental services such as medical care and grocery shopping, but it is also crucial for enabling the elderly to stay connected with the outside community. Good transportation products and services for the elderly will encourage elderly to engage in more community activities, allowing for both their physical and mental well-being to be strengthened. Innovative services and technologies can help elderly stay mobile and live autonomously through either physically assisting their movement or preventing injuries and accidents occurring. Sections 2.4.1 to 2.4.3 will cover existing healthcare products within Hong Kong, while section 2.4.4 will be based on unique successful products in other economies.

2.4.1 Wheelchairs and Walking Canes

As people grow older physical changes arises and these changes that occur with ageing can lead to problems with a person's ability to move around. These mobility issues are usually contributed by muscle weakness, joint problems, pain or neurological conditions, and could cause difficulties in stability, getting in and out of a chair and so on. With technological advancement wheelchairs and walking canes have evolved to provide even better assistance to those with mobility impairments. These impairments may range from limitation of stamina to paralysis.

Figure 2.47: Mobilet
Source: Single Person Transport Design

Figure 2.48: Easiseat
Source: MoNi Studio Interactive Design

2.4.1.1 Wheelchairs

There are two major types of wheelchairs, manual wheelchairs and electrically powered wheelchairs. The price range varies greatly, however for typical wheelchairs the choice of appearance and technology used is very limited. Mobilet is an electrically powered wheelchair which was created such that the appearance could be easily customised by the user to remove the stigma of wheelchairs being for the disabled only, and instead used as a transportation vehicle. The majority of the wheelchair uses standard parts and therefore can be replaced and altered according to the elderly's preference. It also incorporates a range of technology into the wheelchair to assist the user such as anti-collision system, turning assistance, driving assistance and so on. Easiseat is another electrically powered wheelchair which has an unconventional appearance to traditional wheelchairs. It is crafted with wood to be both aesthetically pleasing and comfortable, such that the elderly feels like they're sitting on a piece of furniture. Due to its innovative design the wheelchair has a power-assisted toilet using function where the wheetchair can be pushed directly on top of the toilet and no modification to the bathroom is required. Controlled with a remote-control, the elderly is raised up using two support under the arm where subsequently the seat can be opened up to reveal the toilet seat and allow the users to use the toilet independently. Additionally, the wheelchair is also able to move laterally as well as forward and backwards hence enabling the wheelchair to be used within tight spaces, which is particularly useful for apartments in Hong Kong where according to the Maximizing Land Use to Boost Development Optimizing Housing Resources to Benefit All Report by Our Hong Kong Foundation the average living space per person is 170 square feet. The above wheelchairs provide innovative methods to travel laterally on flat ground in Hong Kong, while the stairs climber Scalamobil is an innovative device which assists manual wheelchairs with travelling vertically. The mobile stairs climber is attachable to wheelchairs and enables the users to ascend and descend spiral or straight staircases easily and safely.

Figure 2.49: Scalamobil S35
Source: Janley Ltd.

Figure 2.50: The Smart Walking Cane
Source: LSCM R&D Centre

2.4.1.2 Smart Walking Cane

Visual loss affects both the physical and mental health of an elderly, it places restrictions in physical activities (D.J. Lee, 2005) and results in psychological suffering. Elderly with visual impairment are more likely to be socially isolated and have mental conditions such as anxiety and depression (B.W. Rovner, 1998). Therefore it is important to assist visually impaired elderly with technology and encourage them to stay socially active. The Smart Walking Cane incorporates RFID technology to assist visually impaired users with direction and guidance. This technology requires RFID sensors to be built along paths and corridors for the visually impaired and when the user walks past these tags the reader on the walking cane will give vocal directions leading towards the desirable location. The desirable location is set using a smartphone app which will find a route suitable for the user through the central service system.

2.4.2 Transportation Services

To stay connected to the outside world and regularly attend essential appointments which are a distance away, further assistance through innovative services is required. According to Census and Statistics Department, in Hong Kong there are 58,600 persons with restriction in body movement who requires a wheelchair to move around, but Hong Kong public transport were not built to support this group of people. Public transport in Hong Kong are inconvenient and hard work for wheelchair users, therefore innovative point-to-point services and route services have been established.

The Diamond Cab and UberAssist services are both point-to-point cab services, which have been established to cater for wheelchair users. Diamond Cab's taxis have been redesigned such that wheelchairs along with the user can be pushed directly on to the taxi and secured in place. Since the establishment of Diamond Cabs other taxi companies have also launched similar wheelchair accessible taxis, hence increasing the supply significantly. UberAssist uses a smartphone App to order a car to pick-up the user at a specified location and then dropped off at the desirable destination. The Rehabus, Easy Access Bus and Accessible Hire Car are also alternative options for wheelchair users have multiple scheduled routes, dial-a-ride and pooled dial-a-ride services which are accessible for elderly wheelchair users. A Rehabus can accommodate a maximum of 6 wheelchair passengers and 7 passengers, it has a power-lift at the rear of the bus to assist wheelchair passengers. The Easy Access Bus similar to the Rehabus is commissioned by the Hospital Authority to specifically provide transport service for elderly aged 60 and above with mobility difficulties and their caregivers to access public hospitals and clinics.

Figure 2.51: Diamond Cab
Source: Diamond Cab (Hong Kong) Ltd

Figure 2.52: Rehabus/ Accessible Hire Car/ Easy Access Bus
Source: Hong Kong Society for Rehabilitation

Figure 2.53: RFID Tagged and GDP Tracking Vests
Source: The Hong Kong Research Institute of Textiles and Apparel

2.4.3 Location Devices

For the elderly group who are still active and mobile, technology can be applied to assist with other areas such as tracking and detecting the precise location. For elderly with dementia or a reduction in memory capacity, devices like the RFID and GPS Tracking Vest, NFC Smart Wristband and Smartsole will allow caregivers and family members to locate the elderly quickly and safely when they wader and become disorientated. They are comfortable, light and aesthetically appealing with RFID tags or GPS trackers attached within them. For the RFID tagged Vest, it is useful for when an elderly wanders out of the elderly home centre unaccompanied; the RFID tag will alert a system which is installed at the doorways of the centre and notify the relevant caregiver. The RFID tags themselves are washable and therefore does not require removal when washing the vest. The GPS device however is not washable but allows for more accurate tracking of the elderly's whereabouts and is placed comfortably inside a pocket at the back of the neck of the vest or worn on the wrist of the elderly. The Smartsole is a shoe insole with an integrated GPS device and can be placed within shoes to track the elderly, this design is particularly useful for seniors with dementia since they may take off their vest or accessories outdoors but it is highly unlikely they will forget or lose their shoes. With the GPS devices seniors can be taken outside for expeditions and outdoor activities but still be safely monitored.

2.4.4 Unique and Successful Products in Other Economies

A successful product developed in Japan is the Honda Walking Assist Device, this device can assist elderly users to regain their walking ability and provide ample assistance for the arm and knee joints. Although there are similar products available in Hong Kong, the product found in Japan is more portable, smaller in size and lighter, hence significantly increasing the functionality and probability of use. Moreover due to its size, weight and ease of use, the devices can be used at any time and place without space limitation concerns.

Other innovative products which are not available within Hong Kong include the Foldawheel electric wheelchair, available in Malaysia, and the XiaoxinTM Multi-Functional Healthcare Chair for the Elderly, available in Mainland China. The Foldawheel is a very affordable electric wheelchair which can be folded away for convenience when travelling in a car. It is the lightest power-electric wheelchair in the world, it weighs only 45 pounds including the Li-ion battery pack, using two batteries the wheelchair is able travel up to 16 miles. Its compact size when folded allows for the user to travel in normal standard cars by simply folding away the wheelchair and placing it in the back, making travelling long distance more convenient. Caregivers can also maneuver and take care of seniors more easily since the light weight of the wheelchair reduces the weight-load required to accomplish different tasks. XiaoxinTM Multi-Functional Healthcare Chair on the other hand is a high-end luxury versatile wheelchair. It core functions consists of electrically powered walking, massage function, heating, medication reminder and smart raising, where the chair has a propelling base which helps the elderly stand up or sit down slowly in the same manner of human assistance. Again, this is a product which could significantly enhance an elderly's independence or reduce the workload of caregivers whether it is used at home or within an elderly care home.

Figure 2.54: NFC Smart Wristband
Source: Bjorgass Foundation

2.5

CONCLUSION

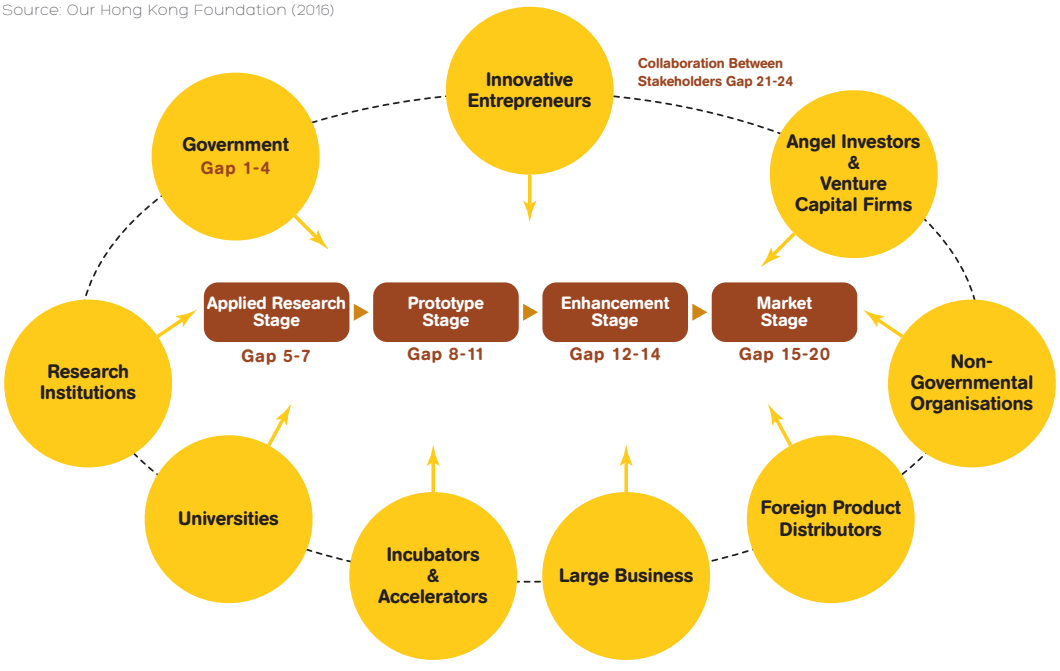
In conclusion, although not all products within Hong Kong has been mentioned in this Chapter, it can be seen that there is a wide range of gerontechnology products available to assist with ageing in place and the enhancement of the elderly healthcare system. However, even though many of these products have obvious benefits it has yet to be popularized within Hong Kong and therefore in the following chapter the various reasons for this occurrence will be investigated and further discussed.

Chapter 3
Gaps and Difficulties within the Ecosystem

The gerontechnology ecosystem in Hong Kong, of which a diagram is shown in Figure 3.1, can be divided into four main product development stages: 1) Applied Research Stage; 2) Prototype Stage; 3) Enhancement Stage; and 4) Gerontechnology Market from both the producer and consumer's perspective. These stages are coloured in the red boxes. The gerontechnology business process begins with stage 1, where universities and research institutions carry out applied research. The applied research being carried out may inspire an idea for a product or a service. Stage 2 is the prototyping stage, where applied research is transformed into an early-stage model for a commercial product or service by innovative entrepreneurs. The next part is stage 3, the enhancement stage. Here, product designs are enhanced and refined to suit the target consumer market. Stage 4 is the final stage where products and services enter the gerontechnology market.

Figure 3.1 Stages and Stakeholders of the Gerontechnology Ecosystem

Source: Our Hong Kong Foundation (2016)

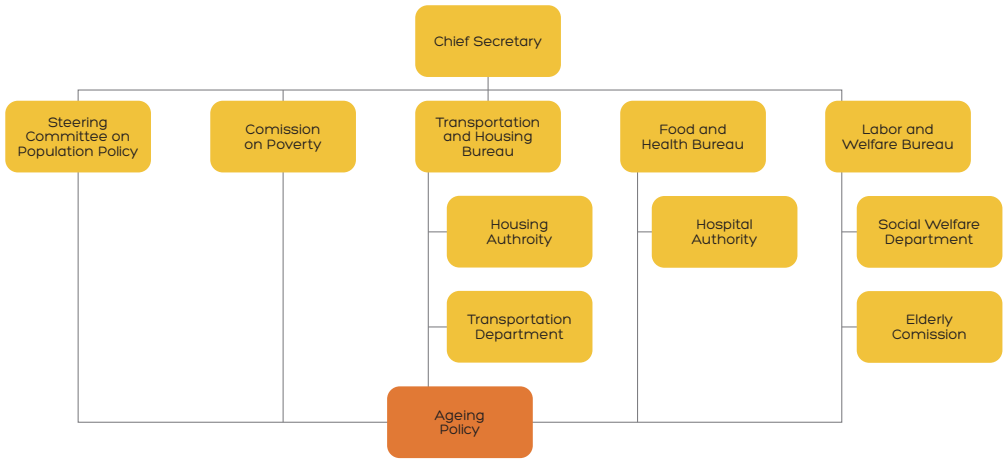


There are numerous participants in the gerontechnology ecosystem, but the very key stakeholders are circled in yellow and are as follows: the government, investors, universities, research institutions, innovative entrepreneurs, incubators and accelerators big business, foreign product distributiors and non-governmental organisations (NGOs), which also includes day care centres and residential care homes for the elderly (RCHEs).

The government is one of the most important stakeholders, as its role in overseeing the entire gerontechnology ecosystem and capacity to set and implement policies and regulations will impact all stages of the cycle and all other stakeholders. However, its influence is perhaps the most significant in the earlier stages, predominantly stage 1 for applied research and stage 2 for prototyping. The roles of the government extend from conducting research in its five R&D centres operating under the Innovation and Technology Bureau (ITB)[13], funding schemes for supporting research[14] to incubator and accelerator programmes[15] for supporting the development of spinoff companies and other start-ups that have arisen independently of research institutions. There are numerous bureaus and departments operating under the government in relation to the gerontechnology ecosystem, and the most fundamental ones are illustrated in Figure 3.2.

Figure 3.2: Government Bodies which Set Policies Impacting the Elderly in Hong Kong

Source: Our Hong Kong Foundation (2016)



Investors are another stakeholder group in the ecosystem and their influences are normally in the later stages. This stakeholder category includes angel investors and venture capital firms[16]. They are primarily responsible for providing funding to gerontechnology companies during the enhancement and market stage. They may also provide advice to startups about their business strategy and help the company expand its network during the prototyping or product enhancement stages to eventually facilitate pushing the product out to the market.

[13] Hong Kong's five R&D centres are as follows: Automotive Parts and Accessory Systems R&D Centre (APAS), Hong Kong R&D Centre for Information and Communications Technologies under the Hong Kong Applied Science and Technology Research Institute (ASTRI), Hong Kong Research Institute of Textiles and Apparel (HKRITA), Hong Kong R&D Centre for Logistics and Supply Chain Management Enabling Technologies (LSCM R&D Centre), and Nano and Advanced Materials Institute (NAMI).

[14] HKSTP's corporate venture fund and the ITB's Innovation and Technology Fund can provide financial support to companies. The 2017-2018 Budget Speech outlined government plans to reserve HKD 10 billion to support innovation and development, as well as a proposal to set up a new HKD 2 billion Innovation and Technology Venture Fund (ITVF) to encourage private investment in local startups (HKSARG, 2017).

[15] HKSTP has an incubation programme that is split into three key areas, specifically for startups in the fields of ewb and mobile technology, technology and biotechnology - Incu-App, Incu-Tech and Incu-Bio.

[16] An example of an investor would be Qiming Venture Partners, a Hong Kong-based venture capital firm with a portfolio consisting of investments in industries such as healthcare, as well as information technology and clean technology amongst others.

[17] Hong Kong's eight funded universities are as follows: City University of Hong Kong (CityU), Hong Kong Baptist University (HKBU), Lingnan University (LU), The Chinese University of Hong Kong (CUHK), The Education University of Hong Kong (EdUHK), The Hong Kong Polytechnic University (PolyU), The Hong Kong University of Science and Technology (HKUST) and The University of Hong Kong (HKU).

Universities and research institutions focus on conducting applied research. There are five R&D institutions under the government as mentioned before and eight higher education institutions[17] funded by the University Grants Committee. Universities in their own right cannot profit from products arising from applied research, so private spinoff companies or academic-industrial partnerships are formed to take the product or service to market. Spinoff companies then fall under a stakeholder category we have termed "innovative entrepreneurs".

Innovative entrepreneurs refers to start-up companies that have branched off academic and research institutes[18], The innovative entrepreneurs category also includes businesses that have arisen independently of R&D institutions, as not all product ideation occurs at R&D institutes.[19]

Incubators and accelerators nurture and mentor early stage start-up companies[20]. They respectively run incubator programmes, which assist companies in refining early business ideas to develop a first prototype, and accelerator programmes, which help start-ups at later stages that already have a prototype develop a feasible business model and hone them. Both incubators and accelerators provide funding as well as other support through mentoring or business consulting to companies to aid business development.

Last but not least are non-governmental organisations (NGOs), which also includes institutions like day care centres and residential care homes for the elderly (RCHEs). NGOs take on a number of different roles, from being providers of care services to gerontechnology product innovation[21] and even funding.[22]

All the stakeholders above are linked together with a dotted line, which represents the interdisciplinary collaboration that should occur between them at different stages of in an ideal situation. However, collaboration in the ecosystem is currently insufficient, and this will be further discussed in Section 3.6.

The product development process and the roles of key stakeholders in the gerontechnology ecosystem have been explained. We will now look at the gaps and difficulties at each of the four development stages, but before this we will first address the hurdles faced by the government as they are the most influential stakeholder group. This section will end with a discussion of the difficulties stakeholders face in collaboration.

[18] Cognix Limited, which is a real-time integrated cognitive assessment and training platform to help patients fight against dementia. This limited company is a spin off from the Chinese University of Hong Kong (CUHK) and the Polytechnic University of Hong Kong (PolyU).

[19] Diamond Cab (a private enterprise offering transportation services for wheelchair users), MoBiLET (a motor wheelchair produced by the company Single Person Transport Design) and Sit n Shower (an automatic showering device that allows users with limited mobility to shower independently and safely) are examples of local product ideas that have been inspired by the founders' own experiences with caring for elders in their family, and independently of academic or research institutes.

[20] The SOW Asia Fund is a charitable foundation founded in 2009 that runs an accelerator programme with a focus on supporting enterprises with a social and/or environmental impact.

[21] The Hong Kong Sheng Kung Hui Cyril and Amy Cheung Aged Care Complex is a day care centre and an elderly home. They are also entrepreneurs, as they developed innovative aesthetic pureed kaiseki meal product for seniors. Further information can be found in Section 2.3.2.

[22] The Hong Kong Jockey Club Charities Trust donated HKD 380 million in 2006 to establish the CADENZA initiative for seniors, which organizes numerous community projects and public education events to promote new and innovative methods of providing care to the elderly (HKJC, 2006). It further provided a donation of HK$ 12 million to set up The Chinese University of Hong Kong Jockey Club Institute of Ageing ("IoA") to "promote positive ageing through research, public education and knowledge transfer" (CUHK, 2015).

3.1

GOVERNMENT

As a governing body with the power to implement new policies and regulations, the government has the means to make substantial transformations to the gerontechnology industry at every stage of the ecosystem. As part of Hong Kong's longer-term strategic plan, Hong Kong 2030+, the government proposes creating an age-friendly environment to promote ageing in place, active ageing and enhance intergenerational harmony through adopting universal design in private residential areas and ensuring there are elderly care facilities in public estates for ageing in place, and encouraging increased participation in community activities for both the elderly and younger generations to foster active ageing and intergenerational support (OHKF Ageing Society Report, 2016). Existing gaps and difficulties involving the government include the lack of awareness in the importance of technology within the elderly healthcare system as well as the lack of encouragement for modernization of elderly care facilities, its highly risk averse tendencies, not updating its regulatory framework causing there to be a widening gap between the existing framework and modern technology, and an insufficient retirement protection plan to reduce the number of uncertainties for the elderly after retirement.

3.1.1 LACK OF AWARENESS (GAP 1)

The present position of gerontechnology within Hong Kong, even from a government's perspective, is as a supplementary product rather than a core functional foundation for improving the elderly healthcare industry. This is proven by the fact there is currently no official department or body that is solely focused on promoting gerontechnology or providing financial and qualitative support (mentorship and training) to the gerontechnology industry in Hong Kong, Even the Elderly Commission[23] acts only as an advisory role. In comparison, Japan has a public body called the Japan Agency for Medical Research and Development, which aims to fast-track medical R&D that directly benefits people by improving quality of life and lengthening lifespan.

Although the Department of Health is issuing vouchers under the Elderly Health Care Voucher Scheme (EHCVS)[24], these vouchers again demonstrates the government's disregard for technology since the vouchers cannot be used solely for purchasing medical equipment or products. The vouchers can only be used for preventive, curative and rehabilitative services, and possible products which can be purchased such as spectacles and walking canes cannot be purchased directly and require a referral from a medical professional. If the vouchers were to include technology products, the market would be able to open up more opportunities for entrepreneurs and investors, as more money will be injected into the gerontechnology industry. During a focus group session, our stakeholders have voiced their opinion on the voucher's lack of usability as being a waste since elderly seldom seek for medical services until they are ill.

Another example which can demonstrate the under-appreciation of technology within elderly care is the initial development of protective clothing which was originally developed as sportswear but was later reapplied to protect seniors from serious injuries due to falls. Few products are developed with the silver economy in mind, especially since not enough awareness is raised. Additionally, stakeholders have expressed that the concept of applying technology within the care system is still seen as a luxury, where not many elderly would purchase products or have the means to, and therefore finding funding to purchase these products is difficult since any spending towards gerontechnology products appears excessive. Currently, the understanding for the importance of technology within the industry is largely insufficient and could be greatly enhanced to stimulate more focus and solutions to improve elderly care.

[23] The Elderly Commission advises the HKSAR government and its departmental bodies such as the Social Welfare Department (SWD) on formulating and implementing elderly policies (Elderly Commission, 1997). The SWD implements and manages social security schemes - namely the Old Age Allowance and Old Age Living Allowance.

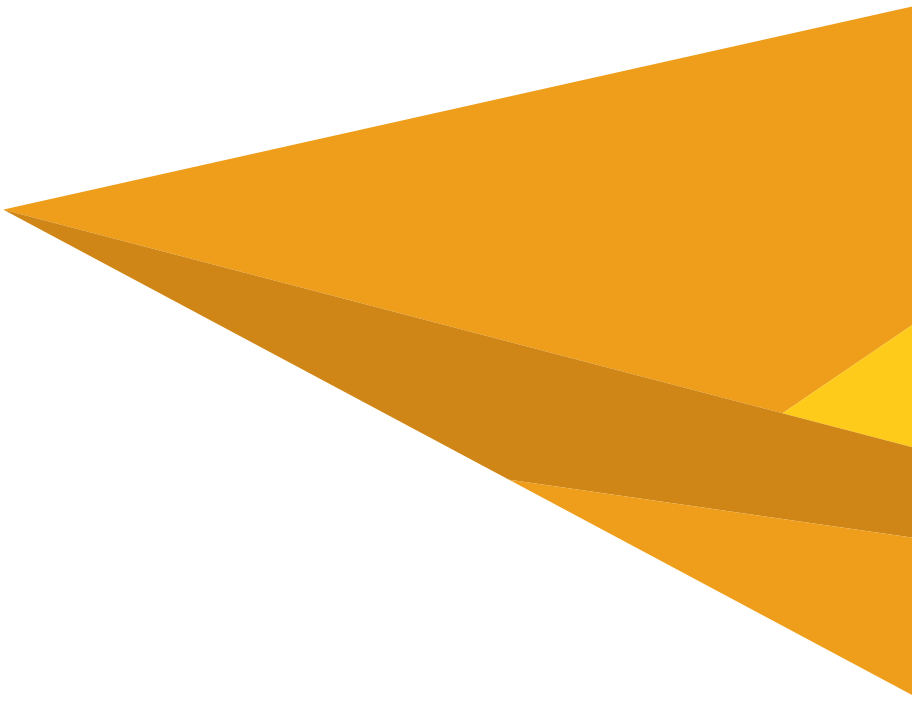
[24] EHCVS vouchers provide HKD 2,000 per year in subsidies for those aged 70 or above to spend on general medical health services and unspent EHCVS vouchers can be carried forward and accumulate to a maximum of HKD 4,000 (HKSARG, 2008).

To highlight the insufficient use of technology within the elderly health system, an obvious comparison can be made with Hong Kong's hospitals. Both facilities provide health care, though one is a short-term medical facility while the other is a long-term or end of life-care residential facility. Technology is incorporated within every aspect of a hospitals healthcare system in Hong Kong, from medical instrumental devices to help with diagnosing, treating and monitoring to software systems which helps with logging patient information, results and appointments. However, contrary to the healthcare system in hospitals, technology within elderly home centres has minimal technology to support with providing long-term care to the elderly, where even basic technology applications such as Wi-Fi is not a standard requirement for these residential centres.

Initially, hospitals were not inclined towards being technology friendly until the Hospital Authority Ordinance was established on 1st December 1990, this move by the government pushed forward the momentum for Hong Kong hospitals to modernize. Quoted from the Ordinance:

"The Authority may do all such things as are necessary for, or incidental or conducive to, the better performance of its functions and in particular but without prejudice to the generality of the foregoing, may erect, provide, equip, maintain, alter, remove, demolish, replace and improve the buildings, premises, furniture and equipment used by the Authority for the provision of hospital services"

The ordinance gave the Hospital Authority a certain degree of discretionary power to improve the public healthcare system. Changes were made to enhance the medical system, which was lagging in comparison to other international cities, through the use of modern technology. If the government was to implement a similar modification for Hong Kong's long-term elderly health care system, elderly home centres may receive the motivation and means to revamp the system and modernize their facilities and enabling a technology friendly environment.



3.1.2 HIGHLY RISK AVERSE (GAP 2)

Innovation, owing to its nature, brings some degree of risk and the fear of failure can be an innovation inhibitor. Rightfully the government has to carefully manage risks to protect the economy and the citizens' wellbeing. However, when too averse to risk it becomes increasingly difficult for innovation and technology to flourish within the city, therefore the right balance of risk and advancement is key to nurturing the gerontechnology industry. Presently, government owned and subsidized facilities prefer to implement mature foreign technology and tend to avoid using new local products due to the lack of beneficial evidence from insufficient usage experience. Yet, without the government taking a lead to use and test local gerontechnology products, other facilities and users' confidence in local developers will decline and will hence be less inclined to try these products, resulting in a vicious cycle. Stakeholders have expressed their frustrations with the pressure to take their local product abroad in order to gain foreign recognition before being able to gain acceptance by the highly risk averse government. A well-known example is the case regarding the Hand of Hope device which only gained recognition in Hong Kong after it had won an award at the International Exhibition of Inventions of Geneva, however only very small numbers of technology companies will be able to achieve international awards and many may not even get the opportunity to participate in these competitions. If the government was to be more opportunistic then the local gerontechnology startup industry will be able to gain more user-experience and recognition faster, hence boost the confidence of the local industry and retain more talent within Hong Kong.

3.1.3 OUTDATED REGULATORY SYSTEMS (GAP 3)

The government role is very important in promoting awareness and opportunities within the system. With technology developing at an increasingly fast pace, the government ensure its regulatory system is also kept up-to-date and interventions are made to regulate newly developed technology or alter past regulations to facilitate the advancement of innovation. An example of this is the need to define a clearer regulatory framework for devices such as wheelchairs, where there is currently no speed limit nor any compulsory insurance coverage. If an accident involving the use of an electrical wheelchair was to occur the person responsible is unclear and legal practicality becomes difficult. A regulatory framework can give more confidence to users and give a better guideline for developers to explore with. An example of an outdated system is The Drug Handling Manual for Residential Care Homes for the Elderly, the manual was compiled over a decade ago and forbids the combining of different resident's drugs, quoted from the manual:

"The drugs used by each of the residents (including drugs used when necessary) would be stored separately in the set cell within the medicine container, so as not to disturb the drugs of different residents. Each cell must only store one resident's drugs."

This drug management manual was designed a decade ago to reduce the risk of errors when distributing drugs manually, however with new technology these procedures can be automated using devices such as the Automatic Tablet Dispensing and Packaging System, for more detail see Section 3.6.4. Yet, as a result of the decade old drug management manual the use of this technology is halted even though the device would allow for a more efficient and safer drug distribution process.

Likewise, the Furniture and Equipment List for Care and Attention Home for the Aged Blind, Residential Care Home for the Elderly is also outdated. Not only is the list poorly compiled together but it also limits the range of products a residential care home can purchase through government funding. The list include items such as "specially-designed table for handicapped child" and "children chair" but not items such as wearable monitoring devices or GPS tracking systems which raises the question of whether the list is sufficient for present day elderly care. There is also an absence of a pilot scheme lead by the government to enable the testing and trialing of new technology products to be encourage institutions to integrate more gerontechnology within its care system and make advancement in the quality of care.

3.1.4 INSUFFICIENT RETIREMENT PROTECTION (GAP 4)

Hong Kong's population is to maintain a mild upward trend till 2041, while the workforce is predicted to show a slight negative growth starting from 2018 (HKSARG, 2014) and according to the Census and Statistics Department the trend for expectation of life at age 60, the number of years of life that a person aged 60 in a given year is expected to live, has been increasing steadily for the past 30 years, for more detail see Section 3.5.2.1 Longer life expectancies means financial uncertainties becomes increasingly problematic since retirement funds become increasingly difficult to save and estimate with regards to sustaining old age living. These uncertainties may be a contributing reason for the elderly population's reluctance in spending, and an obstacle to stimulating the gerontechnology industry. Although there are no signs of decrease in monetary support for the elderly from family and their children, with the decrease in number of children as well as the increase in number of single elderlies, the buffering effect of family support would likely wane (HKSARG, 2014).

The current existing retirement protection system may not be sufficient for providing support for retirement living. In Hong Kong, elderly support falls into three main categories - social security allowances, voucher schemes and "pension" initiatives (see Appendix for more detail). Yet, comparing the replacement rate[25] for the average income of Hong Kong to OECD and G20 Countries, Hong Kong ranks the lowest at 34.8% and 31.5% for male and female respectively (OECD, 2013). Stakeholders from the Future Development of Retirement Protection in Hong Kong research report expressed their concern and difficulties in making plans for retirement living.

Even though the Mandatory Provident Fund (MPF) has helped reduce the number of retirees in need of Comprehensive Social Security Assistance (CSSA) during the earlier years of retirement, the MPF can only provide a short-lived retirement protection for retirees with lower-income (HKU Department of Social Work and Social Administration, 2014). A better retirement protection system is needed if the elderly is to have a sustainable life after retirement which in term will increase the inclination towards spending for the elderly and subsequently boost the gerontechnology industry. The government has launched two relatively new "pension" programmes, the Reverse Mortgage Programme and the Life Annuity Scheme in recent years, in hope to improve the retirement protection for the elderly. However, since the two initiative are at its early stages, the popularity and effectiveness of the schemes is still up for discussion.

[25] Replacement rate is the percentage of a worker's pre-retirement income that is received through pension programs upon retirement.

3.2

APPLIED RESEARCH STAGE

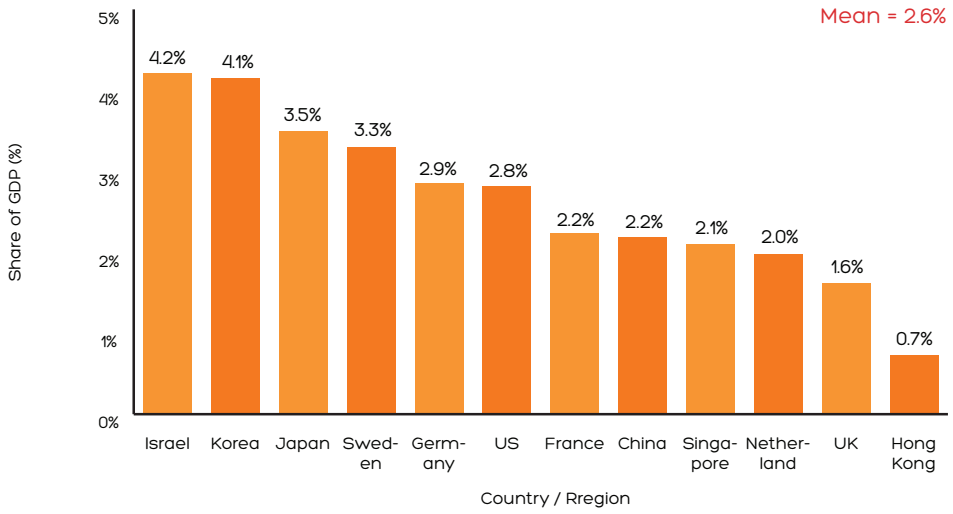
The applied research stage is critical for innovation and technology breakthroughs in gerontechnology which are made through research and development. The applied research consists of midstream to downstream research involving practical application of science, the majority of this section can be applied to the innovation and technology industry in general as R&D is the very foundation for technological advancement. The gaps and difficulties within this stage includes the shortfall in funding for applied research from both the public and business sector, the lack of human resources especially those who specialize in both health and technology, and systematic issues in academia such as the skewed credit assessment system for funding.

3.2.1 SHORTFALL IN APPLIED RESEARCH FUNDING (GAP 5)

There are two main sources for R&D funding: 1) the Government and 2) the Business Sector. Even though overall Hong Kong government research funding is low as a percentage of GDP, at 0.4% of GDP and the total research funding from business and government in Hong Kong being a mere 0.7% of GDP, the under-investment in applied research is evidently more notable, and thus even more so for research on gerontechnology (Figure 3.3). Japan in comparison has a total R&D spending of 3.5% as a percentage of GDP which is significantly more but has also chosen specific industries that can benefit the ageing population to support. The Japanese government has outlined R&D support specifically for the medical and pharmaceuticals sectors. The Ministry of Economy, Trade and Industry gave 24 selected companies, including the Toyota Motor Corporation, subsidiaries to develop nursing care robots (Iida, 2013). The government has also stepped in to assist the trialing of products - the Ministry of Health, Labour and Welfare recommended 15 nursing robot makers to 20 nursing homes to join a trial initiative attempting to familiarise nursing homes with robots (JIJI, 2013). Government support for nursing care robot equipment is expected to increase from an estimated JPY 16.7 billion (HKD1.1 billion) in 2015 to JPY 404.3 billion (HKD 29 billion) by 2035 (Japan Economic Newswire, 2013). The US has also jumped on the bandwagon for robotics - U.S. Robotics Roadmap policy framework in 2009 defined a development for robotics, with an emphasis on autonomous vehicles and providing assistance to live in old age (Klimczuk, 2012). Although in the 2017-2018 Budget Speech Hong Kong outlined government plans to reserve HKD 10 billion to support innovation and development, as well as a proposal to set up a new HKD 2 billion Innovation and Technology Venture Fund (ITVF) to encourage private investment in local startups (HKSARG, 2017), these funding allocations are for the general Innovation and Technology industry and not specifically for gerontechnology industry and innovations that will benefit the elderly.

Figure 3.3: Total R&D Expenditure as a Percentage of GDP, 2013

Note: * 2012 for Singapore and 2013 for all others
Source: Our Hong Kong Foundation (2015)



As mentioned earlier in Chapter 3, there are five R&D centres in Hong Kong but there is currently no formal entity that is dedicated to researching and developing gerontechnology in Hong Kong. Only three of the five research centres, Hong Kong Research Institute of Textiles and Apparel, Hong Kong R&D Centre for Logistics & Supply Chain Management Enabling Technologies and Hong Kong Applied Science and Technology Research Institute, set up by the ITC have produced gerontechnology related products. Yet, even after setting up these centres the funding for applied research is still fragmented and the approval requirements are exceedingly restrictive and inflexible, which may subsequently defer incentives for generating R&D projects. Although strategically focused, there are opinions that the R&D initiatives funded by the HKSAR Government are by and large short-term-oriented and too dispersed (OHKF Innovation and Technology Report, 2015). This hinders the building up of research scale and excellence (Shih and Chen, 2010).

The business sector constitutes a key component of an economy's technology and innovation ecosystem. For most OECD countries the largest component of R&D spending, as seen in Figure 3.4 more than half of most economies' total R&D spending approximately 60-70%, comes from the business sector. Typically businesses collaborates with universities and research institutes in R&D. Owing to their market orientation, businesses are often major drivers of research commercialisation of innovation concepts and prototypes (OHKF Innovation and Technology Report, 2015). As Guellec and van Pottelsberghe (2001) point out, business R&D often results in higher quality of output, as well as in new goods and services. Many empirical studies conclude that business R&D matters to productivity. Moreover, analysis done by Guellec and van Pottelsberghe (2001) suggests business R&D increases the ability of the business sector to absorb technology coming from abroad, government, and universities. In other words, the high spill-over effects mean business R&D offers more than private return. However, relative to other wealthy parts around the world, Hong Kong's business sector spends significantly less on R&D and comprising of less than half of the Total R&D spending, as shown in Figure 3.4 and 3.5.

Figure 3.4 Business Spending on R&D as a Percentage of GDP, 2013

Note: * 2012 for Singapore and 2013 for all others
Source: Our Hong Kong Foundation (2015)

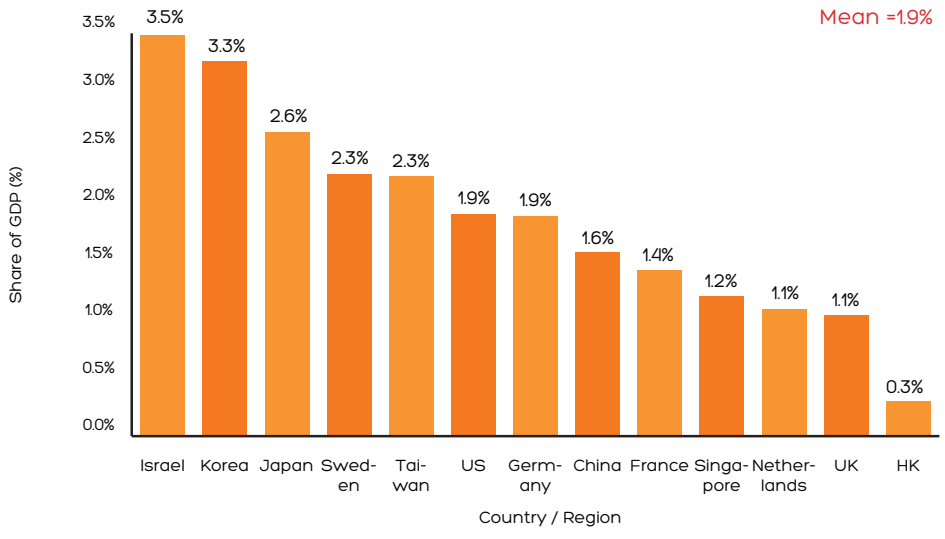
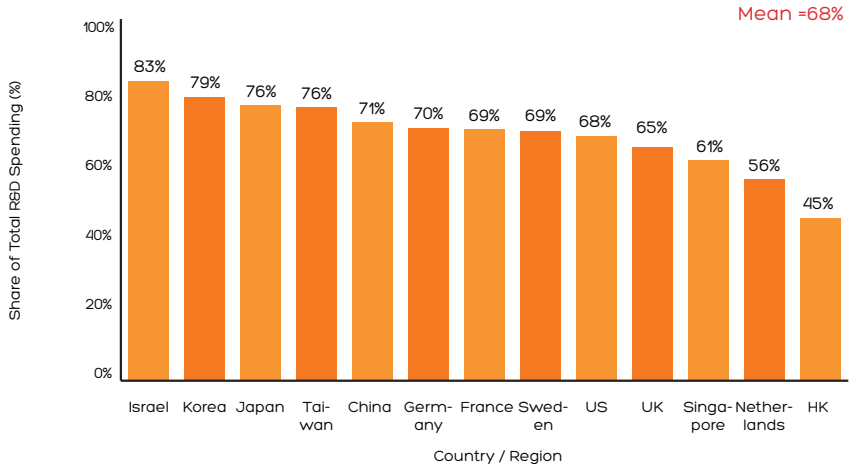


Figure 3.5 Business R&D Spending as Percentage of Total R&D Spending, 2013

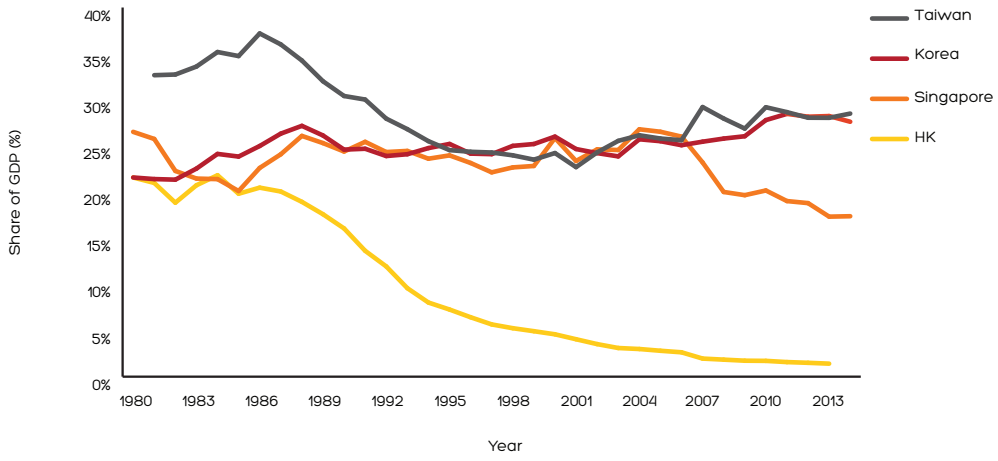
Note: * 2012 for Singapore and 2013 for all others
Source: Our Hong Kong Foundation (2015)



According to the OECD, the manufacturing industry is the major driver of an economy's innovation and technology. Manufacturing firms tend to undertake more in-house innovation and are more likely to introduce new-to-market innovations than service firms in general (OECD, 2010). However, many Hong Kong industrialists took advantage of the cheap labour brought about by the economic modernisation of Mainland China post World War II, and relocated their factories across the border to drive down costs. This cost-down focus distracted many Hong Kong businesses in the past decades from building a more sustainable competitive advantage via technology upgrades (OHKF Innovation and Technology Report, 2015). Today, Hong Kong's manufacturing sector is small compared to regions with otherwise similar economic makeup, see Figure 3.6. This smaller manufacturing scale is another possible explanation of the relatively low level of business R&D and related incentives (Guellec & van Pottelsberghe, 2001). Another possibly explanation is the absence of preferential profits tax treatment for cooperates that are designated as "high tech" or innovative technology, if Hong Kong was to offer tax credits, particularly for socially beneficial technology such as gerontechnology, then the business sector may be more likely to invest in R&D.

Figure 3.6 Manufacturing Sector as Percentage of GDP, 1980-2013

Source: Our Hong Kong Foundation (2015)

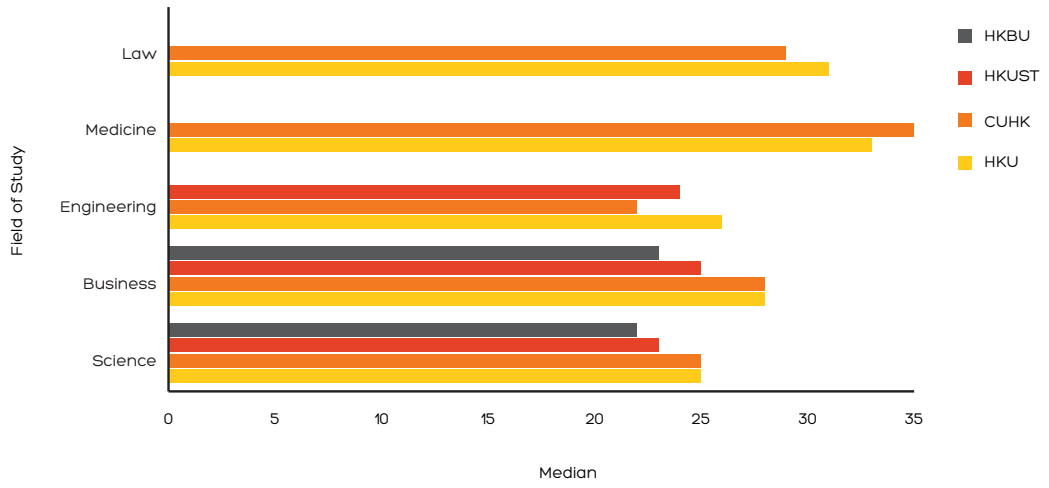


3.2.2 LACK OF HUMAN RESOURCES (GAP 6)

Human capital is one of the essentials of innovation and technology and education plays an important role in nurturing these talents. However, despite Hong Kong universities' academic excellence, with several Universities ranking in top 30 for subjects such as computer science, mathematics and electronic engineering globally. Hong Kong ranks relatively low in "Capacity for Innovation" - 29th and "Availability of Scientists and Engineers" - 43rd according to the 2016-2017 Global competitiveness report by the World Economic Forum (World Economic Forum, 2016). STEM programmes in Hong Kong fail to attract high caliber students with the best academic results. As shown by universities' admission medians, See Figure 3.7, the admission requirements for engineering and science degrees is significantly lower than those of law, medicine and even business programmes. On the other hand, world class universities from other economies have seen a higher percentage of their best students study STEM degrees compared to Business degrees.

Figure 3.7 Hong Kong University's Admission Median, 2014

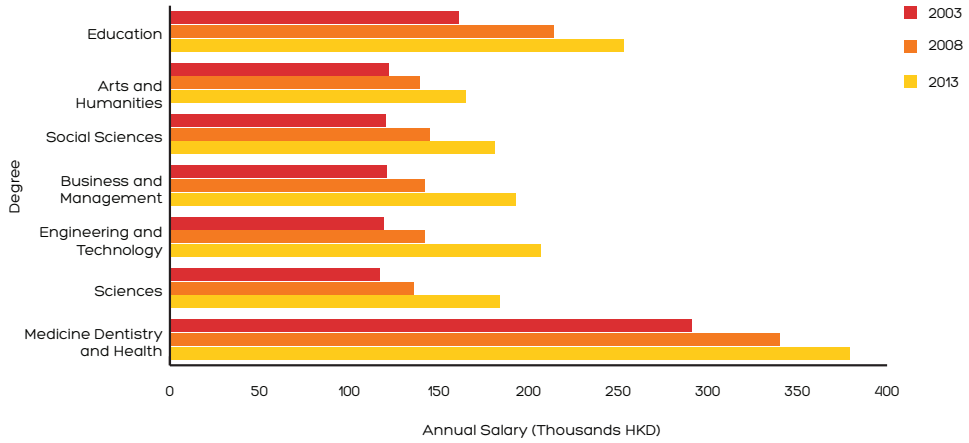
Source: Our Hong Kong Foundation (2015)



One possible explanation for this phenomenon is the limited career prospects and unattractive income, see Figure 3.8. Hong Kong, an international financial hub, has focused predominantly on the financial and service sector, whilst the emphasis on innovation and technology industry has had significantly less weighting, and hence when comparing the development between the two industries the inferiority of technology within Hong Kong becomes much more obvious. Not only was the average salaries of engineering and science undergraduates considerably lower but the number of jobs available in the IT industry only accounted for a mere 0.9% of total employment in 2013 (OHKF Innovation and Technology, 2015).

Figure 3.8 Average Annual Salaries of Undergraduates of Different Degrees, 2003, 2008 and 2013

Source: Our Hong Kong Foundation (2015)



Despite engineering and technology programmes making up for the largest student population in research postgraduate studies. In 2013, there were 1,224 science and engineering & technology postgraduates, more than the combined population of other research postgraduate programmes. However, only a small portion, 133 in 2013, ended up in non-academic professions related to their studies (OHKF Innovation and Technology Report, 2015). The key question is whether these talents are familiar with both technology and healthcare but also willing to enter the gerontechnology start-up field instead of the stability of a hospital career. Thus, the combination of all the reasons mentioned will have a negative effect on both the quality and quantity of human resources within the Gerontechnology industry and hinder the advancement of Hong Kong's elderly living standard.

3.2.3 SYSTEMIC ISSUES IN ACADEMIA (GAP 7)

Hong Kong assesses its academics through a performance-based evaluations system called the RAE. The system assesses the research capability of Hong Kong's higher educational institutions in allocating institutional funding for research. The RAE adopted by the research portion of the UGC Block Grant is heavily focused on academic output. According to the UGC (2013) the weighting is divided into three different categories,

I. 80% of the weight is based on the quality of research outputs;
II. 10% of the weighting correlates with research inputs, i.e. the number and magnitude of external competitive peer-reviewed research grants received; and
III. 10% of the weight is centered towards esteem measures e.g. awards and editorship in prestigious academic publications

Although the RAE adopts an inclusive definition for research output covering publications, patents artefacts, that are publicly accessible, contains an element of innovation and contributes to scholarship, according to the Innovation and Technology Report by Our Hong Kong Foundation the majority of academics engaged had noted that publication remains the dominant output in RAE, thus implying that the KPIs for universities research efforts are skewed towards publication.

Hong Kong's credit system is lagging behind in comparison to other advanced economies, the credit system does not account for the impact produced by applied research. Consequently causing there to be a lack of incentive for academics to pursue projects in applied research rather than basic research which traditionally allows for more publications. United Kingdom, who share remarkable similarities to Hong Kong when assessing their academics, began to give additional recognition to non-academic impact in 2014. Even though academic outputs remain as the most valued item (65%) of the Review Excellence Framework (REF) assessment, it also gives a 20% weighting to the "reach and significance" of research impacts on the economy, society and/or culture with the remaining 15% is weighted on the contribution made to the vitality and sustainability of the wider discipline or research base (REF, 2012). Professor Dame Ann Dowling's 2015 review of business- university research collaborations has confirmed that this additional credit rewarded towards impact on the economy and society in the REF has triggered university and academics to change the way in which university-business collaborations are viewed and valued. Therefore, impact appears to have been a useful tool in encouraging for downstream innovation which if applied within the Hong Kong assessment system could help promote the research committed towards elevating to the elderly community and the gerontechnology industry. The Government announced in the 2017 Policy Address an allocation of a one year time-limit for the UGC to develop a plan to include research impact and effectiveness of knowledge and technology transfer when reviewing on the allocation of research grants. This was recommended previously in Our Hong Kong Foundation's The Ecosystem of Innovation and Technology in Hong Kong Report in order to promote more impactful and translational applied research projects that benefits the society. Analysis in the future will be required to determine whether or not the new assessment criteria is sufficient enough in assisting with the expansion of applied research in Hong Kong.

3.3

PROTOTYPE STAGE

The prototype stage is the initial stage for when technology is transferred from being research to commercialisation, where the early model of a product or service is built and tested. This stage is where most guidance and changes are needed for developers, but it is also the stage in which small-to-medium sized technology firms have difficulty in finding funding hence leading to the term "The Valley of Death". The current gaps and difficulties identified include the obstacles faced when spinning-off from universities and research centres, the lack of support for start-up companies and the risk of sharing ideas when manufacturing the product and pitching to potential investors.

3.3.1 OBSTACLES IN SPIN-OFF AND LICENSING PROCEDURES (GAP 8)

An intellectual property (IP) is a creation of the mind which is protected by the law, such as patents, copyrights and trademarks, allowing inventors to gain recognition or financial benefits from their inventions. There is a strong positive correlation between the number of IPs, technology transfer and development for the advancement of a region. Technology IPs are evidence of innovative breakthroughs which can then later be commercialised for public good. In terms of the total number of IPs, Hong Kong compared to other cities is largely inferior, and this can be shown by comparing the total number of different types of patents. The most relevant type of patent for Hong Kong is the Patent in Force in Mainland China and according to the Census and Statistics Department and the State Intellectual Property Office of the PRC, Hong Kong had a mere total of 621 while Shenzhen has a total of 16,956. As for Patents in Force in the United States, which is the most recognisable type of patent in the world, Hong Kong's most active companies and organisations, such as ASTRI and Johnson Electric, only has around 20 to 30 while companies in Shenzhen, such as Huawei and Huaxing Photoelectric Technology Limited, has over several hundred. Hence emphasising the insufficient number of gerontechnology IPs found in Hong Kong.

In order for companies to spin-off from university research projects, a licence of the IP in question is required from the university or owner. This license gives the user permission to exploit the IP, this license maybe exclusive, sole or non-exclusive. Licensing is the most common mechanism for technology transfer to take place, where by the developer of the IP transfers the technology to a user or commercialiser of the IP. According to the University of Hong Kong's Technology Transfer Office, the timeframe for licensing an IP with Hong Kong Universities varies from case to case, with startup companies requiring a substantially longer timeframe. Stakeholders have stated from past experience these processes can take up to years. A stakeholder has expressed their dissatisfaction with the slow and tedious system, even in the case where the applicant for the license was part of the research team for the technology the process still took a total of three years. During this timespan, companies are forced to be inoperative and may lose out on their competitiveness or even abandon the project from discouragement. In comparison to mature industries, attracting talent to pursue a career in gerontechnology is already difficult but with long unnecessary procedures such as the licensing process, incentivising entrepreneurs to take initiatives in improving the elderly health care services will be made even more formidable.

3.3.2 LACK OF SUPPORT FOR START-UPS (GAP 9)

There is a lack of support for Hong Kong gerontechnology companies in overcoming a common issue termed the "Valley of Death". The valley of death is a funding gap that start-ups often face in the later stages of prototyping and throughout the product enhancement stages because venture capitalists prefer to invest at the later stages of a business's development when more information is available and the firm faces a lower risk of failure. As a result, the lack of funding makes it difficult for firms to successfully commercialise their business idea (National Research Council US, 2007). In the US, there exists a funding scheme called the Small Business Innovation Research (SBIR) programme, which is a competitive awards-based programme that helps early stage small businesses aiming to commercialise technologies cross the valley of death. In Hong Kong, while the ITB has proposed setting up a HKD 2 billion Innovation and Technology Venture Fund (ITVF) to encourage more private investment in local startups by co-investing with the government (HKSARG, 2017) this new initiative has yet to be implemented and at the moment there is minimal support for local start-ups in crossing funding gaps. The gerontechnology industry is currently still at a very early stage and the number of start-ups in this field is also relatively small. These characteristics make it difficult for startups to get government funding, as they might go to start-ups from more mature and competitive industries. Thus, there is room for improvement for providing funding support to startups in Hong Kong.

The small size of the gerontechnology industry in Hong Kong also hinders effective clustering and networking. Although there has been a surge in accelerator programmes and networking events from public and private incubators and universities in the past year or so, they are often fragmented and lack critical mass to make an impact. Very little guidance and information is available to support early stage start-ups with setting up, pitching and finding manufacturers. Even when startups manage to claim a placement within the limited amount of incubation and accelerator programmes, according to the Innovation and Technology Bureau, mentorships are only typically range from 18 to 24 months. Moreover, social attitudes and support towards failure are immature and weak. Among the younger generation in Hong Kong, the culture of risk aversion still dampens entrepreneurship in general (Compass, 2015). A better support system for entering the start-up industry as well as during the early prototype stage could incentivize young potential entrepreneurs to pursue a career in innovation, rather than be deterred by the daunting nature of the unknown.

As suggested by stakeholders consulted in the OHKF Innovation and Technology Report, 2015, there is little interaction between various start-up clusters that exist among foreigners, who mostly locate in Sheung Wan, with the more local ones either incubated in the Hong Kong Science Park and Cyberport or in various private entities. There is no support with promoting more interaction between the two different clusters. This separation between clusters will hinder the benefits of agglomeration, where by the effects of competition, such as the increase of productivity, drive in innovation and stimulation of new businesses, will not be at its full potential. Bringing awareness on the different existing start-ups within the community can allow potential talent to be educated more about the different opportunities within gerontechnology.

3.3.3 RISK OF IDEA SHARING (GAP 10)

The open sharing of knowledge and collaboration between businesses and organisations is most often beneficial - it can enhance R&D, bring new insight and invaluable perspective to existing ideas, create new business contacts and speed up the commercialisation process. It is part and parcel to business development. However, the sharing of ideas between different parties does not come without risks. One of the greatest liabilities is theft of an original business idea by competitors or other business groups.

Local Hong Kong start-up companies have voiced fears of having their business ideas and intellectual property stolen by competing firms, and especially by competitors that already have the capital, resources and technical know-how to bring the business idea to market more quickly than themselves. It was also highlighted during interviews that once a competitor has stolen the business idea, it is very difficult to legally prevent the thief from further developing and profiting from the idea, particularly in regions where the rule of law is weak.

There is also a risk of start-ups pitching their ideas to supporting partners, such as angel investors or venture capital firms. These partners may take aspects of a start-up's business idea or strategy and share it with other firms they have equity in to improve their business prospects, in the hopes of profiting from it. Furthermore, investors prefer investing in start-ups with cutting-edge technology or a high level of complexity in comparison to gerontechnology companies which tends to encompass products that are consumer based and involve little to no breakthrough science. The nature of gerontechnology products means the risk of replication by competitors is very high and therefore the market share gained of an already small market is even less.

3.3.4 EXHAUSTING REGISTRATION PROCESS FOR MEDICAL DEVICES (GAP 11)

Gerontechnology products face an additional barrier in commercialisation, as some products may be classified as medical devices[26]. Medical devices require additional certifications and time-consuming registration that non-medical devices would not in order to be successfully sold to the local Hong Kong market. Medical devices in Hong Kong are overseen by the Medical Device Control Office (MDCO). Registration with the MDCO is currently voluntary, but private and government hospitals prefer MDCO-approved devices to ensure the product is safe, good quality and allowed[27] in the local market and they may become "mandatory requirements". This process creates additional costs to gerontechnology producers and takes a significant amount of time, anywhere from 8-12 months (Emergo, 2017), making it an additional difficulty firms must overcome and the commercialisation process more complicated for gerontechnology companies.

[26] According to the MDCO, a medical device refers to any instrument, apparatus, appliance, material or other article, excluding drugs, used for human beings for diagnosis, prevention, treatment, monitoring of diseases or injuries; or for rehabilitation purposes; or for the purposes of investigation, replacement or modification of body structure or function. An accessory to a medical device is subject to the same regulations that apply to the medical device itself.

[27] Registration of products with the MDCO requires an ISO 13485:2016 certificate from a certification body, evidence of marketing authorisation (CE-marking certificate from Australia, Canada, the EU, Japan or FDA 510(k) letter from the US) and a Hong Kong in-country representative (a Local Responsible Person).

3.4

ENHANCEMENT STAGE

The enhancement stage is when companies refine the design of their products for the target consumer market. Tailoring and honing product or service design is a crucial part of the business development process, as it has the downstream impacts on how well the product sells once it has reached the market. The business ecosystem in Hong Kong presents a number of gaps and difficulties to gerontechnology start-ups at the enhancement stage - poor product design that fails to carefully consider elderly tastes or the external effects utilising a new technology might have on the daily lives of seniors or the workflow of caregivers, the lack of a testing ground for refining product function or design, and differences in culture and difficulties in product localisation.

3.4.1 PRODUCT DESIGN NOT CATERED TO ELDERLY CONSUMERS (GAP 12)

A gap highlighted during stakeholder interviews is that many locally produced gerontechnology products are not sufficiently designed and tailored to the needs and wants of elderly people and caregivers. Poor product and user experience design is a consequence of insufficient user testing during the enhancement stage. Entrepreneurs understandably focus more on ensuring the product or service achieves the core function, but they may neglect other important aspects of the user experience, such as whether the technology might be too complicated for the elderly to use and whether it creates external side effects that prevent the technology from seamlessly integrating into the daily lives of end users. For instance, stakeholders have commented that alarm systems for alerting caregivers for regular routine incidents can create additional stress for workers. Caregivers must supervise not just one, but many elderly persons and they have a strict time schedule to follow. Alarm systems should ideally only notify caregivers for emergencies or critical issues, such as if a senior leaves the elderly home alone - otherwise, the alarm system may disturb and disrupt the workflow of a caregiver. If the technology does not assimilate well and creates additional work for the user, it may result in abandonment of the product. Some products might be very costly to produce, so a difficulty firms may encounter is they are unable to make enough products to test with a large group of users to collect sufficient user feedback. This is particularly the case with more advanced technologies, such as robotic devices like Hand of Hope, a robotic hand used for stroke rehabilitation. Moreover, firms might find it difficult to access elderly opinions as they may be hard to contact. However, design consultancies could be hired to facilitate market research and user experience testing for gerontechnology products, although it appears this is not a common practice for entrepreneurs in Hong Kong and highlights a lack of collaboration between different stakeholders.

Another issue concerning product design is that many local gerontechnology products made for use by seniors give them the impression of being sick and disabled, an appearance and stigma they are opposed to. Products nowadays not only have to be functional, but must also possess design that appeals to elderly tastes. Products that take this into consideration can perform much better than those which do not. For instance, regular traditional wheelchairs connote an image of physical disability, but motor powered wheelchairs that are newer to the market and are designed to look trendier, might eliminate the negative impression. However, designing a product to look fashionable might not be applicable for many products and it is not the product's main purpose anyway. Products might be age-friendly, but not tailored specifically to an elderly cohort.

3.4.2 LACK OF A TESTING GROUND FOR NEW PRODUCTS FOR USE IN ELDERLY HOMES (GAP 13)

The lack of a testing ground for products and services is a significant gap in the gerontechnology ecosystem. In the later stage of product development, new products require thorough market research and in particular, user feedback during the development process to turn a prototype into a final product that is targeted and tailored to elderly consumers. The user feedback would be crucial for product improvement, allowing the product to better fit the user requirements and therefore helping the R&D to succeed. However, as stakeholders revealed, Hong Kong currently lacks of testing grounds for new gerontechnology products.

Residential Care Homes for the Elderly (RCHEs) are favourable testing grounds for gerontechnology products in development stage. RCHEs provide a real and practical environment with large number of testers (residents and care workers). In Hong Kong, RCHEs faced significant manpower shortages (Audit Commission, 2014). Care workers in RCHE were under huge workload and tension[28]. Stakeholders stated that adapting a new assistive device took time and was not easy for these care workers, which were lower educated. Involving in gerontechnology product testing would increase workload and lower their efficiency of work at the beginning, as they need to be trained, to learn and to practice using the technology.

Some of the new products would facilitate the care workers' work efficiency later, while some would fail and not improve their work at all. Testing a fail product would end up wasting the care worker's time in the testing period and provide no benefit to the RCHEs. Hence to the RCHEs, new product testing is a speculation with a high cost, stakeholders said. It is unsurprising that RCHEs are not keen to test new technologies, but turn to enjoy the matured products that have been proved for quality by their peers, or use the resources to hire more labour instead. As a result, product developers can hardly find a suitable testing ground for their products. Not only would the developers receive insufficient user feedback before launching the product, but also the RCHEs would have limited experiences in using various technology products.

[28] According to the Hong Kong Council of Social Service's 2013 survey of 174 elderly service units, there was a high turnover rate of more than 20% for personal care workers.

3.4.3 CULTURAL DIFFERENCES AND DIFFICULTIES IN PRODUCT LOCALISATION (GAP 14)

There are examples of commercially successful gerontechnology products overseas - they are functional, well designed with seamless user experience and are well-received by the target consumer market. In theory, they should also be successes if brought into Hong Kong or if they were reproduced by local companies for the Hong Kong market. Yet this is not the case, with a major reason being cultural differences between economies - a product that suits one market may not for another. The importance of considering the differences in culture during product enhancement can be illustrated through a number of examples.

For instance, bathing is an important ritual in Japanese culture but this is not the case in Hong Kong, where showering is more common. If a commercially successful assistive bathing device from Japan were brought to Hong Kong, it would be unlikely for the device to be as successful due to the lack of a bathing culture in Hong Kong. Another example would be elderly-friendly mobile phones, which meet the needs of Western families, where the elderly often live separately from family (informal caregivers) as well as further away because buildings are generally more spread out, compared to Hong Kong, where it is more common for multiple generations to reside in the same house, and even if seniors lived separately, due to the more compact structure high-rise structure and higher urban density of a city like Hong Kong, there would be relatively little need for the mobile device.

In addition to cultural differences, another difficulty in developing gerontechnology products for a different market is product localisation. GPS tracking shoes developed in the US were successfully sold to the local American market and could be refined and localised for a Hong Kong market. However, because Hong Kong's gross elderly market is small compared to other markets, such as its mainland neighbour[29], it would be too costly to localise a product for smaller market when more lucrative business opportunities are available elsewhere. With technologies produced in a foreign language, they could be easily translated into the local language and should be commercially successful if brought into a new market. However, the issue lies in localisation costs being too high for a small market size. Another case is a cognitive assessment mobile application designed for the elderly to help them improve cognitive function. This mobile application was produced with Western end-users in mind, but when brought into the local Hong Kong market, there was no product localisation. Hong Kong elders may not be familiar with Western animals, such as a rhinoceros or a hippopotamus, and therefore may not be able to recognise them while playing cognitive games in the application.

It is clear that cultural differences and difficulties in product localisation are major hurdles to the successful development and commercialisation of gerontechnology products in Hong Kong.

[29] Hong Kong's elderly population above the age of 65 was 1.12 million in 2015 and is expected to rise to 2.58 million by 2064 (Legco, 2015). Mainland China currently had 123 million people aged 65 or over in 2013. This figure is expected to rise to 330 million in 2050 (Population Research Bureau, 2010).

3.5

GERONTECHNOLOGY MARKET

The gerontechnology market is still at a very early stage in Hong Kong but with an ageing population, the market will slowly become increasingly important. In this section, the market is divided into two groups: 1) Producers; and 2) Consumers. The gaps and difficulties which are affecting the producers the gerontechnology industry consist of the limited profitability due to a small market size, poor market and product segmentation and risks involving a rental business model. On the other hand, the issues which may affect consumers are problems such as the gerontechnology products being too expensive for the elderly and unnecessarily exhausting procurement procedures.

3.5.1 PRODUCER

3.5.1.1 Limited Market Size (Gap 15)

The decline in fertility rates and the increase in life expectancy has led to a growing elderly population. As mentioned in Chapter 1, by 2040 approximately 30% of the population will be aged 65 or above in Hong Kong and with the baby boomer generation, who are generally more technologically savvy and wealthier than the previous generations, entering old age, the gerontechnology market is becoming increasingly more promising.

In spite of this, when compared with other demographic locations, Hong Kong's gerontechnology market is still too small. In Hong Kong, according to the Social Welfare Department and Census and Statistics Department, there are a total of 924 residential care homes for elders and 1.19 million elderly, which equates to 16.2% of the total population. These figures in comparison to Mainland China's 27,903 elderly residential care homes and 130.97 million elderly is miniscule (China Statistics Press, 2014). With the gerontechnology industry still being at its early stage, Hong Kong's small market size in comparison to other places, such as Mainland China, limits the potential profitability for companies, and therefore may reduce the incentives for developers and investors to pursue their innovative venture within the city. The sector within Hong Kong is also poorly defined, there is no information available on the precise market size or the total capital and spending power of the elderly population within Hong Kong. If a clear outline of the industry is defined and made available, with the different gaps and products needed within the elderly industry is stated, then it will enable a better understanding of the sector. This information could incentivise start-ups and companies to invest, as there will be less uncertainty and a stronger sense of market demand.

3.5.1.2 Poor Segmentation (Gap 16)

The current gerontechnology industry lacks market segmentation, rather than aggregating prospective buyers into groups with common needs and purchasing power the current industry is groups all consumers into one unified category. For example, there are hundreds of different types of baby prams, ranging from basic non-foldable prams to luxury multifunctional prams which can be later adjusted as the baby grows. Yet, the variation of wheelchairs, which is also for transportation, is minimal. The variance is between whether the wheelchair is mechanically or electrically powered and whether it is foldable. Market segmentation can enable companies to target different consumers from different categories and maximize its overall efficiency in marketing to the correct group, hence having a better chance at gaining a share of the specific target market through different advertisement strategies.

If a single type of product was to have minor variations to target different consumer groups, then the chances of the product succeeding may increase by minimising the risk through spreading the product across several target market groups rather than selling the product within a single market. If Hong Kong's market is too small for market segmentation then segmentation through selling variations to different regions could be considered, such as selling masses of lower-end products with smaller profit margins to Mainland China to compete with cheap labour cost and higher-end products to Europe and the United States due to higher production cost. By selling sister models of the product at different prices to different segments, even if one segment reacts poorly another may respond positively. Hence, over time analysis can be made to refine the various needs and preference of the gerontechnology market segments and developers can identify the different market requirements.

3.5.1.3 Rental Risks (Gap 17)

A rental business model may be able to provide benefits for both gerontechnology companies as well as consumers, these innovative rental services can increase the number users subscribing to the service but also reduce the prices for the customers. However, this business model comes with risk due to the nature of the industry, stakeholders have revealed their concern for the potential publicity problems when redeeming rented products from poor seniors, who can no longer afford for the service, causing issues with the company's image profile even if its action is in accordance with the law. Incidents where elderly refuse to pay for their rental subscription becomes problematic, as a decision is then required for the length of period in which an overdue payment can be allowed before cancelation of the service for the user, common products which faces these problems include the widely subscribed 24-Hour Personal Emergency Link Service. Secondly, investors are reluctant to invest in the rental market due to the relatively slow turnover time unless the market size is considerably large enough which the gerontechnology market within Hong Kong is not.

3.5.2 CONSUMER

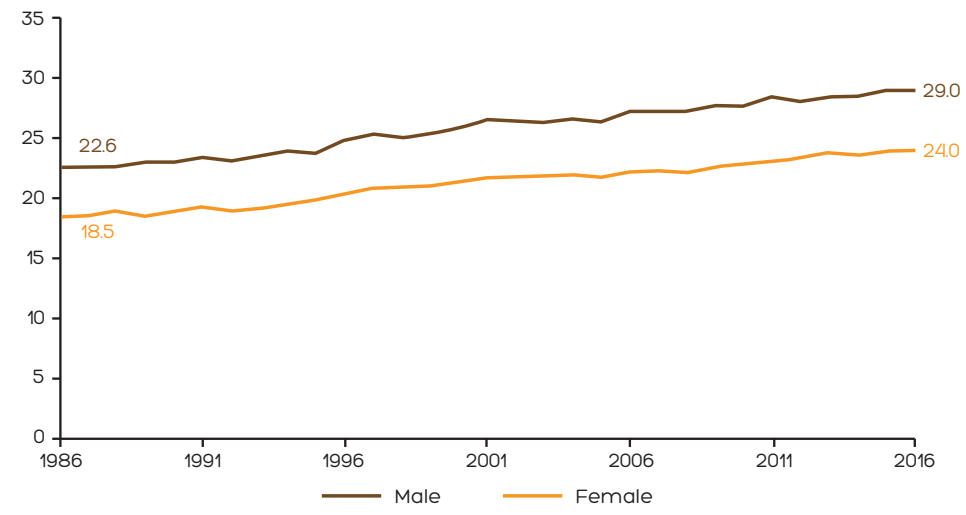
3.5.2.1 Gerontechnology Products Are Too Expensive for Elderly (Gap 18)

Elderly people in Hong Kong generally think most of the gerontechnology products are too expensive. For example, the Hand of Hope costed about HKD 300,000 when it was just launched. Even though the producer has worked hard to depress the price of the product to about HKD 200,000, it is still hardly affordable by the general elderly population.

In the last three decades, the life expectancy at age 60 in Hong Kong had been increase from 22.6 to 29.1 for female and from 18.5 to 23.8 for male (Figure 3.9). The extension in retirement life might not be taken into account in retirement planning of elderly people when they were still working. Moreover, the uncertainty in when the elderly people will actually end their lives put weights on the post-retirement financial planning. As discussed in Section 4.2.1, the retirement protection system in Hong Kong was to be improved. With the risk of outliving their resources, elderly people were forced to reduce their standard of living at old ages, and thus their spending.

Figure 3.9 Life Expectancy at Age 60 by Sex, 1986-2016

Source: Census and Statistics Department (2017)



Some interviewees reflected that some elderly refused to purchase their product or subscribe to their service unless it is very cheap or even free of charge. Some children of elderly also said that they had to cheat on their parents that the gerontechnology product is free, while they actually pay for it.

3.5.2.2 Exhausting Procurement Procedures (Gap 19)

On the other hand, the exhausting procurement procedures of government or NGO funded elderly homes and centres prohibited the use of gerontechnology in institutions. For these elderly homes to purchase technology products, extensive amount of support evidence of benefits, e.g. proof of efficiency, is required to convince and persuade their funders. Stakeholders reflected these procedures are exhausting and usually take a long time.

Furthermore, the procurement regulations of these institutions make the purchasing of new gerontechnology products difficult. Institution staffs usually find it very difficult, if not impossible, to have more than one price quotations for new gerontechnology products, which is required by the regulations of their funders.

In contrast, staff hiring procedure is much more convenient and smooth. As a result, institutions would prefer hiring more staffs instead of purchasing gerontechnology products, even though the latter is cheaper and more efficient in the long run. However, the labour force in this industry is undoubtedly in shortage, not even mention the labour force will further drop due to population ageing.

3.5.2.3 Refusal to Accept Products with New Technology (Gap 20)

Stakeholders revealed that elderly have strong customer loyalty. They usually tend to favour the products that they are familiar with and thus refuse to use new technology. For example, a stakeholder recall that an elderly prefer to use cathode ray tube television (old-fashion, large in size) rather than led television as the elderly intuitively believed led televisions are non-durable. The elders also have little knowledge in new technology and they might be afraid of breaking the device. Moreover, the elders are afraid of being deceived. Stakeholders said that there are a lot of gerontechnology products who make false or exaggerated statements on their functions. Some elderly people might not be able to distinguish between the true and false information. Therefore, some elderly people are conservative in buying products with new technology.

3.6

COLLABORATION

Given the interdisciplinary nature of gerontechnology, cross-sectoral collaboration between different spheres of activity from the public, private and non-government sectors is needed. Even if the technology is available and ready for commercialisation, most of the time, without collaboration with other stakeholders, the product is unlikely to successfully reach the market. Stakeholder interviews revealed there is generally a lack of engagement and collaboration between different entities in Hong Kong's gerontechnology ecosystem, between universities and research institutions, between research groups and the private sector, and within across the medical and social sectors.

3.6.1 INSUFFICIENT COLLABORATION BETWEEN UNIVERSITIES AND RESEARCH INSTITUTIONS (GAP 21)

There is a lack of collaboration between universities and research institutes in Hong Kong compared to other economies. In the US, much of this type of collaboration regarding gerontechnology is enabled with the support of the National Institute of Health (NIH) funding interdisciplinary research programmes (Carnegie Mellon University, 2011; Levkoff & Fozard, 2014). A notable example of where collaborations of this nature occurs is an R&D centre called AgeLab, which was established at the Massachusetts Institute of Technology (MIT) in 1999. AgeLab aims to invent new ideas and translate technologies into practical solutions to improve the health of ageing citizens. It is interdisciplinary and international, encouraging collaborations with researchers and students across MIT, with domestic groups and foreign partners in joint research projects, and provides open access to data collected by the institute through press releases and social media (Klimczuk, 2012).

Although examples of collaborative efforts exist in Hong Kong, such as between the Hong Kong Research Institute of Textiles and Apparel (HKRITA) and its host institute, the Hong Kong Polytechnic University (PolyU)[30], there is still not enough collaboration between other R&D centres and universities in Hong Kong and more needs to be done to encourage open dialogues and partnerships between different research groups to facilitate technology development and transfer.

[30] HKRITA often draws upon the research expertise of PolyU to develop new innovative technologies for competitive textiles and clothing companies in Hong Kong and mainland China.

3.6.2 INSUFFICIENT COLLABORATION BETWEEN RESEARCH ORGANISATIONS AND THE PRIVATE SECTOR (GAP 22)

Whilst the collaboration between universities and R&D centres discussed above occurs at the earlier applied research stage, cooperation also usually occurs between various research organisations and the private sector at the later prototyping and enhancement stages. Collaboration between academia and industry is particularly important at the prototyping stage because universities cannot profit from business ideas that have stemmed from applied research, so input from the private sector is important in taking products or services to market. However, there is insufficient collaboration at these fundamental stages in Hong Kong. One of the reasons is because of the research credit system at Hong Kong universities favours academic basic research over more commercial projects. As mentioned previously, stakeholders revealed during interviews that academic-private sector collaborations are uncommon in Hong Kong unless researchers have a vested interest in the commercial venture. Otherwise, the incentives for researchers to pursue academic-private sector collaborations are limited. Without collaborations between these two sectors, gerontechnology research that may revolutionise elderly care may never be realised, or may take a very long time manifest as a commercialised product.

Hong Kong does not have many examples of large-scale collaborations between the research institutions and corporates. Large business corporations in Hong Kong have seldom launched any innovative products or services in regards to the elderly healthcare industry and are still hesitant despite the growing potential within the sector. However, numerous cases can be found overseas. For instance in the US, the I-70 collaboration project was an initiative to develop an interdisciplinary network for ageing research involving representatives from nine colleges and universities and seven business enterprises from the states of Kansas and Missouri (Woolrych, 2014). Germany encourages collaboration between research organisations and corporates by promoting the formation of R&D clusters and networks. These organisational structures foster exchange of information and ideas and facilitate partnerships and collaboration between industry, academic research institutes and government. In Germany, the Federal Ministry for Economic Affairs and Energy also has a policy that supports the development of cluster structures called the "go-cluster initiative" (GTAI, 2017; clusterportal, 2017). The programme offers seminars and individual coaching to develop expertise in each cluster. Another cluster-related policy in Germany is the High Tech Strategy 2020. The Federal Government's research and innovation policy provides support to 30 innovative technology clusters that promote partnerships between companies, hospitals, universities and other research organisations specialising in medical technologies.

With insufficient collaboration between research organisations and the private sectors, Hong Kong is losing out on a number of benefits that increased engagement, dialogue and partnerships can bring to technology transfer and commercialisation. Multiple interviewed stakeholders expressed that they felt Hong Kong's gerontechnology ecosystem lacks a platform for the exchange of information and ideas and to encourage collaboration between different stakeholders. Hong Kong's gerontechnology sector would benefit from having such a platform and more collaboration between research organisations and the private sector.

3.6.3 INSUFFICIENT COLLABORATION BETWEEN THE PRIVATE SECTOR AND NGOS (GAP 23)

Collaborations are rarely found between the Private Sector and NGOs two sectors, although both may be able to provide significant assistance with enhancing each other's initiatives through combining their resources, such as funding, industry related experience and information. For example, the stairs climbing device provides a useful solution for seniors who require a wheelchair to climb stairs. However, even though this product offers evident benefits, in order to utilize this technology a service must exist to bridge the technology to the end usersexecute the climbing of the stairs, where volunteers or staff members must physically assist the elderly with the usage of the device and many technology require a form of service which bridges the technology to the end users. Recently, Caritas in Macau successfully launched a service using the stair climber device to assist elderly with ascending and descending staircases. Although St. James' sSettlement is soon to exploreing the possibility with launching a similar service in Hong Kong, however this will have to be at a much larger scale due to the difference in demographics and this is one of very few examples where NGOs have collaborated with the private sector in pushing out products to end users.

3.6.4 INSUFFICIENT MEDICAL-SOCIAL COLLABORATION (GAP 24)

Elderly are much more prevalent to have chronic diseases like hypertension and diabetes (CSSD, 2014). Aside from formal medical care from the hospitals and clinics, the care from the community is also crucial for an all-rounded patient-centred care, which is more effective than physician-centred care in stabilising the condition (OHKF Ageing Society Report, 2016). With sufficient and efficient support from the community, elderly could be kept away from re-entering the medical system. The difficulty in enhancing the drug handling workflow with the assistance of technology is a typical example of insufficient medical-social collaboration. The

existing drug handling arrangement hinders the use of medicine dispensing machines in RCHEs (see Section 2.2.2 for the detail of The Automatic Tablet Dispensing and Packaging System).

It is the RCHE care workers' duty to manage and monitor the drug intake of the residents. Currently, after medical consultation in the medical system, the patients would obtain the drugs from the hospitals'/ clinics' pharmacies. The drugs would then be stored in the RCHEs. When it is about time to take drugs, care workers would dispense drugs for every residents in unit dose.

The Automatic Tablet Dispensing and Packaging System provides an alternative workflow to streamline the drug handling process. The basic function of the machine is to automatically package unit-dose drugs according to a pre-entered instruction. Each patient's unit-dose medication would be put in one single pack. (see Section 2.2.2 for more detail) This system could help to solve the problems in the existing drug handling process. First, it saves the waiting time of both the elderly and care-givers for obtaining medication from the hospitals'/ clinics' pharmacies, which might take hours. The medication instruction in either paper form or electrical form from the doctor would be brought to the drug dispensing machine to obtain the drugs directly in the RCHEs. Second, the existing workflow also cause the waste of drugs. Currently, after medical consultation, the elderly patient usually collect medicine for, say, 2 months from the clinic or hospital. However, if they see the doctor again in this duration due to deterioration of health, the patient will collect new medicine for 2 months and the untaken old medicine would be disposed of. Third, it frees the care workers from the routine and complicated drug handling procedures. They could have more time to take care of the residents in other forms. Last but not least, the machine lowers the risk of medication incidents resulting from manual mistakes and errors[31].

[31] Wrong intake of medicines by elderly residents could lead to death. According to Legislative Council Questions, during the period from April 2006 to August 2008 (when the Drug Handling Manual for Residential Care Homes for the Elderly was published), the Hospital Authority received 39 reports of wrong intake of medicines by elderly residents in residential care homes for the elderly (RCHEs) and, among them, three elderly residents passed away allegedly because of this.

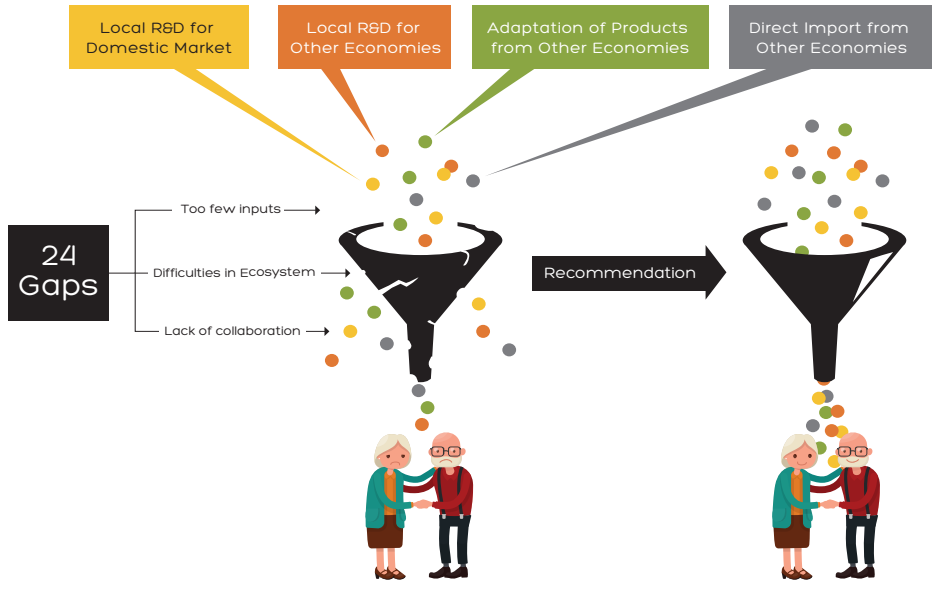
However, even though The Automatic Tablet Dispensing and Packaging System is available in Hong Kong, the adoption of this gerontechnology product is rare and difficult in Hong Kong as it involves not only a new product but also a head-to-toe change in drug handling workflow. First, the medical sector (HA, DH and other private service providers) would need to change their medication dispensing practice. Medication instructions, instead of the drugs, would be given to the patients or the RCHEs[32] they resided in. Second, the drug handling manual for RCHEs, which was published by SWD, HA and DH, had to been revised to match the enhanced workflow. Third, the social sector (the RCHEs) would need to adopt to the new procedures. Stakeholders revealed that although some RCHEs are interested in using the drug dispensing machine, the rules and regulations are not ready for this change. Stakeholders also pointed out there was no dialogue between the multiple stakeholders.

3.7

CONCLUSION

To summarise the gaps and difficulties in Chapter 3, a funneling system will be used as an analogy to describe the problems faced by the gerontechnology ecosystem. The left is the current situation where the sparse input at the top, this is then funneled through the system and streamlined. The ecosystem is very weak from the start due to the lack of applied research input caused by issues, such as under-investment in applied research and a skewed academic credit system, and also the scarcity of foreign-developed gerontechnology products entering the Hong Kong market because of its small size. However the funnel, which represents the gerontechnology ecosystem, is full of gaps and difficulties such as the lack of support for startups and testing ground for companies to fine tune their products, and insufficient collaboration which hinders products from reaching the market even if the ideas, technology and other resources for producing and commercializing gerontechnology products exists. This leaves very few successful products being commercialised and reaching the gerontechnology market. The ideal ecosystem is represented by the diagram to the right where the amount of input required is increased substantially and the various gaps and difficulties are eliminated within the funneling process to maximize the number of technology making it downstream into the gerontechnology market and benefiting the society.

Figure 3.10 Illustration of the Problems Faced by the Gerontechnology Ecosystem



The lack of collaboration between the different sectors prohibited the adoption of innovative technology. However, there have been examples of NGOs collaborating to promote community care. The Hong Kong Jockey Club Charities Trust launched the Jockey Club Community eHealth Care Project in 2016, which aims to integrate health management technology with community care. The project aims to empower elders in managing their own health and to improve the quality of life for elders by detecting health patterns and trends of the user through advanced data analytics. This was an interdisciplinary collaboration between the CUHK Jockey Club Institute of Ageing (IoA), a R&D centre, the Senior Citizen Home Safety Association (SCHSA) and various NGOs such as the Hong Kong Sheng Kung Hui Welfare Council Limited. E-health corners will be set up at 80 elderly homes as part of a telecare programme, where health data is transferred using cloud technology to SCHSA for monitoring and analysis. The IoA will conduct well-being surveys for approximately 10,000 people and also assist in applying big data analytics to information collected from the telecare programme and well-being surveys (Hong Kong Jockey Club, 2016). This is a good example of the growing collaboration for the well-being of seniors.

Chapter 4
Conclusion

The challenges posed by our rapidly ageing society are significant, and demand that we take thoughtful and immediate action. At the current rate of ageing, caregivers and nursing homes will struggle to cope with the rising number of elders entering institutions over the coming years and there will be greater pressure on public resources, as increases in expenditure on healthcare and welfare services are expected. This report began by explaining how gerontechnology and other care technologies can improve the quality of life for older persons and their caregivers and also mitigate the aforementioned issues by promoting ageing in place, thereby reducing economic costs to the government and social costs to the public. With all the benefits technology can bring to Hong Kong, it is a social, moral and economic imperative that the industry for gerontechnology and eldercare technologies are supported and further developed. The variety of products developed by local entrepreneurs and their foreign counterparts to assist elderly users and their caregivers was subsequently reviewed. Despite the variety of innovative products existing in the Hong Kong market, they are not widely adopted or commercially successful domestically compared to how foreign products fare

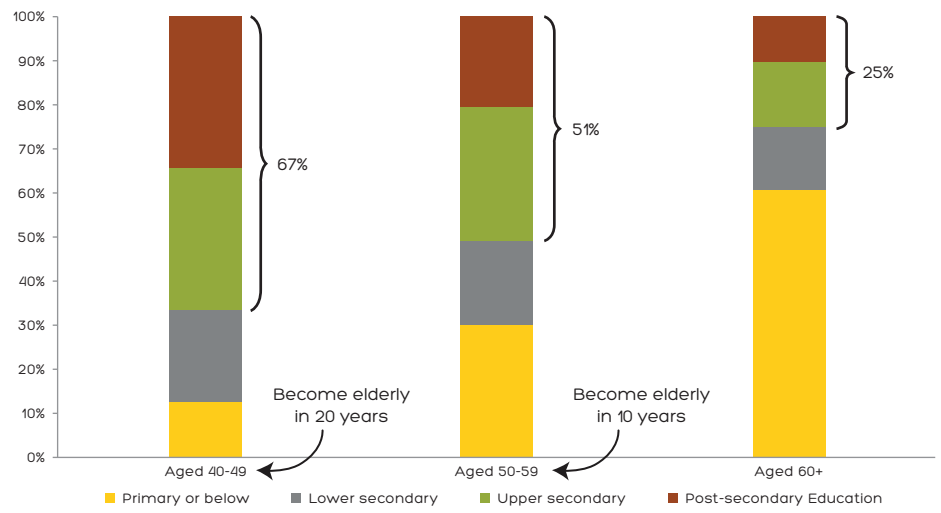
in their respective local markets. This is attributed to a plethora of gaps and difficulties faced by the gerontechnology ecosystem in Hong Kong at different stages of the commercialisation process. Key gaps and difficulties facing the ecosystem include the lack of awareness of the importance of technology in improving the lives of the elderly and their caregivers, outdated regulatory systems, the lack of a testing ground for enhancing design of new products, minimal collaboration between stakeholders, and cultural differences between markets and difficulties in product localisation. Nevertheless, we are optimistic about the future of gerontechnology and care technologies in Hong Kong. Public awareness and activity in the ecosystem has picked up in recent years, with the private sector, Government and non-government organisations initiating and participating in more conferences, exhibitions and symposiums to encourage dialogue between stakeholders and encourage collaboration between different parties.

Gaps and difficulties aside, the market for gerontechnology and elderly care products in Hong Kong has huge potential. The number of elderly consumers aged 65 or above currently stands at 1.2 million, but is expected to grow swiftly to 2.5 million or 30% of the total population in Hong Kong by 2040. Moreover, data from the Census and Statistics Department shows that the future elderly population will not only be more highly-educated, but also wealthier. In 2016, only 25% of people aged 60 and over had attained at least upper secondary education, compared to 51% for those aged 50-59 and 67% for persons aged 40-49. The latter two groups will shift into the 60 or above age group in the next two decades. (Figure 4.1) Future seniors will have accumulated more assets, especially as more women enter the job market and median income grows in the coming years. Both trends signal greater elderly spending and a significant silver market. One must also not forget that the market for elderly products is comprised of both older persons and the formal and informal caregivers that look after them. The potential in this market and its abundance of business opportunities have yet to be fully realised or grasped. The Ageing Asia Silver Economy Index ranks economies in the Asia-Pacific region based on the spending power of their ageing population and their supporting children, which includes household savings and GDP per capita. The 2015 ranking places Singapore first, followed by Hong Kong in second-place and Australia in third for possessing the most silver market potential (Ageing Asia, 2015). Additionally, total healthcare expenditure in Hong Kong is expected to increase alongside the elderly population. Spending from 2013-2014 was HKD 123 billion or

5.7% of Gross Domestic Product (Food and Health Bureau, 2017). Although, health technology is only one component of this figure, as the use of technology becomes more widespread in future, we can expect this spending on this component to grow. Besides, these above spending only encompasses health and medicine-related gerontechnology, which is one of four areas described in Chapter 3, and does not factor in the increases in spending in the other three areas relating to transport, living, diet, as well as greater expenditure on general research and development. Therefore, we expect the total spending on gerontechnology and hence, its market size, to grow significantly in the future.

Figure 4.1 : Population by Age and Educational Attainment, 2016

Source: Census and Statistics Department (2016)



This report was written with the aim of establishing a baseline and providing a comprehensive summary of the gerontechnology industry in Hong Kong and the gaps and difficulties faced by stakeholders in the ecosystem. We hope this study will galvanise policy makers, health professionals, companies, investors, NGOs and other stakeholders to work together to address the gaps and difficulties faced by the gerontechnology sector in Hong Kong. This is a chance for us begin addressing some of the serious challenges posed by an ageing society and is a golden opportunity for Hong Kong to emerge as one of the most technologically-advanced cities in the world.

Appendix I List of Stakeholders

Company/Organisation	Name	Title
Acesobee Limited	Albert AU	Founder
Cognix Limited	FONG Ching-Hang	Chief Executive Officer
Cognix Limited	HO Yik-Him	Vice President, Software Engineering
Cognix Limited	Felix HUI	Vice President, Production
Contact Design Limited	Mazing LEE	Marketing Director
Diamond Cab (HK) Limited	Doris LEUNG	Chief Executive Officer
Doro Limited Hong Kong	Calle KROKSTADE	General Manager
Elderly Commission	LAM Ching-Choi	Chairman
HKSTP Corporate Venture Fund	Sammi WONG	Manager
Hong Kong Applied Science And Technology Research Institute Company Limited	IEONG Mei-Kei	Chief Technology Officer
Hong Kong Applied Science And Technology Research Institute Company Limited	Vincent LAU	R&D Director
Hong Kong Applied Science And Technology Research Institute Company Limited	Dennis LEE	Director
Hong Kong Applied Science And Technology Research Institute Company Limited	WU Xiao-Hua	Director, Software & Systems Technology Division
Hong Kong Applied Science And Technology Research Institute Company Limited	Jacko LEUNG	Senior Engineer
Hong Kong Applied Science And Technology Research Institute Company Limited	John TSANG	Senior Technical Manager
Hong Kong Pharmaceutical Care Foundation	CHIANG Sau-Chu	Director
Hong Kong Science and Technology Park Corporation	Carrie LING	Technical Leader, Healthy Ageing Platform
Hong Kong Sheng Kung Hui Welfare Council Limited	Joe SHAM	Assistant Director
Housing Society	Marco WU	Chairman
Housing Society	CHEUNG Moon-Wah	General Manager, Elderly Services
Human Washer Ltd	Samuel HUI	CO-Founder
Institute of Active Ageing, Polytechnic University	Daniel LAI	Director
International China Ageing Industry Association	Yvonne LI	Founder
New World Development Company Limited	Eleanor KAM	Head of Ageing Innovation
Qiming Venture Partners	Nisa LEUNG	Managing Partner
Rehab-Robotics Company Limited	Michael TSUI	Chief Executive Officer
Senior Citizen Home Safety Association	Timothy MA	Board Member
Single Person Transport Design (SPTD) Limited	Richard HAINSWORTH	Chief Executive Officer
Single Person Transport Design (SPTD) Limited	Arnold WU	Chief Innovation Officer
Single Person Transport Design (SPTD) Limited	Dennis CHUNG	Business Development Manager
St James' Settlement	Jenny CHOI	Senior Manager
System Aid Medical Services Limited	Wilson YEUNG	General Manager
The Hong Kong Council of Social Service	John FUNG	Business Director, Sector and Capacity Development
The Hong Kong Council of Social Service	Grace CHAN	General Manager, Innovation and Technology for Ageing
The Hong Kong Council of Social Service	Jessica TAM	Head, Social Enterprise Business Centre
The Hong Kong Jockey Club	Horace LIT	Senior Charities Manager
The Hong Kong Jockey Club	Liberty LAM	Charities Officer
The Hong Kong R&D Centre for Logistics and Supply Chain Management Enabling Technologies	Simon WONG	Chief Executive Officer
The Hong Kong R&D Centre for Logistics and Supply Chain Management Enabling Technologies	Vincent WONG	Senior Project Manager
The Hong Kong R&D Centre for Logistics and Supply Chain Management Enabling Technologies	David CHUNG	Project Manager
The Hong Kong R&D Centre for Logistics and Supply Chain Management Enabling Technologies	Eliza CHENG	Manager, Public Relations & Marketing
The Hong Kong Research Institute of Textiles and Apparel	Edwin KEH	Chief Executive Officer
The Jade Club	Patrick CHEUNG	Managing Director
Tung Wah Group of Hospitals	Alice LEUNG	Assistant Community Services Secretary, Elderly Services

Appendix II List of Gerontechnology Products in this Report

LIVING 住
SURVEILLANCE AND EMERGENCY ASSISTIVE SYSTEMS

Product	Company	Figure
The Telecare System	PolyU	N/A
The Infrared Thermal Sensing Safety Alert System For Elderly	LSCM	2.1
AccurCare	Accurtag Solutions Limited	2.2
Sensara Senior Care Solution	Qorvo	2.3
The Smart Elderly Bed Exit monitoring system	Rondish Co. Limited	2.4
WhizPad	SEDA G- Tech	N/A
The 24-hour Personal Emergency Link Service	Senior Citizen Home Safety Association	2.5

BASIC ACTIVITIES OF DAILY LIVING

Product	Company	Figure
Sit and Shower device	Human Washer Limited	2.6
Toilet Monitoring Device	LSCM	2.7
VT Care Real Time Wet Diaper Monitor	HoHo Life	2.8
3D Smart Textile Materials for Protective Apparel for the Elderly	HKRITA	2.9
iShoe	HKRITA	2.10
Floor Tiles	SAFE Concept Limited	2.11

INSTRUMENTAL ACTIVITIES OF DAILY LIVING

Product	Company	Figure
Self-Cleaning Fabric	HKRITA	2.12
RFID Reader	LSCM	2.13
Communication Electronic Cards	LSCM	2.14
Adlens Adjustables product	HoHo Life	2.15
Doro Initiative Smartphone	Doro Hong Kong Limited	2.16
Mobile Link, Safety Phone Service	Senior Citizen Home Safety Association	2.17

UNIQUE AND SUCCESSFUL PRODUCTS IN OTHER ECONOMIES

Product	Company	Figure
PARO robot	AIST (Japan) through idsMED	2.18
Joy for All Companion Pets	Hasbro	N/A
BUDDY Robot	Blue Frog	2.19
ZoraBots	QBMT	2.20
Care-O-bot	Fraunhofer Institute	2.21
Robotic Beds	Panasonic	2.22

HEALTHCARE 醫
MONITORING DEVICES

Product	Company	Figure
Smart Respiration Belt	Advanpro	2.23
HeHa Qi	iHeHa	2.24
Heartisans Wearable	Heartisans	2.25
Body Fat Analyser	Appo Tech Limited	N/A
Smart Mattress	Advanpro	N/A
Non-Invasive Blood Glucose Meter	PolyU	N/A

Appendix II List of Gerontechnology Products in this Report

Kiss & Tell	eNano Health Limited	2.26
Automatic Retinal Image	CUHK	N/A
Reflective Pulse Oximeter	ASTRI	2.27
The Cardiovascular Monitoring Device	ASTRI	2.28

THERAPEUTIC DEVICES USING HIGH TECHNOLOGY

Product	Company	Figure
The Hand of Hope	Rehab-Robotics Company Limited	2.29
MedExo	MedExo Robotics	2.30
Rex	Deltason	2.31
VRehab	Deltason	2.32
Elderly E-Educational & Infotainment Platform	ASTRI	2.33
Smart Medicine box	HoHo Life	2.34
Automatic Tablet Dispensing Packaging System	Deltason (JVM)	2.35

SOFTWARE AS A SERVICE

Product	Company	Figure
Cloud-based Personal Care Plan eHealth Solution	Acesobee Limited	2.36
Electronic Health Record Sharing System (eHRSS)	Department of Health	N/A
A&D Connect	Kingsford Far East Limited	2.37
Hong Kong Intelligent Cognitive Assessment Platform	Cognix	2.38
Brainastic	MindVivid	N/A

UNIQUE AND SUCCESSFUL PRODUCTS IN OTHER ECONOMIES

Product	Company	Figure
HAL (Lumbar Type)	cyberdyne	2.39
ROBEAR Nursing Care Robot	RIKEN	2.40

DIET 食
DENTAL PROSTHESIS

Product	Company	Figure
EnvisionTEC's E-Dent	Persona Surgical Modelling Co. Limited	2.41

AESTHETIC PUREED "SOFT" MEALS

Product	Company	Figure
Tender Love Cuisine	Hong Kong Sheng Kung Hui Welfare Council Limited	2.42
Graceful Meal	St James' Settlement	2.43

UNIQUE AND SUCCESSFUL PRODUCTS IN OTHER ECONOMIES

Product	Company	Figure
Kewpie Gentle Menu Products	Kewpie	N/A
Mousse Food	Nissin	2.44
Jelly Formed Food	Nissin	2.45
Biozoon	Biozoon	2.46
FoodJet Printing Systems	FoodJet	N/A

Appendix II List of Gerontechnology Products in this Report

TRANSPORT 行

WHEELCHAIRS AND WALKING CANES

Product	Company	Figure
Mobilet	Single Person Transport Design (SPTD) Limited	2.47
Easiseat	Easiseat	2.48
Scalamobil S35	Janley Ltd.	2.49
The Smart Walking Cane	LSCM	2.50

TRANSPORTATION SERVICES

Product	Company	Figure
Diamond Cab	Diamond Cab	2.51
UberAssist	Uber	N/A
Accessible Hire Car	The Hong Kong Society of Rehabilitation	2.52
Easy Access Bus	The Hong Kong Society of Rehabilitation	2.52
Rehabus	The Hong Kong Society of Rehabilitation	2.52

LOCATION DEVICES

Product	Company	Figure
RFID Tagged and GDP Tracking Vests	HKRITA	2.53
NFC Smart Wristband	Bjorgaas Foundation	2.54
SmartSole	GTX Corp	N/A

UNIQUE AND SUCCESSFUL PRODUCTS IN OTHER ECONOMIES

Product	Company	Figure
Honda Walking Assist Device	Honda	N/A
Foldawheel electric wheelchair	Foldawheel	N/A
XiaoxinTM Multi-Functional Healthcare Chair	CapitalBio eHealth	N/A

Appendix III Current State of Retirement Protection and Financial Support for the Elderly in Hong Kong

In Hong Kong, elderly support falls into three main categories - social security allowances, voucher schemes and "pension" initiatives.

[33] The Guangdong Scheme, which provide Old Age Allowance for eligible Hong Kong elderly people aged 65 or above who choose to reside in Guangdong, is out-of-scope of this report.

III.I Social security allowances

Social security allowances provide monthly allowance to Hong Kong elders to meet special needs arising from disability or old age. The main function of most of the schemes is to alleviate poverty by serving as a safety net for those elderly people who are unable to have adequate retirement protection or by supplementing their living expenses (CoP, 2015). The schemes are[33] Comprehensive Social Security Assistance (CSSA), Normal Disability Allowance (NDA), Higher Disability Allowance (HDA), Old Age Allowance (OAA) and Old Age Living Allowance (OALA). The schemes are designed with different allowance levels and eligibility criteria (including residence requirement, means tests, etc.) to support different elderly groups (Table A1). Each elderly person is allowed to receive only one type of allowance.

I. Eligibility Criteria and Amount of Monthly Payment of Selected Social Security Allowance Schemes

Scheme	Eligibility Criteria			Amount of Monthly Payment (HKD)
	Age Requirement	Income Limit	Asset Limit	
CSSA	Nil	Monthly Payment to Meet "Recognised Needs" *	47,000 (Single Person)	5,548 #
OALA	65	Single Person: 7,750 Couples: 12,620	Single Person: 225,000 Couples: 341,000	2,565
OAA	70	Nil	Nil	1,325
NDA	Nil^	Nil^	Nil^	1,695
HDA	Nil^	Nil^	Nil^	3,390

Note:
* The total assessable monthly income of the applicants and their family members must be lower than the monthly "recognised needs" under the CSSA Scheme.

2015 figure. The average monthly CSSA payment for the elderly singletons aged 60 or above (excluding recipients of the Portable CSSA Scheme) is estimated to be $5,548.

^ Eligible applicants have to be certified by the Director of Health or the Chief Executive, Hospital Authority (or under exceptional circumstances by a registered medical practitioner of a private hospital) to be severely disabled and his/her disabling condition will persist for at least 6 months.

Source: Social Welfare Department (2017), Commission on Poverty (2015)

To strengthen the support for elderly persons, the Government has announced to introduce a higher tier of assistance to OALA. It is proposed to provide a monthly allowance of $3,435 per person for elderly persons with more financial needs who are eligible for the allowance, i.e. elderly singletons with assets not exceeding $144,000 or elderly couples with assets not more than $218,000.

III.II Voucher Schemes

Voucher schemes are another type of elderly support and are a way to provide direct subsidises to consumers on dedicated usages. The Elderly Health Care Voucher Scheme (EHCVS) provides HKD 2,000 per year in subsidies for those aged 70 or above to spend on general medical health services as an incentive to encourage elders to choose private healthcare services in addition to public services (HKSARG, 2008)[34]. Moreover, the Social Welfare Department is currently piloting community care service vouchers (CCSV). The first phase was implemented in 2013 with a maximum of 1,200 vouchers issued. The second phase was launched in 2016 and will span three years, with 3,000 vouchers issued (SWD, 2016). Currently under this scheme, elders aged can choose community care services that suit their individual needs using the vouchers.[35]

They can increase service quality by introducing competition as elderly consumers are free to choose on their own, which service providers to use (OHKF Ageing Society Report, 2016).

III.III "Pension" Initiatives

The third type of elderly support is "pension" initiatives, which are defined contribution plans[36] providing a stable cash flow for the elderly in exchange of a fix amount of contribution. The Mandatory Provident Fund System is an employment-based, privately-managed mandatory system. Employees and employers are each required to make regular mandatory contributions, which equivalent to 5% of the employee's relevant income, to the employee's MPF account, subject to the minimum and maximum relevant income levels (HKD 7,100 and HKD 30,000 respectively, as at June 2017). For a monthly-paid employee, the minimum and maximum relevant income levels are $7,100 and $30,000 respectively. When scheme members reach the age of 65, the member can withdraw the accrued benefits with interest for retirement.

The reverse mortgage programme, launched by the Hong Kong Mortgage Corporation Limited (HKMC), is a loan arrangement that enables people aged 55 and over to use their residential property or properties as a security to borrow from the bank. The borrower usually does not need to repay the reverse mortgage loan during his or her lifetime[37]. The HKMC would provide insurance coverage for the reverse mortgage programme against the risk of shortfall in property price. Furthermore, the HKMC introduced a new life annuity scheme in April 2017, where elderly participants aged 65 and over can now receive immediate lifetime payouts after a premium ranging from HKD 50,000 to HKD 1 million is paid[38]. The scheme will provide elderly people with a steady stream of income, providing better financial support during their retirement years (Mortgage Corporation, 2017). HKMC and Hong Kong Monetary Authority (HKMA) will jointly work together in terms of distribution network and investment management of premiums.

III.IV. Special Schemes in Other Economies

There are lots of financial aid scheme targeting the elderly population in other economies. Japan's Long-term Care Insurance (LTCI) policy provides direct force to promote the use of gerontechnology. The programme allows users to choose their own health, medical and welfare service providers, and this freedom is "as an important way to control quality" of services. This policy creates a more competitive market environment that encourages interest and investment from the private sector (OHKF Ageing Society Report, 2016). The LTCI subsidises purchasing and leasing of assistive products from the government and designated providers too. So far, the insurance policy has been well-received by elders but "the uptake of services has far outstripped expectations and the Japanese government is faced with spiralling costs. Their response has been to introduce higher co-payments for wealthier adults." (Holder, 2014).

[34] Unspent EHCVS vouchers can be carried forward and accumulate to a maximum of HKD 4,000.

[35] There are five service package values: the monthly values are HKD 8,830, HKD 7,500, HKD 6,680, HKD 5,340 and HKD 3,700) to suit their individual needs.

[36] The periodic contribution is prescribed and the benefit depends on the contribution plus the investment return.

[37] When the reverse mortgage loan terminates, the borrower (or his/her inheritors) have the preferential right to redeem the property by repaying to the bank in full the outstanding loan amount owed under the reverse mortgage. If the borrower (or his/her inheritors) choose not to exercise such a right, the bank will sell the property to recover the outstanding loan amount.

[38] According to the preliminary estimation of the HKMC based on internal rates of return in the range of 3%-4%, the monthly fixed payout for a male at entry age 65 ranges from HKD 500-HKD 580 per HKD 100,000 premium paid (corresponds to annuity rates 6%-7%). Female annuitants, which generally have longer life expectancies, will receive payouts ranging from HKD 450-HKD 530 per HKD 100,000 premium paid (corresponds to annuity rates of 5.4%-6.4%).

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