

Digital Health as an Enabler of Healthy Aging in Southeast Asia

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Introduction

As a result of both, increases in life expectancy and reductions in fertility, countries in Southeast Asia are aging rapidly (UNESCAP 2017). The relative speed of this transformation is startling: In France, an increase from 7% to 14% of the population being over age 65 took 115 years (1865-1980), while the equivalent transition occurred in Singapore in just 15 years (2000-2015) (UNESCAP 2017).

Whereas innovations in public health and healthcare have been instrumental in increasing longevity, longevity itself poses new challenges for the region. Increasing population shares living with chronic disease, decreasing old-age support ratios¹ and changing societal attitudes and family structures have intensified the strain on healthcare systems to meet the growing demand for care for older adults.

At the same time, there is an equally significant rise in the adoption of digital technology throughout the region. Digital technology refers to the hardware and software that can process and transmit information in a digital format (Lessard et al. 2019), such as online platforms, mobile applications, wearable devices and the Internet of Things (IoT). In 2015, the numbers of combined internet users in Malaysia, Indonesia, Singapore, Vietnam, Thailand and the Philippines was 260 million. Cambodia, Myanmar and Laos have also seen rapid growth of internet users (ASEAN 2018). There are now 360 million users connected to the internet in Southeast Asia, 90% of whom connect through mobile phones, with the value of the internet economy estimated to have surpassed \$100 billion (Google, Temasek, and Bain & Company 2019).

These converging trends point to the potential for digital health technologies to become a critical enabler for meeting the challenges of aging, with the potential to increase access, expand service coverage, improve the quality of service delivery, reduce health disparities, and lower healthcare cost. Digital health technologies that are currently in use range from consumer devices designed to capture and report on individual health data, to complex systems of integrated information that monitor, analyse and sort health information for entire communities intended for use by physicians, managers or healthcare planners. For digital health technology to reach its full potential in the region, such technology not only needs to address the complex needs of aging adults but to do so in a low cost and scalable manner given the lack of third party funding in most countries in the region.

This paper surveys the range of digital health technology currently addressing the needs of older adults in Southeast Asia, and reflects on opportunities and challenges in the next stage of its development. To accomplish this, we conducted a narrative review of select digital technologies in use the region, complemented by a series of key informant interviews. First, as background, we briefly review the context of Southeast Asia's aging societies and the needs that are most pressing for this population, as well as the evolving digital health landscape. Second, we report where digital health technology has been deployed to meet the health care needs of older adults in the region. Third, we highlight gaps in service delivery and challenges to broader regional implementation and provide recommendations for how these challenges can be addressed.

¹ The number of adults aged 15-64 per adult aged 65+

The Aging Landscape and Priorities in SE Asia

All countries in Southeast Asia are aging, albeit at different rates (Figure 1) (Jones 2013). For instance, Singapore and Thailand are, or are soon projected to be, “aged” societies, meaning that over 14% of their populations will be over the age of 65. In Singapore, the percentage of people above the age of 65 is expected to reach 24% by 2030 and to surpass 30% by 2050 (Department of Statistics 2019), and in Thailand, 25% of the population is projected to be aged 60+ by 2030 (Sasat and Bowers 2013).

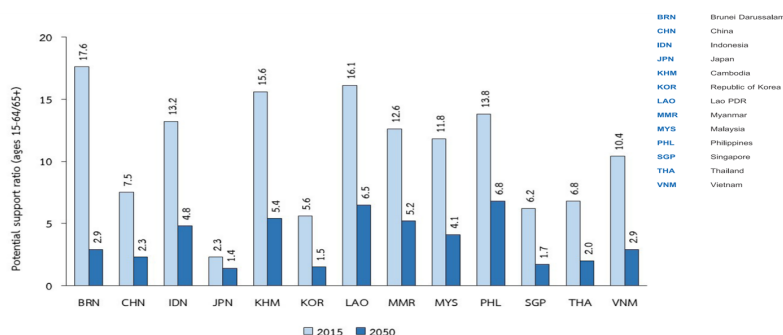


Figure 1: Percentage of the population aged over 65 in SE Asia (Jones 2013) Even nations with lower and slower rates of aging must contend with a significant increase in the elderly population. For instance, although Indonesia is only just beginning its transition into an aging society, with 8.9% of its population aged 60+, in absolute numbers, this means approximately 23.4 million people. By 2030, the UN has projected that the elderly will make up 13.2% of the population, or 39 million people (UNFPA 2014).

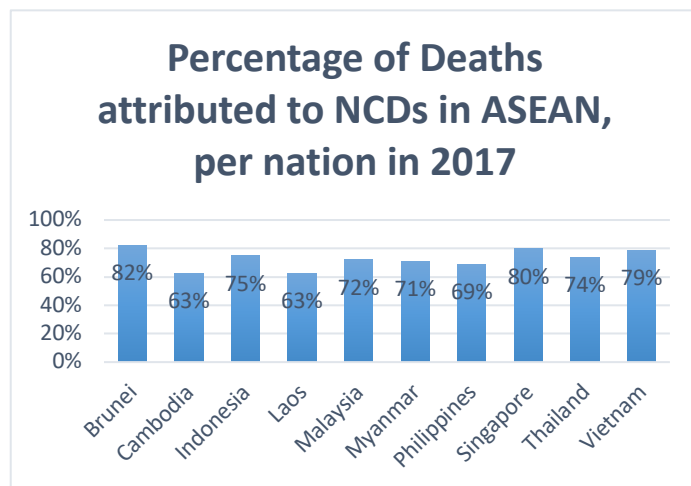


Figure 2: Percentage of deaths attributed to NCDs per ASEAN nations in 2017. Source: Global Burden of Disease Study, 2017

The burden of chronic NCDs have steadily risen with aging and changing lifestyles. In 2017, the majority of deaths in each of the ASEAN nations were attributed to NCDs, totalling approximately 3 million deaths in the region (GBD 2017).

The greatest burden of morbidity and mortality comes from cardiovascular disease, chronic respiratory disease, diabetes and cancers (GBD 2017). Among older adults, dementia is also a rising concern with prevalence rates in Asia Pacific projected to triple from 23 million in 2015 to 71 million people in 2050 (ADI 2014).

The design of formal healthcare systems in the region largely reflects the need for acute care and control of infectious diseases (Hong, Teng, and Gan 2019). However, with the demographic and epidemiological shift towards aging comes an increasing demand for chronic disease management as well as long-term care (LTC) (Yeung and Thang 2018). With these trends and the movement towards universal health coverage in some countries, healthcare spending in the region has and will continue to increase.

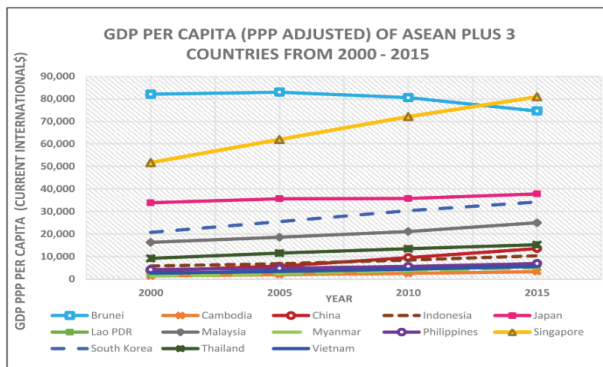


Figure 3: GDP per Capita of ASEAN Countries Plus 3. Source: World Bank, World Development Indicators (2017), Yeung & Thang 2018

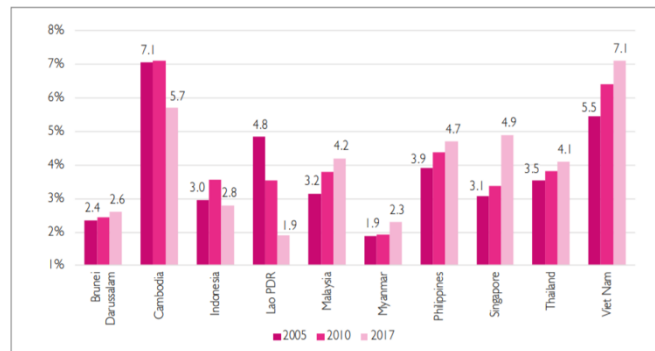


Figure 4: Health expenditure to GDP (%), ASEAN Member States, 2005-2017 Source: ASEAN Secretariat

Informal healthcare plays a large role, as a majority of the financial and social burden of aging is shouldered by families and occurs in homes, with caregivers experiencing significant financial and opportunity costs resulting from caring for aging relatives (Loichinger and Pothisir 2018). An additional complication is that significant proportions of the elderly live in rural areas making access to the formal healthcare system difficult. For instance, in Vietnam, in 2012, more than 68.2% (6.150.000 people) of elderly people lived in rural areas (Ngoc, Barysheva, and Shpekht 2016).

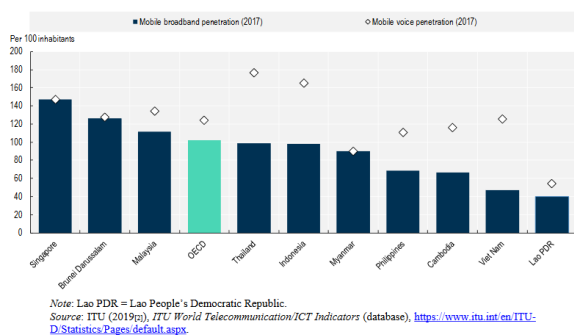
These trends highlight the need for healthcare delivery solutions that cost-effectively extend the reach of formal healthcare systems, allow older adults or their caregivers to live independently, and improve the quality of home and community-based care.

The Digital Landscape

The uptake of digital technology in the region has been rapid, distinguished by the immediate adoption of mobile internet connections rather than fixed internet connections. A decade ago, internet connections were scarce, slow and unreliable. Today, mobile broadband reaches more of the region's populations and remains a more affordable option than fixed broadband subscriptions due in part to the competitive market among providers (ITU 2019).

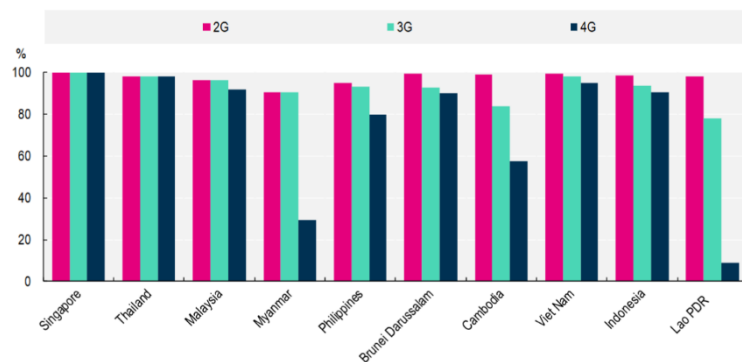
Figure 5 shows the adoption rates in Southeast Asia of fixed and mobile broadband connections compared to OECD countries (OECD 2019). In 2017, fixed broadband penetration was low at 5.2%, but mobile broadband has an average penetration rate² of 84.9%. However, there remain significant differences in penetration rates across ASEAN nations, although the numbers are quickly increasing. Singapore leads the way in mobile internet subscription at a rate of 147% or 147 phones per 100 habitants, indicating that many subscribers use more than a single phone or sim card, followed by Brunei (127%) and Malaysia (111%), both above the OECD average (102%). Even at the lower end of the spectrum, Vietnam and Lao PDR have mobile subscription rates of 47% and 40%, respectively (OECD 2019).

Figure 5: Mobile Broadband subscription per 100 inhabitants in SEA and OECD



95% of the population in Southeast Asia has access to a 2G network, at least 78% to 3G, and 4G is available in most countries (Figure 8) (OECD 2019; Asian Development Bank 2019). As a result, consumer access to digital technology has leapt forward, with countries like Myanmar skipping the use of feature phones and heading straight for low cost smartphones (Zainudeen et al. 2016).

Figure 6: Evolution of share of broadband subscriptions per 100 inhabitants in SEA vs. OECD (2009-17)



² According to the OECD broadband penetration is measured by the number of subscribers per 100 inhabitants.

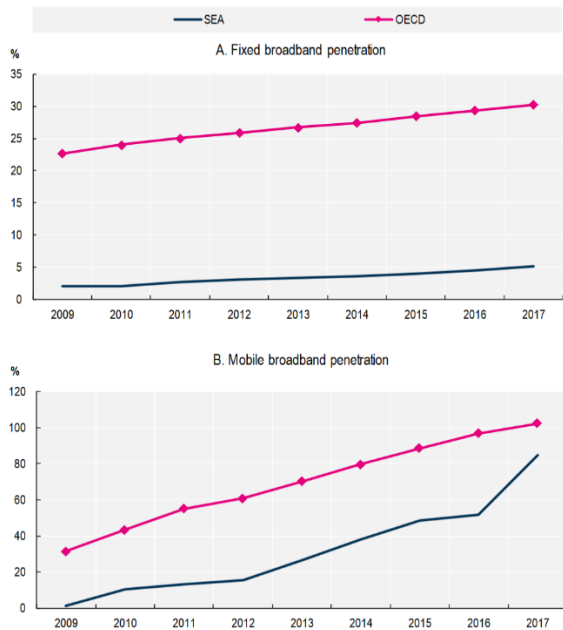


Figure 7: Percentage of population in SEA covered by mobile networks, by technology (Cento 2017)

Innovations in digital technology bring significant advances in information and communications both to the private and public sector, by enabling exponential increases in the quantity of data from new sources and new populations, the quality of data in terms of accuracy and timeliness, and the overall efficiency of responses and interventions. Spurred by the growth of regional e-commerce and online platforms, internet start-ups have proliferated in SE Asia, with a significant investment in health technologies (Cento Ventures 2019). In the first half of 2019, the digital healthcare sector attracted \$128 million in funding, more than 2017 and 2018 levels combined (Cento Ventures 2019), including significant investments in solutions for healthcare data management and analytics as well as consumer empowerment.

Using Digital Technologies To Address Emerging Health Needs

Much of the investment in health IT has focused on the following domains:

- **monitoring and tracking outcomes and behaviour**, using technologies that collect and transmit health-related data via mobile, wearable and home-based technology. These technologies are being used to monitor clinical indicators, track high risk patients, and improve response times in cases of emergencies or falls.
- **supporting individual self-management**, via platforms and applications that help individuals and their families to maintain independent lifestyles (before or after the onset of chronic disease). This includes technologies that promote healthy aging by nudging healthier behaviours related to both physical and mental health and offering health education and goal setting activities and/or disease management support via self-care or a shared relationship with a health coach or care provider.
- **enabling access to professional healthcare goods and services**, by reducing the cost of service delivery, by delivering telehealth solutions or by more efficiently linking consumers with third-party providers. These technologies help users manage information and healthcare related decisions, support caregivers, and integrate online services into daily living.
- **engaging community-based resources**, including technologies to crowd source health information, or to facilitate engagement by the wider community outside the formal healthcare system to provide support or promote inclusion.

Each of these areas is discussed in detail below with Table 1 (found in the appendix) providing examples of technologies currently in use in ASEAN in each of these domains.

Monitoring and tracking outcomes and behaviour

A wide array of technology now exists to convey individuals' health information, either for self- or third-party monitoring by medical staff or caregivers (or, increasingly for shared self and third-party use). These include devices that automatically detect vital signs and basic health indicators (such as smart heart rate monitors and pedometers) as well as systems that receive and transmit user signals (such as patient or provider alerts). The usability of these technologies critically depends on design and the compliance of the user (Wu, Choi, and Ghovanloo 2015; Kruse et al. 1992). Within ASEAN, many wearables to monitor heartbeat, stress, blood pressure and physical activity are available from mass-market solutions such as Fitbit or Xiaomi, integrated into mobile phones, smart watches or wrist bands, or discreetly attached to belt clips or necklaces for older adults.

Monitoring Clinical Indicators

Special purpose wearables for chronic disease patients include devices such as BPro and Hypoband. BPro, developed in Singapore, measures blood pressure over the course of a full day's activities, then produces a report with several other indices related to blood pressure (Komori et al. 2013). Hypoband, a wearable developed in Malaysia, detects cold sweats that potentially presage a hypoglycaemic crisis in elderly diabetic patients.

Geo-tracking Dementia Patients

Monitoring technologies, such as SOSBuddy and the OMGElderly GPS Watch, are being used to track dementia patients via wearables fitted with GPS tracking devices (Asian Scientist 2018). Allowing caregivers to monitor the movements of dementia patients means that if they become lost or disoriented, their location can easily be shared with family members.

Improving falls-prevention and emergency response

A final example is the prevention of and response to falls, which increase with age and are associated with higher rates of morbidity and injury-related mortality. Providing security against falls improves not just physical but mental well-being for elderly and their caregivers, as the fear of falling causes individuals to avoid activities that they enjoy (Tinetti and Powell 1993).

Today, many smartphones come pre-installed with their own sensors for physical activity that individuals use to monitor their step count and are also being fitted with sophisticated fall- detection sensors, a design feature specifically targeted to the elderly (Comstock 2019). Other commonly used systems rely on motion sensors, strategically placed throughout the home to detect activity and connected to a family caregiver or service provider via a web platform or mobile app. For instance, in a pilot project run by the Singapore Management University and Tata Consultancy in Singapore, passive infra-red sensors are installed into room corners to capture active motion and generate alerts due to irregular activity or inactivity (Liming et al. 2015). Thailand's "DoCare Protect" project similarly uses home motion sensors to send information using cloud technology to a dedicated nurses' station or a family caregiver, and to ambulance dispatch if needed (Samejaidee 2019). Other novel applications include sensors fitted into mats and mattresses that detect sudden changes in pressure and temperature (Simonite 2011), as well as sensors in other household appliances to detect and control irregular patterns of use (Tai 2016). However, due to cost considerations, personal home sensor systems are not yet as widely accessible as wearable technology (appliances, sensors).

Supporting individual self-management

Digital health technologies are also being used to more actively support independent living, including reducing the physical burden of activities of daily life as well as promoting behaviours and decision-making that promote healthy aging both physically and mentally. This includes lifestyle management (such as diet and physical activity) and disease management (such as compliance with medication and exercise). This can be done firstly through data analytics and visualizations that make individual health data more relevant and salient to users, and allow for more personalized healthcare strategies, systems of timely reminders and nudges to incentivize compliance with a given health regimen in ways that enhance user engagement or even the ability to provide real time feedback from real or virtual health coaches or providers. Gamification and virtual reality also present many opportunities to nudge healthy physical and psychological behaviours and increase the well-being of seniors. These features may be particularly important for older adults who may not fully understand the rationale for behavior change, or who may find preventive lifestyle change or chronic disease management tedious.

Increasing Physical Activity

At the population health level, Singapore's Health Promotion Board conducts a National Step Challenge yearly, which enables seniors (and other citizens) to earn monetary rewards for daily steps, which are measured using a low-cost activity tracker. Alternatively, playing a virtual reality game such as Pokemon Go (although not explicitly health-related) can also motivate seniors and others to continue to walk, and to engage with their friends and family, both on- and offline. A more unconventional way of using technology to support older adults in health promotion has been the development of consumer-facing robotics. Robocoach, a prototype robotic fitness instructor, has been rolled out to select senior activity centres in Singapore and helps run gentle exercise classes. It's main function is to model exercises and correct the movements of elderly patients through the use of built-in sensors. The robot can sense the motions of 6 individuals at one time, and the exercises are customizable to the needs of the users. In its early pilot phase, Robocoach has been found to be popular, attracting greater number of participants in community fitness classes (Lotfi, Langensiepen, and Yahaya 2018; Holmes 2015).

Other health promotion interventions are fully online, using dedicated virtual health coaches to provide timely, tailored advice to users. Valea Health, in the Philippines, has each user connected to a health coach through their messaging system. The coach provides personalized instructions and feedback throughout the day regarding physical activity and nutrition and provides additional information regarding nearby fitness classes and workshops that may benefit the user. The health coach follows up regularly and the data of the fitness program is tracked and shared via the app.

Empowering Chronic Disease Patients

A variety of specific solutions have emerged for chronic disease management. These include Pill Pocket in Thailand, an app that helps elderly patients take their medicines as prescribed. It has a reminder function to take medication, while also offering chatbots and pharmacists to answer questions regarding follow-up care and advice on which medications can be taken together. For Type 2 diabetes, apps like Sugosure or GlycoLeap, developed in Singapore, connect patients with healthcare coaches to monitor glucose levels, food, intake, activity and weight. Zinmed, in Vietnam, has also developed a device to take non-invasive glucose readings and share that information through their app for users to observe.

More generic platforms such as mClinica, available in Malaysia, Indonesia, Vietnam, Cambodia and the Philippines, provide patients with medication adherence support. Once enrolled by their providers, patients receive regular refill reminders and incentives such as free gifts or cash rebates.

Promoting mental well-being

Technologies that promote positive mental health are also now emerging. For instance, Alo Health is currently piloting VR technology in some of Singapore's nursing homes by creating experiences for elderly residents that they can no longer physically perform, such as visiting a different country, or swimming with fish (NUS Enterprise 2019). The elderly are then encouraged to engage with their peers regarding their virtual experience. Immersive technology of this kind is able to stimulate cognitive function, while raising spirits and encouraging sharing to reduce social isolation (Lange et al. 2010; Hughes et al. 2017).

Another company, SilverActivities in Singapore, designs and reviews games, applications and devices for seniors. They have also produced a senior friendly tablet (SilverPad) which provides a selection of activities that are tailored for dementia patients. The games are meant to assist seniors in stimulating and preserving their cognitive function by targeting memory and simple problem-solving skills, in a way that is fun and engaging. Their tablet has a simple interface, with big buttons and large text, is available in the 4 local languages and curates its content to reflect the context of elderly Singaporeans (Silver Activities 2019).

Enabling Access to Healthcare Goods and Services

In ASEAN, the health tech sector has seen significant growth in healthcare data management and analytics, with firms such as UCare and MyDoc providing comprehensive solutions at the provider level. However, for an aging population, key areas of service delivery include not only medical care but also long term care (LTC) and support services offered either in the home or in community-based facilities, which can range from additional home help with managing daily tasks to medical, physical therapy or nursing services. Digital technology enables families navigate and connect with home and community-based services, using online repositories for medical information, personal electronic medical records, digital marketplaces and virtual platforms for service delivery.

Managing Information and Supporting Decisions

One example of improving access via a consumer-facing digital information aggregator is HealthHub, an online portal created by the Singapore government to support user access to public sector services and their own individual health records. The portal can be accessed by using a unique government-issued identity card number, and consolidates information regarding users' medication, appointments and test results, which can then be managed via the mobile app or website. Beyond providing a comprehensive overview of their medical records, HealthHub acts as a "digital health companion" for health education and facilitates participation in public health promotion programs, simplifying the process of finding and receiving public healthcare services. For older adults, HealthHub also has a built-in "caregiver mode" which permits third- parties to manage these appointments and medications on behalf of their dependents if they are not able to use the application.

In settings where private healthcare is more widely used, online directory services can be essential for navigating the healthcare system. Directory services such as ViCare, BookingCare (Vietnam) and Aide (Philippines) provide a listing and discovery platform for health care facilities, health care service

providers and laboratories, complemented by an 'Ask a Doctor' forum where users can post queries to get answers from listed doctors.

For more specialized needs, advanced analytics are used to transform online directories into discovery platforms. DocDoc, a virtual network of physicians and hospitals in the region vets physician and facility records to ensure quality, and uses an artificial-intelligence engine to match patient needs with suitable doctors from their current roster of over 23,000 doctors in 8 countries.

Providing Healthcare Services Online

Propelled by the widespread adoption of smartphones, a variety of online consumer marketplaces have seen tremendous growth within ASEAN, which are now extending to the healthcare sector. The last five years have seen rival platforms competing for investments, collaborators and market share by reducing barriers to adoption and providing more comprehensive services to enable “one-stop shopping”. In addition to curated content and health advice, such platforms permit users to directly receive services in their home or consult a professional online. Integration with mobile payments or other financing solutions can facilitate the seamless nature of an end-to-end healthcare experience. Services that provide in-person house-calls include Doctor on Call in Thailand, Home GP in Malaysia, Medifi in the Philippines and Speedoc in Singapore. At the other end of the spectrum, In Vietnam, Vie Vie Healthcare provides fully online consultations with licensed doctors. Some platforms combine both: HaloDoc and Alodokter in Indonesia connect licensed doctors and pharmacies to patients through chat, video, or voice call. Halodoc is working to allow online booking and cashless transactions within an expanded physical provider network of clinics, hospitals and insurance companies. Through the app, users can book a live consultation, order lab tests, receive prescriptions, order medication and have it delivered by ride hailing service, Go-Med, a specialized delivery service powered by its parent company, Go-Jek. Recently, HaloDoc has announced a collaboration that will allow the integration of reimbursements from Indonesia’s national health insurance scheme (Yasmin 2019).

Supporting Family Caregiving

While solutions like HaloDoc meet the everyday healthcare needs of older adults who are less mobile as part of their overall customer base, some platform technology-based enterprises cater specifically to the needs of the aging population as a key product differentiation strategy, notably in provision of flexible home-based caregiving arrangements. These include Caregiver Asia (Malaysia& Singapore), Care Concierge and Carer (Malaysia), Homage and Jaga-me (Singapore), and Health at Home (Vietnam), all of which focus on linking the elderly and their families to nurses, therapists or trained caregivers that provide flexible care tailored to patient and caregiver needs. In addition to providing care on demand or by schedule, the range of services offered includes training for caregivers to empower them with the skills they need (Caregiver Asia), specialized services for post hospitalization rehabilitation (Care Concierge) and specialized services for dementia patients (all). A key component of making these platforms user-centric is the provision of tools that enable caregivers to monitor performance (e.g. daily report of patient activity or digital diaries that can be remotely accessed by family caregivers) and make choices regarding patient care and nursing staff, including feedback and rating systems.

Creating “Smart” Cities for Seniors

A comprehensive city-wide initiative to harness digital technology for aging in place is currently being piloted in Thailand, where the Saensuk Smart City project in the Chon Buri district has been designed around the needs of elderly residents living alone (Din et al. 2018), supported by a team of community nurses who regularly make home visits. A range of solutions use cloud technology, the internet-of-

things (IoT), and wearables to monitor seniors' vitals and their home environment, enable them to ask for assistance anywhere and to establish geo-fenced safe zones for dementia patients. Individual health data is transmitted to the local nursing headquarters cloud system, where city-wide updates are displayed in real-time. Nurses can then prioritize their interventions and deliver appropriate care at the right time (Leesa-Nguansuk 2016). What distinguishes this project from other services is the level of integration into city infrastructure to create a better patient experience and a more efficient use of resources.

Engaging Community-Based Resources

Digital technology is also playing a pivotal role in bringing communities together beyond the formal healthcare system, complementing existing physical and social networks, raising public awareness on how to appropriately support community members' "aging in place" and fostering a greater sense of inclusion, by facilitating regular and more meaningful touchpoints between elderly individuals and their families, friends and/or service providers.

Overcoming Social Isolation

Both older adults and their caregivers may be at risk of social isolation, defined as the "absence of social interactions, contacts and relationships with family and friends" (Berg and Cassells 1990). As the social network of the elderly naturally thins over time, social isolation has been linked to increased rates of depression and suicide (Findlay and Cartwright 2002; Hawkey and Cacioppo 2010), and poorer physical health and well-being (Routasalo and Pitkala 2003). Research from Indonesia, Malaysia, Thailand, Vietnam, Myanmar and Singapore (Van Eeuwijk 2006; Ibrahim, Momtaz, and Hamid 2013; Teerawichitchainan, Pothisiri, and Long 2015; Lim and Kua 2011) shows that in ASEAN, living communally (which is the prevailing social norm) does not automatically preclude such isolation, while more older adults are also increasingly living alone. Online peer groups and virtual support networks enabled by digital technology can help reduce the isolation felt by seniors and caregivers and empower them to manage their healthcare needs. Peer-to-peer chatgroups among older adults and platforms such as Facebook and WhatsApp create new avenues for more engaging, direct interpersonal communication among family members and peers and help to reduce social isolation.

Organizing Dementia-Friendly Neighbourhoods

In Singapore, digital technology is being used to coordinate a community-based support network in 8 pilot neighbourhoods. If a dementia patient goes missing, an alert is sent through a "Dementia Friends" app to partners, caregivers and members of the public, who can then bring the patient to "Go-to-Points" in 8 different neighbourhoods where trained community partners are on hand to reunite patients with their caregivers. The app also delivers tips on how to communicate with dementia patients and the best ways to assist them, enabling members of the public to become more familiar with dementia related challenges.

Crowd-sourcing Emergency Response

Platforms for crowd-sourcing knowledge and information can also complement and extend existing public resources with community-based assets. For instance, to help deliver swift medical attention in an emergency situation, Singapore's Civil Defence Force recently launched an app called MyResponder that crowd-sources assistance from members of the public with first aid training. A quick response time can be crucial in cases of cardiac arrest, and the technology allows the public to report incidents and receive alerts with real-time feedback. If an emergency is called in, an alert goes

out over the app to the members of the public within a 400 meter radius of the incident. The app will also identify the locations of nearby automated external defibrillators (AEDs) for the trained members of the public to use. They then administer CPR until an ambulance can arrive. The ability to leverage a large network of willing members of the community to provide assistance swiftly increases efficiency, but also indirectly helps to promote pro-social behaviour and strengthen online and in-person community relationships that develop with each interaction.

Gaps and Opportunities

For pragmatic reasons, we omit discussions of technologies for healthcare management and broad population health that do not specifically address a particular need of older adults (such as the introduction of electronic medical records). However, our scan of existing technologies in ASEAN, many of which are only a few years old, provide cause for optimism that applications will become increasingly relevant for the aging population, including in underserved areas of psychological and cognitive health. As demand for innovations in this market grows further, the incentive to design products and systems that serve elderly populations will increase.

At the systems-level, we found that in spite of some striking examples, fewer solutions exist in low and middle income countries. This may be due to a less supportive environment for health technology start-ups to thrive, which includes the ability to attract investors or deficiencies in supporting infrastructure to support scaling businesses. It may also be the result of the limitations of our scan of technologies in SE Asia, which was confined to those technologies and initiatives that were written about in English, within the grey and academic literature.

We also found multiple competing solutions focused on healthcare services and chronic disease management, but fewer instances of technologies that were relevant to dealing with social isolation and dementia, consistent with other studies conducted in Asia (Alzheimer's Disease International and Alzheimer's Australia 2014; Egan and Pot 2016). As dementia places extreme physical and emotional weight upon patients and their families, and significant additional resource requirements within healthcare systems and beyond, this is a gap which remains pressing.

Despite the rapidly developing market for digital health technology, there are still several barriers that must be overcome, and new challenges as health systems transform innovation into implementation. At the level of individual users, the digital divide for older adults across access, capability and outcomes (Wei et al. 2011), remains wide. Firstly, despite the pervasiveness of mobile devices, the supporting infrastructure is still catching up to provide reliable connectivity throughout the region, reducing their practical utility for a significant portion of older adults. Internet connections are the weakest (if available at all) outside metropolitan areas, leaving those in rural areas without reliable access. Even in urban areas, obstacles remain regarding access and cost remain (OECD 2019; ITU 2019). The definition of "access" must be carefully considered as well. Though many respondents may have access, this does not necessarily imply that they own a mobile phone or have unimpeded access to the internet. They may be using devices belonging to a family member or a neighbour, making it less likely that they would use it to store sensitive information like health data.

Secondly, in SE Asia, the need for senior-centric designs has not yet been well demonstrated in the regional digital health technology space (Holzinger et al. 2008; Peek et al. 2016). Adults who have physical access may still have limited capabilities to use technology, in part, due to age-related deterioration of ability in manipulating devices and navigating through programs because they have decreasing dexterity and comparatively lower levels of exposure, respectively, leading to frustration

and deterring them from experimenting with new technologies and applications (Wang et al. 2019). Universal design features like large font sizes, simple interfaces and fewer steps to adopt (Al-Razgan et al. 2012) are therefore critical, while technologies that ask users to create accounts, profiles, or use existing email accounts to login into a service are already putting high barriers to entry for the elderly. In SE Asia, given the spectrum of cultural and economic diversity, designing technologies that would increase the capability of elderly users across the board is compounded by steep educational gradients in countries where many older adults may be functionally illiterate.

For instance, wearable and mobile devices offer many advantages but also have limitations. For older adults, adaptation to the user environment and preferences are key. Early wearable personal emergency response systems (PERS) in the early 1980s (Stokke 2016) were large and unsightly, and contributed to a feeling of stigmatization (Martina et al. 2011) and hence a low compliance with wear them. Older adults may also simply forget their wearables or find it difficult to regularly charge them. Most critically, older adults who suffer a fall or a stroke may not be able to reach for a button to call for help, or may encounter these difficulties while they are not wearing or carrying devices, particularly in the bathroom, where many falls occur (World Health Organization 2018; Aminzadeh et al. 2000; Sophonratanapokin, Sawangdee, and Soonthorndhada 2012).

Finally, older users are less likely to fully take advantage of technology or to use it appropriately. For example, an older person may have a smart phone, but only use it to call or text their friends. Even in well-known cases such as HealthHub, concerns remain about the usability and accessibility of the platform, as the number of options can overwhelm users, and the required level of technology literacy is high for elderly users (Tan 2018). It is also important to recognize that usage evolves over time. While novelty can encourage adoption, over time there may be less use and less compliance (Faust et al. 2017). In order to continue nudging use and encouraging compliance, applications that deploy a variety of strategies, including an intelligent use of gamification, entertainment and financial or social incentives can help maintain engagement.

These observations suggest that applications for older adults need to be developed with these needs and constraints strongly in focus, and that integrating digital technology into a population setting need to go beyond any single application in order to effectively use new health technology to enable healthy aging.

Ultimately, the value of digital technologies lies in creating new ecosystems that are able to increase the reach and quality of existing healthcare systems. While a plethora of apps exist, for healthcare policymakers, it is more important (and more difficult) to assess whether these available technologies ultimately add value. As recent WHO guidance notes, “digital health has [...] been characterized by implementations rolled out in the absence of a careful examination of the evidence base on benefits and harms. The enthusiasm for digital health has also driven a proliferation of short-lived implementations and an overwhelming diversity of digital tools, with a limited understanding of their impact on health systems and people’s well-being” (World Health Organization 2019). At the same time, limitations in the availability or access to population-representative data sources and rigorous evaluations of digital health for older adults remains a constraint to understanding and optimizing the full potential of these applications. Few applications reviewed in our survey provide detailed information about their reach and user activity, and to the best of our knowledge, no publicly available national surveys of older adults investigates the use of online or mobile services for health, especially in low and middle-income countries. Rigorously executed published studies of effectiveness and cost-effectiveness in a population setting are, to the best of our knowledge, not available. This further highlights the urgent need for more substantive evidence on how technologies targeting older adults

are actually being used, their impacts on health outcomes and health systems, and the true cost and benefits of these technologies to consumers and governments alike.

Considerations for Health Policy Makers

Whether considering specific digital health interventions or developing a national digital health strategy to support healthy aging, Ministries of Health need to consider the specific needs and capacities of both their target population and their health systems. Both the health of the aging population as well as their ability and willingness to effectively embrace digital solutions will affect take-up and use, which are also highly contingent on universal design features that support usability for older adults and their caregivers. While solutions that rely on high levels of digital literacy, sophisticated smartphones and strong connectivity may not always be appropriate or may exacerbate existing disparities in less developed countries, in ASEAN, a future-looking orientation is also critical in this regard. The pace of development implies that new cohorts of older adults are likely to be more highly educated and more digitally connected than ever before, and countries that have historically been less economically developed have the potential to leapfrog over more developed systems using new digital tools that outperform existing legacy infrastructure

Ministries of Health also have a direct role to play, as the steward of systemic capacity development. On the one hand, in espousing digital technology, public sector use of digital platforms confers immediate economies of scale and scope, enabling in theory a more coordinated and efficient response to the needs of the elderly that can leverage existing service delivery models. Ministries of Health also have the opportunity to build new public-private partnerships with industry players that bring technological expertise and civil society players that can increase reach and providing insights on the needs of a wider target population, which may be critical for governments whose resources for health are highly constrained.

At the same time, a balanced policy approach towards digital health needs to maintain support for fostering innovation while preventing the potential for costly errors, harm and abuse when handling sensitive information in a vulnerable population, and the need to serve larger health system goals. Developers of “smart devices” need to be regulated to existing medical device standards but may also need to be incentivized to introduce functions that will complement local health systems to facilitate adoption such as interoperability. In the case of platform technologies, online marketplaces for private healthcare services may become increasingly more complex to govern as they develop in parallel to local healthcare systems, and regulations regarding caregiver qualifications and the legal responsibilities of their employers will need to be crafted and communicated clearly.

Finally, the sensitive nature of the data being collected highlights the requirement for strong privacy regulations, even in the most developed ASEAN nations. The trove of health data that accumulates in the servers of private healthcare companies or public agencies can quickly become a liability if the appropriate measures to secure the data are not implemented. Cybersecurity regulations must also cover the other kinds of data collected, which may include GPS coordinates and banking information for example. Policies outlining the kind of data that can be shared or sold must work to protect consumer interests.

Singapore offers one example of such a balanced approach, hosting a regulatory sandbox called the Licensing Experimentation and Adaptation Programme (LEAP) that works with various telemedicine providers to encourage innovation by creating 'safe spaces' where participating companies are granted temporary regulatory waivers. At the same time, Singapore supports Modern

Aging, a community accelerator, and education platform to create new businesses that help people live better as they live longer.

Thailand has also adopted a 20 year eHealth Strategy (2017-2026), under which, healthcare has been identified as a strategic focus of accelerator programs at the National Agency for Innovation (NIA) and the Digital Economy Promotion Agency (DEPA) which aim to boost technology start-ups . At the same time, the strategy is underpinned by the development of appropriate legal and policy frameworks to support and regulate the exchange of health information between public and private sectors to ensure the necessary protection of individual data.

Conclusions

Health systems in Southeast Asia are facing a complex set of challenges along a continuum of care needs for aging populations: to preserve health and well-being as long as possible, to treat disease and disability, and to help manage physical and cognitive decline while providing the independence and social connectedness that promote physical and psychological health.

The scope for digital health is large. Creativity, skill and capital is steadily developing in the region, with some of the world's biggest organizations looking to invest and capitalize on market opportunities that exist in ASEAN. At the same time, aging populations will be the new normal in the coming decades throughout the region, and governments, industries and community organizations have already begun to adapt to the needs and challenges presented by this demographic shift.

Digital health technology is making enormous strides in the region, particularly in the areas of telehealth, telemedicine and healthcare platforms. These technologies alleviate pain points of traditional healthcare systems, with the potential to increase access to healthcare significantly, while allowing seniors to age in place and receive long term care in community-based settings.

Investments in infrastructure to enable this digital transformation are already being made (Cento Ventures 2019), as the internet economy and the number of internet users are growing at staggering speed in the region (Google, Temasek, and Bain & Company 2019). In addition to greater access and investments in infrastructure, there is also a need to make devices more affordable and user-friendly.

Greater research and innovation to alleviate loneliness and promote inclusion are necessary, especially for elderly suffering from cognitive deficits. Digital health technology can play a part in creating solutions to these and other problems, and innovations that respond to these concerns will foster better well-being, especially for the economically disadvantaged elderly. While the speed of digital innovations in health technology far outpaces the speed of the regulatory frameworks that must accompany them, it is particularly important to highlight the need for regulation in this case.

However, in considering the abilities of digital health technology, we must also recognize its limits; digital technology is not a substitute for a robust health system, but rather should be a key component. As the WHO observes, "digital health interventions should complement and enhance health system functions through mechanisms such as accelerated exchange of information, but will not replace the fundamental components needed by health systems such as the health workforce, financing, leadership and governance, and access to essential medicine". Digital health technologies hold great promise in shrinking the distance to quality healthcare for the region's elderly. Partnerships between industry, governments and communities will continue to unlock that potential if they can ensure that effective innovations are accessible to the elderly and a true reflection of their needs.

Appendix

Table 1: Scan of Health Technologies available in ASEAN³

Name	Primary Function	Type	Description	Country	Reference
HealthHub SG	Access to Services	Web and mobile app	Access to health records, schedule medical appointments, check personal health records, manage healthcare.	Singapore	https://play.google.com/store/apps/details?id=sg.gov.hpb.healthhub
Carer	Access to Services	Web and mobile app	Patients with chronic illnesses and caregivers of the elderly (including dementia patients) can use the app to monitor and manage medical appointments and medications, receive relevant caregiving tips and support from an online community of healthcare professionals, and hire qualified local nurses.	Singapore	https://www.carer.com.sg/index
Finizz	Access to Services	Platform, web and mobile app	Platform that allows patients to book healthcare appointments online. It also posts a wide breadth of medical information regarding medical services, procedures and tests, with a built-in Q&A forum with registered doctors.	Vietnam	https://finizz.com/
Homage	Access to Services	Web and mobile platform	Provides on-demand elderly caregiving and nursing services, including specialized care for dementia, Parkinson's and stroke patients.	Singapore	https://www.homage.sg/
Caregiver Asia	Access to Services	Web and mobile platform	Platform that connects patients with freelance caregivers, provides caregiver training and has special services for dementia patients.	Singapore, Malaysia	https://www.caregiverasia.com/?locale=en-SG
Jaga-me	Access to Services	Web and mobile platform and app	Provides access to trained caregivers, nurses and medical escorts on demand for elderly patients. Users can book, track and manage healthcare delivery over mobile app.	Singapore	https://www.jaga-me.com/
HaloDoc	Access to Services	Telemedicine, web and mobile	Provides consultation services with doctors through mobile app and can follow up with prescriptions delivery through GoJek.	Indonesia	https://www.halodoc.com/

³ This list of technologies is not exhaustive, but a sample of health technology initiatives that are directly or indirectly benefit the aging populations in ASEAN. The sample contains public, private and community initiatives across ASEAN.

		platform and app			
Medifi	Access services to	Telemedicine platform, Web and mobile app, cloud technology	Cloud based web application that permits remote patient-doctor consultations through videoconferencing, chat messaging, a personal medical journal of patient profile and medical imaging management.	Philippines	https://medifi.com/
ProSehat	Access Services to	Telehealth, web and mobile platform and app	Online pharmacy plus delivery through mobile app. Users can scan and upload their prescriptions to the app and have the medicine delivered to their home with cash-on-delivery (COD) payment method. User can also check availability and track the delivery process.	Indonesia	https://www.prosehat.com/
MedGrocer	Access services to	Platform, web and mobile app	Online pharmacy that verifies and delivers prescription medicines to patient homes. Users upload their prescriptions using the app, or by sending a message, and can compare the price of different brands. It also supports patients in managing their medicines.	Philippines	https://medgrocer.com/
Health at Home	Access Services to	web and mobile platform	Provides caregivers on demand for the elderly, including caregivers that are available for 12hr shifts. Booking and payment is made through the app, or payment can be made at participating banks.	Thailand	https://healthathome.in.th/
Alodokter	Access Services to	Telemedicine web and mobile app	Health platform that provides original medical advice content, booking for clinics and hospitals, online consultation with doctors and health insurance,	Indonesia	https://www.alodokter.com/
Home GP	Access Services to	Platform, web and mobile app	Online platform that connects healthcare seekers to house call healthcare practitioners. Provides quick access to services offered by fully vetted house call doctors, nurses and caregivers.	Malaysia	https://www.homegp.asia/
Pobpad	Access Services to	Platform, mobile app	Health information to internet users as well as innovative tools to interact with doctors. Part of Alodokter in Thailand	Thailand	https://www.pobpad.com/

Konsulta MD	Access Services	to	Telehealth hotline	24/7 health hotline service manned by skilled and licensed doctors who provide medical assessment and information, including basic healthcare and advice on permissible medication over the phone. The service is available through a subscription.	Philippines	https://www.konsulta.md/
Mydoc	Access Services	to	Platform, web and mobile app	B2B Patient centric digital health platform that provides users with a healthcare network, including doctors, nurses, nutritionists and pharmacists. It also connects to insurers, clinics and hospitals within the one platform. Available by subscription through employers.	Singapore, Malaysia	https://www.my-doc.com/
DoctorOn Call	Access Services	to	Platform, web and mobile app	Online doctor consultation platform that offers healthcare services via chat, phone, and video calls. Besides consultation, the company also provides medical second opinion and medicine delivery.	Malaysia	https://www.doctoroncall.com.my/
BookDoc	Access Services	to	Platform, web and mobile app	Integrated online ecosystem to seek health services throughout the region, with partnerships to facilitate transportation and accommodation. Also includes an active lifestyle app that synchronizes with your personal fitness tracker and provides incentives/rewards when you achieve your goals.	Malaysia, Singapore, Indonesia, Thailand, Hong Kong	https://www.bookdoc.com/
VieVie Healthcare	Access Services	to	Telemedicine, Platform and mobile app	Telemedicine and online patient engagement with doctors	Vietnam	http://vievie.vn/en/home/
Connect (mClinica)	Access Services	to	Telehealth, platform and mobile app	Pharmacy app that enrolls patients through their Healthcare provider. Once enrolled, patients receive refill reminders healthcare advice and clinical advice on their conditions and free gifts or cash rebates.	Philippines, Malaysia, Indonesia, Vietnam, Cambodia,	https://mclinica.com/platforms/connect-patient-assistance-programs/
CARE Concierge	Access Services	to	Platform, web and mobile app	Platform that matches families with nurses, therapists and caregivers to the home for post-hospitalization recovery and eldercare. Once matched the app allows family members to get updates through a digital diary.	Malaysia	https://www.mycareconcierge.com/
Doctor Anywhere	Access Services	to	Telemedicine, Platform, web and mobile app	Telemedicine through video consultation with doctors and includes optional home delivery of prescriptions.	Singapore	https://doctoranywhere.com/

ViCare	Access services	to	Telehealth platform	Platform that connects patients to clinics by keeping up-to-date lists of doctors and clinics and testing across Vietnam. Hosts a portal where users can “Ask a Doctor”, where listed doctors can reply, and post helpful articles.	Vietnam	http://vicare.vn/
DocDoc	Access Services	to	Platform, Artificial Intelligence	A virtual network of physicians that are vetted by expertise and connect to patients through their insurance company. Artificial intelligence is used to find the best match between patient and doctor.	Singapore, Indonesia, Hong Kong, Philippines	https://www.docdoc.com.sg/
Speedoc	Access Services	to	Telemedicine, web and mobile app	Portal that provides on demand access to doctors and nurses for home visits, with a special focus on elderly patients. The on-site team also performs holistic assessments of living conditions for elderly patients to help reduce falls and encourage better health at home.	Singapore, Malaysia	https://speedoc.com.sg/
Aide	Access Services	to	Telemedicine platform, web and mobile app	Platform that allows patients to search, choose and book medical professionals for house calls. Services, including lab tests, and non-emergency doctors’ services	Philippines	https://www.aide-app.com/
PillPocket	Access Services	to	Platform and mobile app	Provides personal assistance from pharmacists for patients with high blood pressure, high blood cholesterol and diabetes. The mobile application component features a chatbot linked to pharmacist services for follow-up care, medication refills and home delivery, and free patient case management	Thailand	https://www.bangkokpost.com/business/1258362/higher-tech-health
Health Buddy	Access services	to	Web and mobile app	Health videos and tips, articles about common medical ailments and treatments, find a GP service, find a specialist service, find a hospital/centre service.	Singapore	https://www.singhealth.com.sg/patient-care/patient-visitor-info/health-buddy-app
BookingCare	Access services	to	Platform, web and mobile app	The platform provides a directory of doctors and clinics, and allows users to search choose and book appointment, in addition to ordering tests.	Vietnam	https://bookingcare.vn/
Saensuk Smart City	Access Services	to	Wearable devices, mobile app, IoT, IS,	Provide improved safety, smart homes and smart healthcare for the elderly and handicapped under the concept of “Smart Living at Saensuk Smart City”. (Pilot)	Thailand	https://www.nationthailand.com/technology/30277848
Robocoach	Behaviour Change		Robotics	Robot that leads exercise sessions for the elderly and can provide feedback to correct exercise movements.	Singapore.	https://www.straitstimes.com/singapore/robocoaches-aim-to-get-seniors-in-shape

Silver Activities	Behaviour change	Mobile app and web, devices	SilverActivities develops products and applications, such as activity sheets games and specialized tablets for elderly to enable increased independence, avoid social isolation and stay engaged.	Singapore	https://silveractivities.com/
Healthy 365	Behaviour change	Mobile and web app	Track daily steps count and calculate the corresponding calories burned. Also, a health and diet tracking mobile application.	Singapore.	https://play.google.com/store/apps/details?id=s.g.gov.hpb.healthy365
ALO Health VR	Behaviour change	Virtual Reality & Augmented Reality	VR experiences to stimulate and engage seniors to break social isolation (Pilot, not market ready)	Singapore.	https://alo.health/
EyeDEA	Behaviour Change	Wearable device	Small wearable device for elderly patients with glaucoma without smartphones to remind them to take their eye drops. (Pilot, still developing)	Singapore	https://agelessonline.net/a-solution-to-help-with-compliance/
Check Up Plus	Behaviour Change	Mobile app, online platform	Aimed at helping individuals subscribe to a healthier lifestyle to manage and control heart disease risk factors. Includes consultation with a doctor of users' choice, the use of the Ourcheckup Platform and Mobile Apps, and health data collection devices.	Malaysia	https://www.checkupasia.com/
Mindworks	Behaviour Change	Web app	Brain training games to boost cognitive health of seniors.	Singapore	https://play.google.com/store/apps/details?id=com.TP.Mindworks&hl=en_SG
NUH Mymeds	Behaviour Change	Mobile app	Helps patients and their caregivers manage medication times, as well as arrange for pick-up or delivery of prescriptions.	Singapore	https://www.healthhub.sg/apps/34/nuh-mymeds
MyEyeGym	Behaviour Change	Mobile app	Eye exercise app for people with certain types of squints that are due to the absence or limited binocular vision.	Singapore	https://www.healthhub.sg/apps/14/app_myeye_gym
SugoSure	Behaviour change	Mobile app, Platform, Cloud	App with 3 interfaces: patient, doctor and health coach that enables management of Type 2 diabetes. Patients record data and receive feedback from coach and doctors to assist them in managing their condition.	Singapore	https://www.connhealth.com/sugosure/overview/
GlycoLeap	Behaviour Change	Mobile app	Diabetes control and prevention through online app that connects type 2 diabetes patients with a healthcare coaches to monitor food, glucose, activity and weight. Coaches provide real time feedback to make a tailored program for patients.	Singapore, Malaysia	https://glycoleap.com/

Valea Health	Behaviour Change	Platform, web mobile app,	Provides chat and message-based health assistant for individuals. The platform provides virtual health coaching, regular health fitness, and wellness assessments, fitness classes, health workshops, and population data analytics.	Philippines	https://www.valeahealth.com/
Match-a-nurse pilot	Community Support	Platform	Platform that connects patients from Singapore's General Hospital to nurses living in their area to assist with care at home after discharge.	Singapore	https://www.ihis.com.sg/Latest_News/News_Article/Pages/'Bid' to care_under_Match-A-Nurse.aspx
My Responder	Community Support	Mobile app	Crowd sources first responders within 400 meters of a cardiac emergency to render assistance until ambulances arrive.	Singapore	https://play.google.com/store/apps/details?id=sg.gov.scdf.RescuerApp&hl=en_SG
E-care Locator	Community Support	Mobile app	Helping seniors find services near their location.	Singapore	https://www.aic.sg/resources/e-care-locator
Singapore Silver pages	Community Support	Website	One-stop portal by Agency for Integrated Care (AIC). The website gives caregivers, seniors, and Community Care partners resources on senior outreach and engagement, community-based care, healthcare, community mental health, financial support, and caregiving.	Singapore	Silverpages.sg
Dementia Friends	Community Support	Mobile app	Provides tips and information for caregivers of dementia patients and the wider public. Also uses social media to act as a neighbourhood watch for elderly who may be lost or disoriented.	Singapore	https://dementiafriendly.sg/
Dinsow Mini 2	Monitoring	Robotics, monitoring device	Designed for patients with Alzheimer or those that are bed ridden, it reminds them to take medication, tracks their health and automatically answers incoming calls from family and doctors. Int also has multi-media capabilities for entertainment and is fitted with facial recognition to detect sudden changes in facial movements.	Thailand	https://www.dinsow.com/about.html
OMG Elderly GPS Watch	Monitoring	Wearable device	Heart Rate Monitor, Pedometer, Blood Pressure measurements, fall detection, SOS button and 2 way calling.	Singapore and Indonesia	http://omg-solutions.com/gps-tracker/elderly-health-monitoring-gps-tracker-watch-gps027/
SOS Buddy	Monitoring	Wearable technology	GPS tracking device to locate seniors with dementia, includes fall detection, SOS button, 2-way conversation,	Singapore.	https://www.sosbuddy.sg/

			and an alert system that is activated when a safe zone is exceeded.		
Zinmed	Monitoring	Sensor, mobile app	Device that uses non-invasive optical sensors to measure glucose levels in the body. The device shares this information through an app on the phone to visualize glucose patterns in the patient.	Vietnam	http://zinmed.com/en/home/#
UCARE.AI	Monitoring	AI, predictive analytics	Uses AI and health data analytics to predict and prevent the onset and development of disease using patient profiles to prevent hospitalization and reduce healthcare costs.	Singapore	https://www.ucare.ai/
SHINE Seniors	Monitoring	IOT, monitoring devices	A project by the SMU-TCS iCity Lab. Sensor-enabled smart homes and personalised home care for the elderly. Monitors physical environment (such as air quality, noise level, temperature and humidity) and daily living patterns (such as their mobility patterns at home, medication adherence and sleep quality). (Pilot)	Singapore.	https://icity.smu.edu.sg/ https://www.tcs.com/helping-seniors-shine-on
BPro by Healthstats	Monitoring	Wearable devices	Wearable watch that provides continuous blood pressure monitoring at 10 second intervals.	Singapore.	https://www.healthstats.com/
DoCare Protect	Monitoring	Monitoring devices, mobile app, Cloud technology	Smart home system to detect falls of the elderly using sensors. Information is relayed to nursing station if the alarm is activated and an ambulance is called.	Thailand	https://www.docareprotect.com/
HypoBand	Monitoring	Wearable devices	Hypoband is paired to a smartphone (android) and triggers it upon the onset of a cold sweat to make phone calls, sms to the caregivers. Includes a panic button for the elderly.	Malaysia	https://hypoband.com/
Smart Health TeleRehab	Monitoring	Wearable and monitoring devices	Enables patients to undergo rehabilitation exercises from the comfort of their homes. This is done through wearable sensors and remote monitoring.	Singapore.	https://www.ihis.com.sg/telerehab

Table 2: Glossary of terms

Glossary	
Term	Definition
Application (app)	A software program that runs on a computer with a specific purpose for the user. Mobile applications are software programs that are specifically designed to be compatible with mobile phones.
Cloud Computing Technology	On-demand access to additional computing power and data storage over the internet rather than the hard drive of your computer. These additional resources are not managed by the users and can be made accessible to several users at once.
Information Systems	Software systems designed to help collect, store, analyse and share information within a given organization.
Platform	A group of technologies that creates and connects a network of users and producers to facilitate the exchange for on-demand services.
Robotics	Design, construction, and use of machines (<i>robots</i>) to substitute or replicate human actions.
Smart Sensors	A device that collects inputs from a physical environment, which is then programmed to issue a predefined response when a specific input is detected. That information is then processed and shared.
Telehealth	The provision of healthcare services outside healthcare facilities through the use of telecommunications technology.
Telemedicine	The remote diagnosis and treatment of patients through the use of telecommunications and technology.
Virtual/Augmented Reality (VR/AR)	Virtual reality is the use of technology to create a simulated environment. Augmented reality is the use of computer-generated content over-laid onto real world environments.
Wearable Technologies	Devices that are worn on the human body and that have built-in technologies that can collect and deliver information about their surroundings.

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