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Benefits of cloud-enabled healthcare in Asia-Pacific edition

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Contents

Report coverage

This report, commissioned by Amazon Institute, seeks to **understand how cloud can accelerate the digitisation of health to increase productivity in health organisations and systems and improve outcomes for patients.** In doing so, it identifies trends that reinforce the case for change and examines the economic benefits associated with cloud enabled healthcare through productivity improvements, improved health outcomes and greater health equity.

The report considers the application of cloud and in healthcare across nine countries: Japan, South Korea, Singapore, Australia New Zealand, Indonesia, Malaysia, India and Thailand.

This is the Asia-Pacific edition of the report and highlights the key findings across the region. This edition uses USD throughout unless otherwise indicated.

To inform the analysis, a meta analysis of 66 use cases involving cloud technology in healthcare settings was used to identify 17 key benefits to patients, organisations and systems. Six consultations with healthcare organisations using cloud technology provided further insights into the benefits alongside important implementation considerations. Data from the International Data Corporations (IDC) was used to assess trends in expenditure on cloud in healthcare across Asia-Pacific.

Countries of focus for this report

Terminology

Acronyms	
ACCA	Asia Cloud Computing Association
AI	Artificial intelligence
APAC	Asia Pacific
AUD	Australian dollars
AWS	Amazon Web Services
CAGR	Compound annual growth rate
CBA	Cost benefit analysis
CVD	Cardiovascular disease
GDP	Gross Domestic Product
IDC	International Data Corporations
IT	Information technology
ML	Machine learning
NSW	New South Wales
OECD	Organisation of Economic Co-operation and Development
PPE	Personal protective equipment
PREM	Patient-reported experience measures
PROM	Patient-reported outcome measures
USD	United States dollar
WHO	World Health Organisation

Terminology	
Base case	A scenario of outcomes in the absence of the intervention.
Benefit cost ratio	An indicator of the relative costs and benefits of a proposed project or investment.
Cloud technology	The on-demand delivery of IT resources over the Internet with pay-as-you-go pricing.
Deadweight losses	Lost taxation (which must be raised elsewhere) and government expenditure on welfare payments and the health system.
Health equity	A state where everyone does not face unfair, avoidable or remediable differences and is able to attain their full potential for health and wellbeing.
Legacy system	Outdated computing software or hardware that is still in use, but unable to interact with newer systems.
Net present value	A financial metric that seeks to capture the total net value of an investment opportunity in today's dollars.
Productivity losses	Costs associated with a person being unable work due to a health condition. This can take the form of a lower likelihood of being employed, or lower productivity at work.
Telehealth	the provision of healthcare remotely by means of telecommunications technology.
Wellbeing costs	Measure of quality of life lost for an individual with a health condition.

The Asia Pacific is facing more complex health system challenges than ever before, including:

Rise of chronic illnesses such as diabetes and chronic obstructive pulmonary diseases

The ageing of populations and the need for innovations in models of care

Per person health expenditure is up 80% and the workforce is under pressure

Patients, populations and health systems have new and changing needs. Digital technologies will play a key role with:

- Telehealth consultations
- Predicting patient outcomes using data
- Augmented reality for clinician training
- Remote monitoring of patients

Cloud technology can deliver these solutions faster, at scale with greater cost efficiency, delivering significant economic benefits and outcomes, including:

$21.6 billion

in **cost savings** if all hospitals in the nine countries transitioned to cloud, which is equivalent to **$5,963 per hospital bed**.

20%

of total healthcare costs accounted for by heath inequality which can addressed by cloud identifying key populations and **increasing accessibility to healthcare**.

7.6%

increase in diagnostic accuracy for cardiovascular diseases (one of the most prevalent chronic illness globally).

2.2 billion

Vaccines administered in India which was supported using the cloud based platfrom, CoWIN.

1 million

hours saved of manual entry for frontline Covid-19 healthcare workers in New South Wales, Australia in 2021, equivalent to saving 0.5% of the total Full Time Equivalent (FTE) roles in NSW Health.

The healthcare sector is embracing cloud, with investment set to grow 16% a year from **$1.4 billion** in 2022 to **$2.5 billion** in 2026 across the nine countries.

However, cloud in healthcare has the second lowest investment in cloud compared with six select sectors and the second lowest growth in investment over the next five years.

Increasing investment and realising the benefits from cloud enabled healthcare will require addressing the following barriers:

- **Lack of awareness of benefits from cloud**
- **Inadequate existing infrastructure**
- **Significant investment in legacy and outdated IT systems**
- **Skills shortages**
- **Resistance to organisational change**
- **Misperceptions around security of cloud and lack of clarity on cloud governance regulations**

Key actions

to unlock the benefits of cloud technology in healthcare

Action 1:

Develop a **digital health strategy** with funded initiatives supporting cloud deployment and adoption and track progress.

Digital health strategy

Action 2: Build **digital and cloud computing skills** in the healthcare workforce

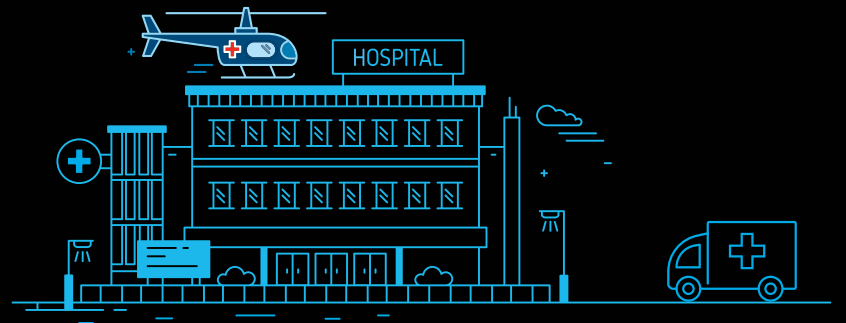
Build skills

Action 3: Make sure **regulatory settings are open to innovation** and clear on data security standards

Consider regulatory settings

Action 4: Get started by **identifying priority areas** (data and operations) to transition to cloud and take action

Identify priority areas



Executive summary

Healthcare across Asia-Pacific is changing, driven by new delivery models, emerging technology and a step-change in citizen expectations.

Healthcare is also facing mounting challenges, with health expenditure per capita growing 80% in the region over the past decade and sector workers facing burnout from the intense COVID-19 period.

More pressure will emerge in coming years because of increasing rates of chronic illness, such as cardiovascular diseases and diabetes, and general population ageing. In the Asia Pacific region, one in four people will be over sixty years old by 2050, three times the share in 2010.

Public and private providers are searching for new ways to deliver quality care in an accessible and cost-efficient way, including by using new technology.

The pandemic saw extraordinary growth in telemedicine. There is an opportunity to build on the experiences with innovations that have been long-promised results, such as electronic health records and remote monitoring of patients, and emerging opportunities, whose dividends are potentially large, such as precision medicine from genomics and use of virtual and augmented reality.

Many changes are needed to deliver on the promising future of digitally-enabled healthcare, across systems, organisations, government policy and acceptance by the community. A key question is what change is needed in technology infrastructure to support change.

This report focuses on the question: **how can cloud accelerate the digitisation of health to support greater health equality, increase productivity and improve outcomes for patients?**

Research for this report draws on a host of evidence from nine Asia-Pacific countries: Australia, New Zealand, Indonesia, Singapore, Malaysia, India, Thailand, South Korea and Japan.

It finds that cloud technology plays an important role in enabling many different types of technologies by providing on-demand data storage and computing power that enables data intensive applications.

To support government decision makers build their case for investment in cloud, a database of 66 unique cloud use-cases in healthcare was developed and analysed for research to demonstrate the range of benefits for patients, healthcare organisations and national health systems.

- **For national health systems:** cloud can help the system respond to health events efficiently. For example NSW Health used an automated system to deliver COVID-19 test results via the cloud which saved over **1 million hours for frontline healthcare workers** manually notifying patients of negative results. This time saving is equivalent to about 480 full time equivalent roles or 0.5% of the total NSW health workforce, which could be used for other purposes.

  Cloud computing has been used by Insilico Medicine to analyse one billion compounds in a single day, a process that would otherwise take a month. One research project was accelerated by three years, reducing average costs by $1.1 billion.

- **For health organisations:** cloud can reduce operating costs by using on-demand data storage rather than fixed infrastructure. Using research from the AWS Cloud Economics Centre, this report estimates that $21.6 billion in cost savings could be realised over five years if all hospitals across the nine countries transitioned to cloud.

  More specifically Blue Mirror's 'PPE buddy' app uses artificial intelligence to train the healthcare workers in donning and doffing of PPE equipment. This reduces the need for senior staff to train new workers, with an average time saving of 10-15 minutes per worker.

- **For patients:** cloud can help deliver improved outcomes. One study found that cloud enabled machine learning was found to detect an additional 7.6% of instances of cardiovascular disease relative to clinician assessments. Cardiovascular disease is the leading cause of death in both Australia and New Zealand, with an estimated 1.2 million Australians and a further 230,000 New Zealanders suffering from the disease.

  DetectedX provides a radiology training program for clinicians to diagnose breast and chest cancer based on imaging, which has improved the accuracy of clinicians by between 21% to 31%.

The range of benefits identified from the use case database is summarised in the benefits framework. While there are 17 separate benefits identified, many reinforce each other, such as diagnostic innovation and improved patient outcomes. Figure 2 supports this with a summary of the costs and benefits associated with cloud technology in healthcare.

The healthcare sector is already cognisant of the importance of cloud. According to IDC data collated for this report, investment in cloud by the public healthcare sector across the nine countries reached $1.4 billion in 2022, a figure expected to grow by 16% a year to $2.5 billion in 2026. This includes investments in cloud infrastructure as well as purchases of platforms that utilise cloud.

Investment in cloud for the healthcare sector is led by **Singapore ($24 per capita), Australia ($18 per capita),** and **New Zealand ($16 per capita).** Other Asia-Pacific countries spend significantly less in per capita terms to these countries.

And despite the significant forecast growth, cloud investment for healthcare is significantly less than other sectors such as finance (worth $5.7 billion in 2022 across the nine countries). Facilitating greater public investment in cloud technology and infrastructure would help realise the benefits identified in the use case database.

Figure 1: Benefits framework of cloud technology in healthcare

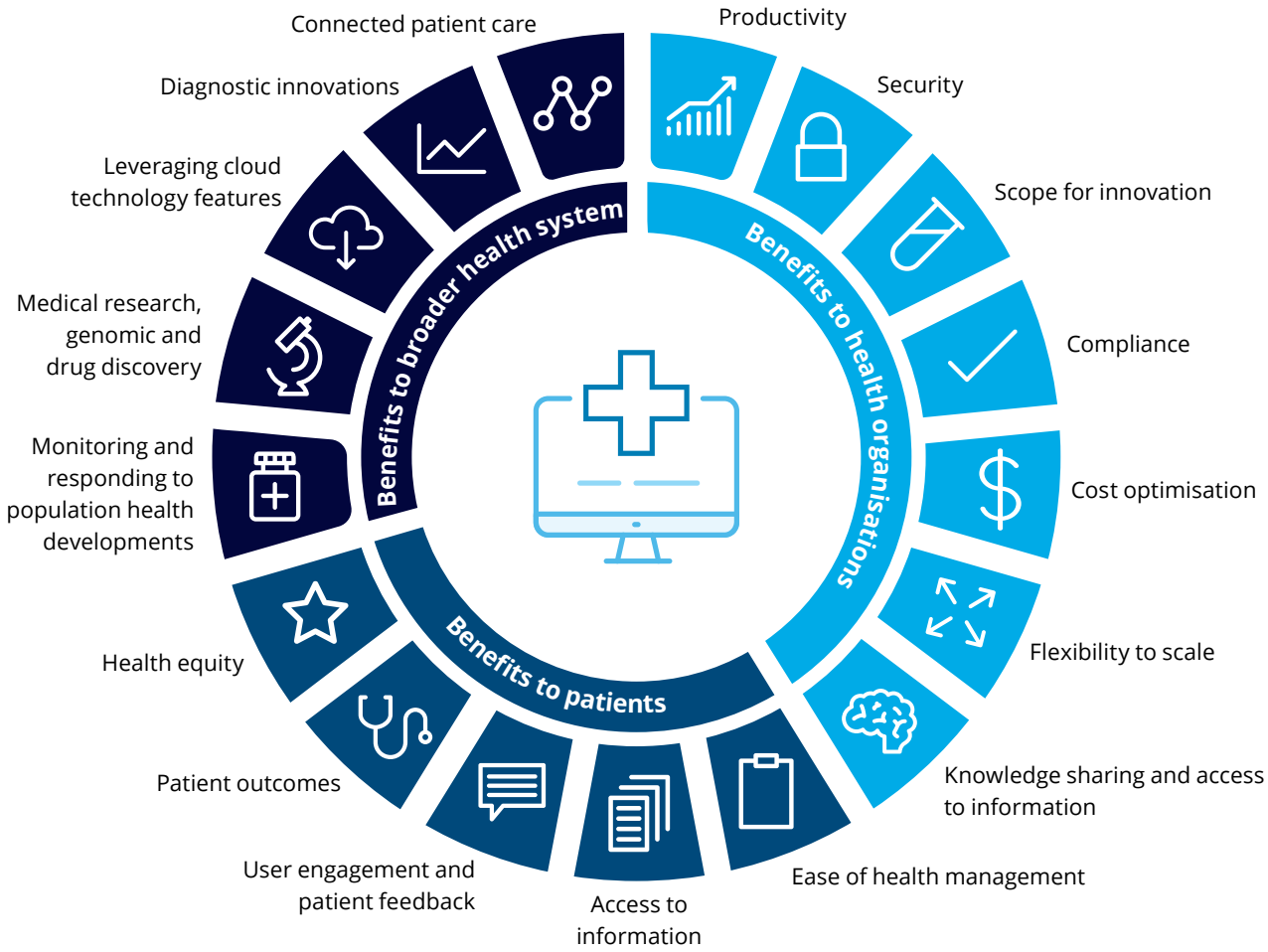


Figure 2: Economics of cloud technology, benefits and costs

Economic benefits	=	Health system productivity benefits	+	Avoided health system costs	+	Patient wellbeing benefits	+	Economic productivity benefits	+ Health equity benefits
Economic costs	=	Build costs	+	Transfer costs	+	Decommissioning costs	+	Operating costs	+ Program management

Next steps

There are several key barriers to greater investment and adoption of cloud enabled health technologies:

- **Significant investment legacy and outdated IT systems** may contribute to lack of investment due to concerns around the cost of transition.
- **Skill shortages in cloud computing,** with one survey finding skill shortages limited cloud adoption in nearly half of public sector organisations across South East Asia.
- **Inadequate digital and cloud infrastructure** which may limit adoption in developing countries and regional areas of developed countries.
- **Resistance to organisational change** for already strained senior decision makers and healthcare workers.
- **Lack of awareness about cloud features,** including the potential benefits, clarity of regulations, perceived costs and security issues.
- **Security and privacy concerns,** driven by a lack of awareness of how data is stored on the cloud and a lack of personal data protection regulations in some countries.

While each national healthcare system or specific organisations may be at different stages in their adoption of cloud, with some barriers having a greater impact or relevance, every system could be doing more to accelerate the adoption of cloud or improve the realisation of key benefits. The following four key priority areas were identified to help address the barriers and support greater cloud adoption.

Develop a digital health strategy and track progress with funded initiatives supporting cloud deployment and adoption

While all countries considered for this research have an overall digital strategy, some do not have health sector specific strategies or explicitly acknowledge the role of cloud. A well developed strategy should include a cloud first mandate for new digital health infrastructure and specify timeframes for transitioning legacy IT systems.

More broadly, the way the healthcare systems are set up needs to change. Traditional funding models for new health infrastructure often involves designing and building physical infrastructure before considering how services will be delivered. Ensuring new infrastructure is fit for purpose will require planning the digital delivery of services as new infrastructure is designed.

Removing fundings arrangements that may create disincentives to delivery of healthcare services through digital means will also encourage adoption of cloud enabled technology.

A digital health strategy should also identify and prioritise use cases that would have the largest impact for their organisation or health system. For those countries that have incorporated cloud in their digital strategies, it will be key to evaluate progress against stated objectives and identify areas where progress has stalled (e.g. in regional or remote areas).

Building digital and cloud computing skills in the healthcare workforce

All healthcare roles are increasingly requiring digital and cloud computing skills. The extent and types of these skills will vary depending on the occupation. For example, frontline healthcare workers (like doctors and nurses) may require data skills to use applications on the cloud while researchers and hospital IT workers will need greater understanding of the back-end cloud infrastructure. Healthcare management staff have a variety of digital tools now available to improve management of health providers.

Cloud computing alongside broader digital skills are some of the most in-demand skills across all industries. Healthcare organisations and systems need to attract ICT workers to consider careers in healthcare alongside supporting existing staff to upskill and reskill through short-courses or microcredentials.

To supplement their direct workforce capabilities, healthcare organisations should partner with external organisations or outsource some tasks and functions to fully utilise cloud enabled technology and the digital applications.

Make sure regulatory settings are open to innovation and clear on data security standards

Broader regulatory environments influence the willingness of organisations to experiment and innovate with new technologies or delivery models. The use of principle based regulations and other regulatory models could be used to encourage innovation to create a healthcare culture conducive to adopting cloud enabled technologies.

Meaningful consultation and engagement with the broader health industry (pharmaceuticals, MedTech and industry associations) will also be important to ensure regulatory settings are fit for purpose and do not have unintended outcomes on digital adoption.

In particular, the existence of clear data protection laws and a privacy enforcement authority, as well as adherence to internationally recognised privacy principles and best practices for data can help develop trust in public healthcare organisations to transition to cloud for the first time or become fully cloud native. Where these structures already exist, the healthcare authorities must work with regulatory bodies and public and private healthcare organisations to develop, update and provide training on regulations related to data security, data privacy and protection.

Get started

Healthcare decision makers should identify priority areas to transition to cloud and take action. This may include foundational datasets or operations can be better stored and analysed in cloud.

Telehealth consultations are a key example of a healthcare service that has been shown during COVID-19 to operate better in a cloud environment to accommodate surges in demand.

Once the foundational datasets are identified, Healthcare decisions makers need to develop a business case for the investment that quantifies the specific benefits and costs of the investment.

Focusing on these four areas will help health systems across Asia-Pacific transition to the cloud and unlock the significant benefits identified in this research. This will help manage emerging challenges facing the sector and improve the quality of life for citizens across the Asia-Pacific.

Checklist for unlocking the potential of cloud in healthcare

A digital strategy to support cloud deployment and adoption

- ✓ Develop a digital health strategy referencing cloud with funded initiatives to support deployment and evaluate progress on objectives
- ✓ Include a cloud first mandate in the strategy
- ✓ Consider digital delivery of healthcare services during the design of new health infrastructure
- ✓ Assess funding arrangements and their impact on incentivising digital delivery of healthcare

Building digital and cloud computing skills

- ✓ Actively attract workers to healthcare with the key capabilities
- ✓ Build skills in existing staff by promoting awareness of relevant microcredentials and incentivising participation
- ✓ Partnering and outsourcing functions and tasks to external organisations

Regulatory settings open to innovation and clear on data security standards

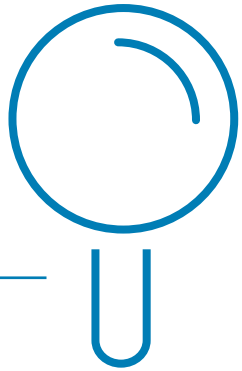
- ✓ Use principle based regulations to encourage innovation
- ✓ Clear data protection laws with a privacy enforcement agency
- ✓ Consultations and engagement with broader industry on regulation development and relevant privacy requirements in cloud

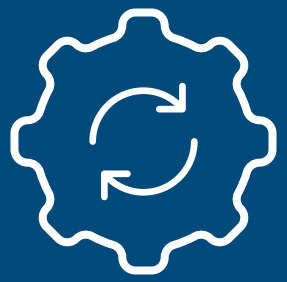
Get started

- ✓ Identify priority areas to transition to cloud and set timeframes for goals.
- ✓ Develop the business case

Key findings

- Ageing populations across the Asia-Pacific are leading to rising demand and expenditure within healthcare systems across the region. More than a quarter of the population of Asia-Pacific will be 60 years or older by 2050.
- Governments are trying to reduce expenditure after significant costs during COVID-19 outbreaks and associated border restrictions.
- Digitisation of the healthcare sector has accelerated during the COVID-19. The digital health market in Asia-Pacific was estimated to be valued at over $20 billion and is anticipated to expand at 21% each year on average between 2021 and 2027.
- Governments are recognising the benefits of digitisation in healthcare but need to make sure investments are targeted to maximise efficiencies and benefits.





The case for change

Demographic changes lead to increasing demand for healthcare

The way healthcare is delivered and its reach is changing. Demographic trends in Asia-Pacific are leading to rising demand and expenditure for healthcare systems throughout the region. **Between 2009 and 2019, health expenditure per capita in the Asia-Pacific region has grown by almost 80%.**[1] These long-term trends combined with rapid spikes in healthcare expenditure resulting from COVID-19 have put pressure on governments to provide healthcare in an accessible and efficient way. New and emerging technologies present means of increasing the efficiency of delivery, improving access and quality of care for patients.

Increasing demand for healthcare

More than a quarter of the population of Asia-Pacific (or 1.3 billion people) will be 60 years or older by 2050, representing a tripling of this share since 2010.

Life expectancy is also on the rise throughout the region, increasing by approximately 4.6 years between 2000 and 2015 to 73.7 years on average.[2] Chart 1 shows the shifting demographic structure across Asia-Pacific.

Ageing populations are expected to lead to a relative increase in the demand per capita for health services while simultaneously decreasing the availability of the working population to meet this demand. Cumulative healthcare expenditures on elderly populations in Asia-Pacific from 2015 to 2030 are expected to exceed $31 trillion.[3]

The prevalence of chronic illness and multimorbidity are also increasing, attributed to rapid urbanisation, sedentary lifestyles and rising obesity levels. This is not limited to developed countries in the region, with China and India having the largest number of diabetes sufferers in the world.[4]

In Australia, modelling around demographics and morbidity suggests that healthcare workers will need to deliver four times the current service level or output to meet forecast needs by 2050.[5]

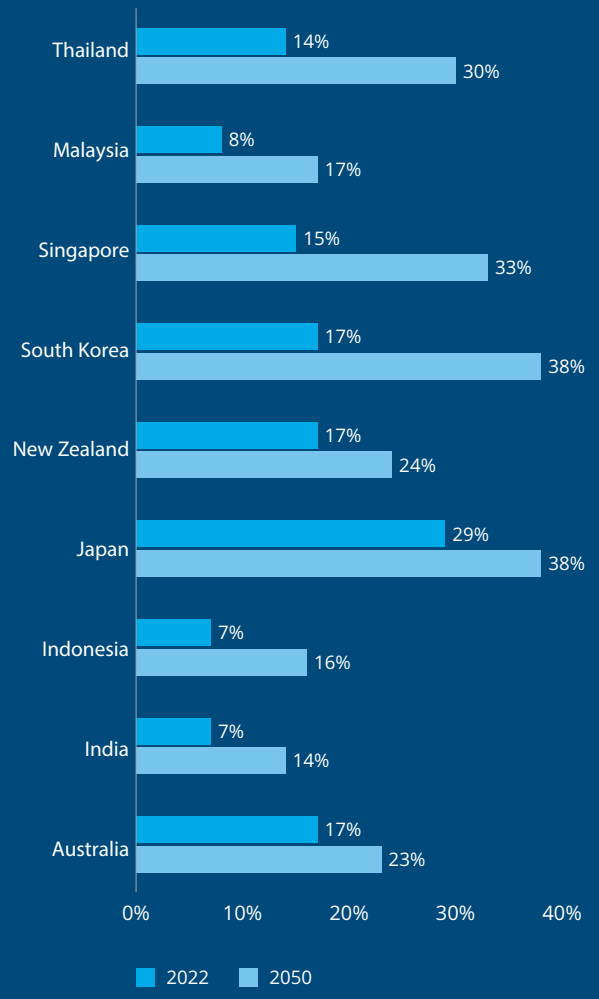
Rising expectations for healthcare

The way that people consume health services is changing. For example, consumers in Asia-Pacific are becoming more conscious of health and wellness and are more actively engaged in health maintenance and preventative care.[6]

Access to healthcare

At the same time as increasing expenditure in healthcare, many countries throughout Asia-Pacific are seeking to increase access to healthcare. Within the Asia-Pacific region, the number of doctors per 1,000 population generally being below the Organisation of Economic Co-operation and Development (OECD) average.[7] Access to healthcare is also often uneven across regional and remote populations. In Indonesia, metropolitan regions have roughly five times the number of physicians compared with remote areas and even within cities patients are often deterred by traffic.[8]

Chart 1: Percentage of population expected to be 65 years and over by country



Source: The World Bank

Technology and digitisation improve the delivery of healthcare

Technology and digitisation of the healthcare sector has brought significant benefits to Asia-Pacific which help to alleviate growing demographic pressures. The key benefits include improved decision making through increased availability of data as well as accessibility of care and automation.

One study estimates that around 40% (or $575 million) of the global economic impact associated with the introduction of 5G enabled applications will be a result of improvements made to healthcare. This includes benefits associated with remote monitoring and online consultations, real time in-hospital data sharing and automation in hospitals.[9]

Availability of data and information

The ability to rapidly share and access data enables healthcare professionals to make more informed decisions faster, improving quality of care. Advancements in large-scale data capture in healthcare has particularly benefited medical research with increased access to larger and more diverse population health datasets.

The use of electronic medical records offers significant benefit by providing an integrated and easily accessible record of a patients medical information. This not only improves efficiencies but allows healthcare professionals to make more timely and informed decisions for their patients.

The growing availability of data has opened the potential for advanced data analytics, with the number of physicians leveraging artificial intelligence or machine learning, which more than doubled between 2019 and 2021.[10]

Accessibility of care

Accessibility of care is an important benefit of digital adoption in healthcare and something that has been accelerated throughout COVID-19.

Technology enabled telehealth services were a crucial means of providing safe and accessible healthcare during the pandemic. Telemedicine usage across the Asia-Pacific region has nearly doubled since 2019 while in Australia it increased ninefold and in New Zealand it has increased fifteenfold.[11,12] This trend has continued to provide benefits in accessibility particularly to those that live in rural or regional areas with limited access to in-person healthcare or in countries where primary care is limited, with 39% of consumers from Indonesia preferring a virtual touch point in 2021, up from 30% in 2019.[13]

Realising this, Halodoc built a rapidly scalable health platform which now provides accessible virtual healthcare to 20 million users every month in Indonesia.

Mobile apps have also been developed to simplify access to healthcare by providing centralised platforms where one can seek health information and manage various aspects of healthcare such prescriptions, consultations and hospital appointments.

Wearable technology also offers accessible means of monitoring health, from fitness apps to the remote monitoring of people with chronic heart issues. Throughout Asia-Pacific, mobile digital health and fitness activity increased by around 25% during the first half of 2020, based on a Global Mobile Consumer Trends Survey.

Automation

Technology has enabled significant advances in automation to improve efficiency in the healthcare sector. This has been particularly beneficial in relieving the high administrative burden associated with compliance or delivering pathology results. For example, NSW Health Pathology in Australia created an SMS automated notification service that delivers COVID-19 test results, this service saved frontline workers over 1 million clinical hours of manually notifying patients.[14] Further, many types training for healthcare professionals are now able to be standardised and automated through online learning systems.

Digitisation of healthcare is accelerating

Growth in digitisation of healthcare

The increasing digitisation of healthcare is expected to continue following the sharp rise during COVID-19. The digital health market for countries located in the Asia-Pacific was estimated to be valued at $22.2 billion in 2022 and is anticipated to increase at a compound annual growth rate of 17% from 2022 to 2027.[15]

A study found that Asia-Pacific will be the fastest growing digital health market out to 2028, a trend which has been associated with comparatively high rates of smartphone use, adoption of smart wearables and demand for electronic medical records.[16]

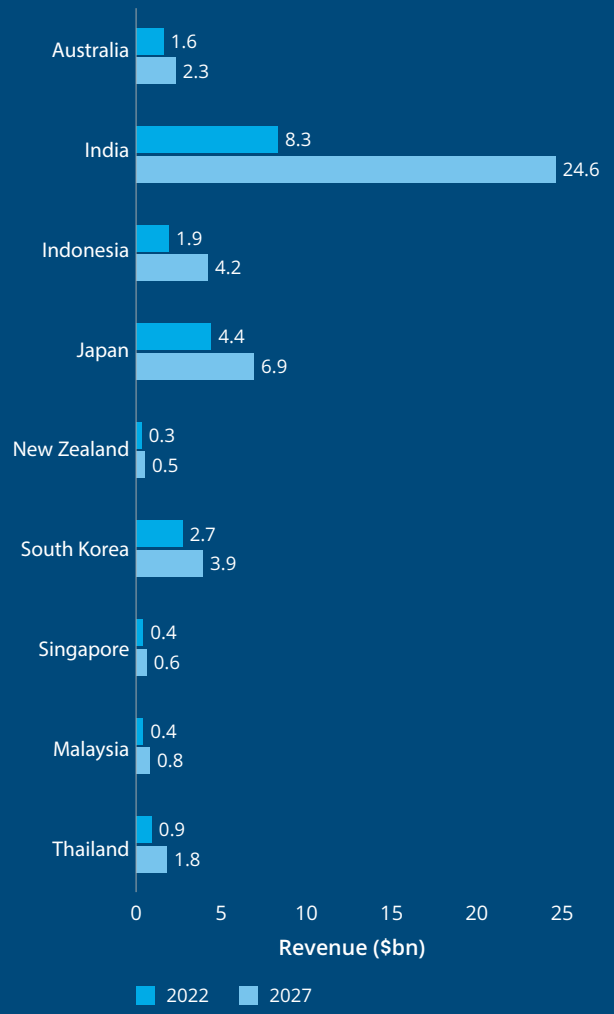
Further, the growing tendency toward digital health among consumers is expected to lead to particularly strong growth for companies producing and developing innovative remote health monitoring devices. The size of the digital health hardware market in the Asia-Pacific is expected to grow by 25% before 2027.[17]

As their digital health capabilities grow, countries have an opportunity to export digital health services to other countries. For example, Australia's digital exports are estimated to grow by 210% by 2030, with related benefits particularly relevant in health, resources and infrastructure.[18]

Chart 2 shows the relative size and expected growth based on revenue of digital health markets in key Asia-Pacific countries. India currently has the largest digital health market estimated at $8.8 billion, followed by Japan ($4.6 billion) and South Korea ($2.9 billion). While there is variability in the expected growth going forward, all key markets are expected to grow by 2027, and some such as India and Indonesia are expected to more than double in size. A key component of these digital health markets going forward is expected to be digital fitness and wellbeing, driven by the increased consumer preference for self-monitoring of health.[19]

As the digitisation of the health industry continues to accelerate, so will adoption of cloud technologies that leverage and complement other aspects of digitisation. However, technology and digital systems need to be implemented appropriately and effectively in order for benefits to be realised and for investment to be translated into patient outcomes.

Chart 2: Relative size of digital health markets based on revenue ($bn)



Source: Statista

Governments are responding to the growing trends in digitisation

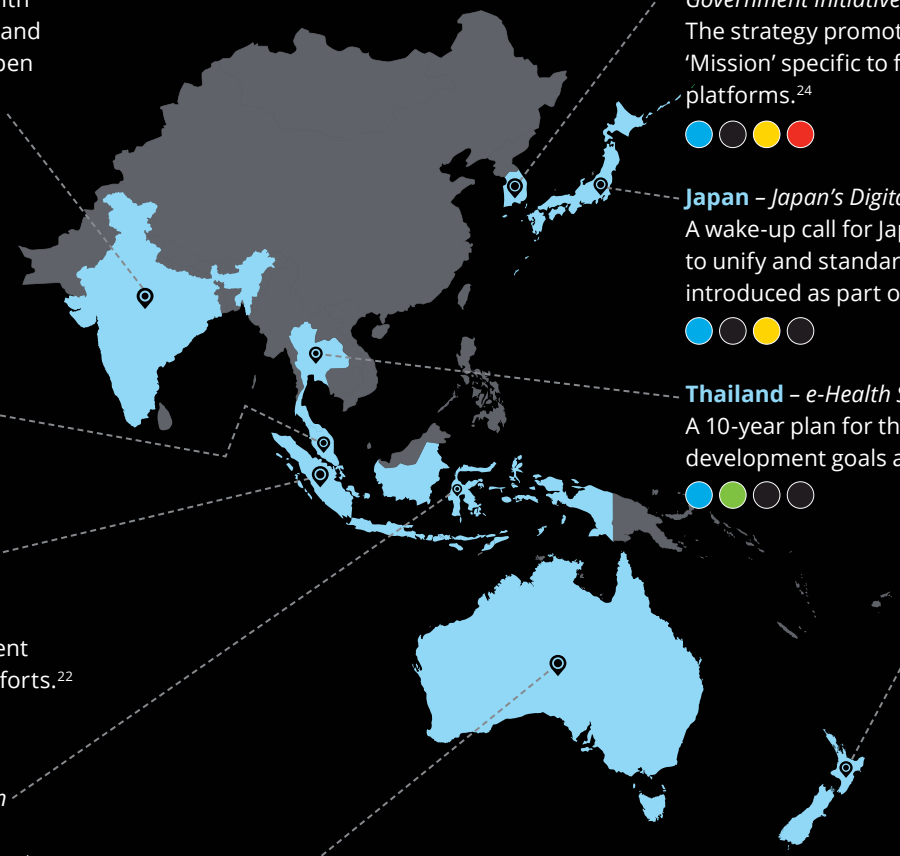
To increase adoption and realise the benefits from digital technologies, a number of governments across Asia-Pacific have developed strategies to support the adoption of technologies and cloud. The figure below summarises the strategies, whether they relate to healthcare sectors and cloud initiatives.

India – *National Digital Health Blueprint (NDHB) (2019)*
Key principles of the Blueprint include universal health coverage, inclusivity, security and privacy by design and from the technology perspective interoperability, open standards and set of registries as a single source of truth.[20] The Government of India also introduced a cloud first policy in 2013.

Malaysia – *Malaysian Health Data Warehouse (MyHDW) (2017)*
A national healthcare information gathering and reporting system covering all government and private healthcare facilities and services.
The integrated nature of MyHDW will overcome system inconsistency problems and make the data accessible without time and location boundaries.[21]

Singapore – *Smart Nation*
Encouraging every industry, business and government agency stepping up to accelerate its digitalisation efforts.[22]

Indonesia – *Blueprint of Health Digital Transformation Strategy 2024 (2021)*
Aims to lay the ground for building enterprise architecture of health technology. Rests on key pillars such as a digital integration of health information on patients and health providers, as well as an integrated development of digital health infrastructure.[23]



South Korea – *Digital Government Master Plan and Digital Platform Government Initiative (2021)*
The strategy promotes the digitisation of public services and features a 'Mission' specific to facilitating data based government through cloud-based platforms.[24]

Japan – *Japan's Digital Policy (2022)*
A wake-up call for Japan's digital transformation. A government-cloud platform to unify and standardise IT systems across local governments is set to be introduced as part of this strategy.[25]

Thailand – *e-Health Strategy 2016*
A 10-year plan for the development of e-government services, including several development goals and government support earmarks for digital health.[26]

New Zealand – *The Digital Strategy for Aotearoa (2022)*
As part of this strategy along with other health reforms $170 million NZD was approved to Hira (a digital health capability), to improve health and disability sector digital infrastructure and capability.[28]

Australia – *Digital Economy Strategy (2022)*
Identifying the key areas for strategic investment across the economy to support digital growth, including an investment of $1.1billion AUD in 2022. Some of this investment will support innovation in health technology.[27]

Legend – National strategies
- Overarching digital government strategy
- Digital health strategy
- Specific cloud references in strategy
- Funding allocated for initiatives supporting cloud adoption

Data security standards vary across the region

Clear data security standards supported by legislation and reciprocal compliance are necessary for ensuring trust in cloud systems and subsequent cloud adoption. One measure of a country's data security standards is reflected in the Global Cybersecurity Index.[29] The below figure summarises key results of the index and health specific data standards.[30,31,32,33]

India is ranked 7th in terms of preparedness related to data security standards, with significant variation in the extent of this preparedness across the country. In 2022, the National Health Authority published its Health Data Management Policy.

- Global Cybersecurity Index: 97.5

Malaysia is ranked 4th in relation to its preparedness, with strong regulatory cooperation and a comprehensive policy regime. However, there is a lack of regulatory clarity related to use of cloud specifically in healthcare.

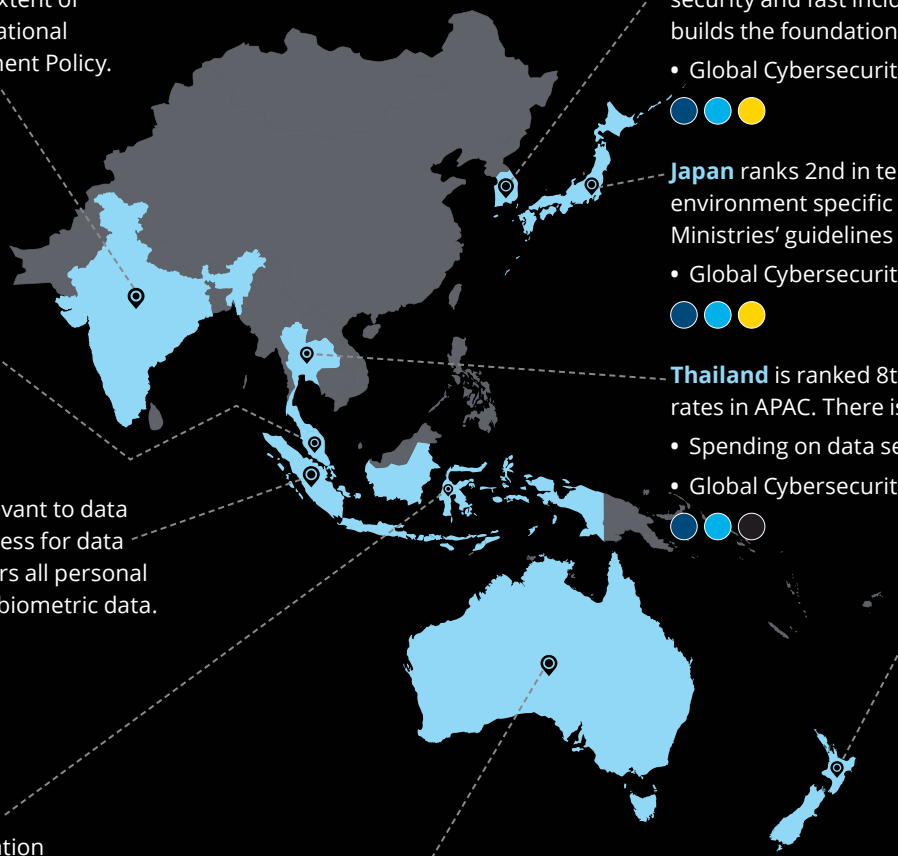
- Spending on data security, 2015-25 CAGR: 15%
- Global Cybersecurity Index: 98.06

Singapore ranks the highest in its preparedness relevant to data security, with sound legal and organisational awareness for data security. The Personal Data Protection Act 2012 covers all personal data, including management of healthcare data and biometric data.

- Spending on data security, 2015-25 CAGR: 12%
- Global Cybersecurity Index: 98.52

Indonesia rranks 9th in data security preparedness. However, increasing digitisation in recent years may lead to enhanced preparedness. Government Regulation on Health Information System provides standard procedures for protection of health data.

- Spending on data security, 2015-25 CAGR: 23%
- Global Cybersecurity Index: 94.88



South Korea ranks 6th in preparedness, boasting high rates of R&D into data security and fast incident response times. The Medical Service Act of 2002 builds the foundation for safe storage of EMR in the cloud.

- Global Cybersecurity Index: 98.52

Japan ranks 2nd in terms of preparedness with a strong legal and policy environment specific to data security. The 'Two Guidelines from Three Ministries' guidelines govern medical information stored in the cloud.

- Global Cybersecurity Index: 97.5

Thailand is ranked 8th in its preparedness and faces one of highest cyber attack rates in APAC. There is no regulatory guidance specific to cloud in healthcare.

- Spending on data security, 2015-25 CAGR: 12%
- Global Cybersecurity Index: 86.5

New Zealand ranks 5th in relation to its preparedness. The Health Information Privacy Code 2020 specifies requirements to protect health data.

Global Cybersecurity Index: 84.04

Australia is ranked 3rd in preparedness related to data security, largely thanks to strong legislation and education. The My Health Records Act 2012 specifically works to protect healthcare data in the cloud.

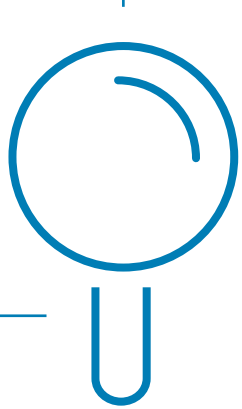
- Spending on data security, 2015-25 CAGR: 11%
- Global Cybersecurity Index: 97.47

Legend – National data security standards

- Legislation on personal data security
- Legislation on data security in healthcare
- Cloud specific legislation on data security in healthcare

Key findings

- A database developed for this research has identified 66 applications of cloud in healthcare along with 17 key benefits for healthcare organisations, healthcare systems and patients.
- The healthcare sector across Asia-Pacific is embracing cloud with $1.4 billion worth of investment in cloud for healthcare. This investment is forecast to increase by 16% each year on average to $2.5 billion by 2026.
- Despite this growth, healthcare accounted for less than 3% of total investment cloud technology in 2022, with the share expected to continue to decline over the next four years.
- High income countries such as Singapore ($24 per person), Australia ($18 per person), and New Zealand ($16 per person) are spending more than five times the next nearest country in per capita terms.



The role of cloud

The growing role for cloud in healthcare

Cloud solutions and platforms unlock the value of technology and digitisation in healthcare by providing on-demand data storage and computing power that enables data intensive applications. Cloud enabled technologies include virtual healthcare, big data analytics predicting patient outcomes using electronic health records, virtual and augmented reality for training purposes, and remote monitoring of patients.

Cloud technologies also enable greater interoperability between platforms and applications which leads to greater integrating and analysis of broad data from multiple sources.

The applications of cloud computing in health in Asia-Pacific are broad and diverse, covering almost all aspects of the health industry from health platforms to organise consults to enabling artificial intelligence to improve diagnostic precision.

For this research, a database of 66 unique use-cases specific to cloud in healthcare was developed to demonstrate the range of cloud enabled applications (see Appendix A for the complete database). The database was built on the following sources of information:

- a broad scan of academic literature
- global organisations such as the World Health Organisation, the Organisation of Economic Cooperation and Development, and the World Economic Forum case
- research and studies provided by cloud providers (including AWS)
- case studies of organisations using cloud enabled technologies provided specifically to Deloitte to inform this report.

The use cases can be broadly categorised into the following six categories, noting that some use-cases may fit in more than one category.

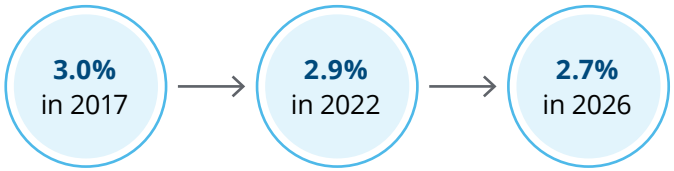
- **Remote monitoring (10 use-cases) –** including the remote monitoring of patients health data to track and predict health outcomes in real time.
- **Telehealth/telemedicine (5 use-cases) –** including digital platforms which enable patients to access healthcare remotely such as through video conferencing.
- **Data analytics and research (19 use-cases) –** including platforms which enable health organisations and researchers to process large amounts of data and derive insights more efficiently.
- **Health databases (12 use-cases) –** including platforms which manage and provide access to large amounts of health data, often interoperable across a health system.
- **Interactive health platforms (13 use-cases) –** including digital platforms which enable patients to access information about their health and manage various aspects of their health remotely, such as prescriptions.
- **COVID-19 response (7 use-cases) –** including digital platforms designed to manage the COVID-19 pandemic such as through contract tracing and distribution of test results.

Cloud investment for healthcare is forecast to grow by $1.6 billion by 2026

The nine countries examined in this report are embracing cloud technology. IDC data was used to analyse to understand investment trends in cloud technology of the healthcare sector across the nine countries in scope for this report.[34] Total investment in cloud technology in healthcare for these countries was estimated to be **$1.4 billion** in 2022. This represents significant growth over the last five years, with spending on cloud growing at a average annual growth of 26%.

This growth is expected to continue with a compound annual growth rate of **16%** over the next four years. By 2026, total investment in cloud is forecast to grow to **$2.5 billion**. Relative growth is expected to be largest in the developing countries including India, Indonesia, Malaysia and Thailand. In comparison, the financial services sector (which already has investment worth $5.7 billion in 2022) is forecast to grow at a compound annual growth rate of 18% over the next four years.

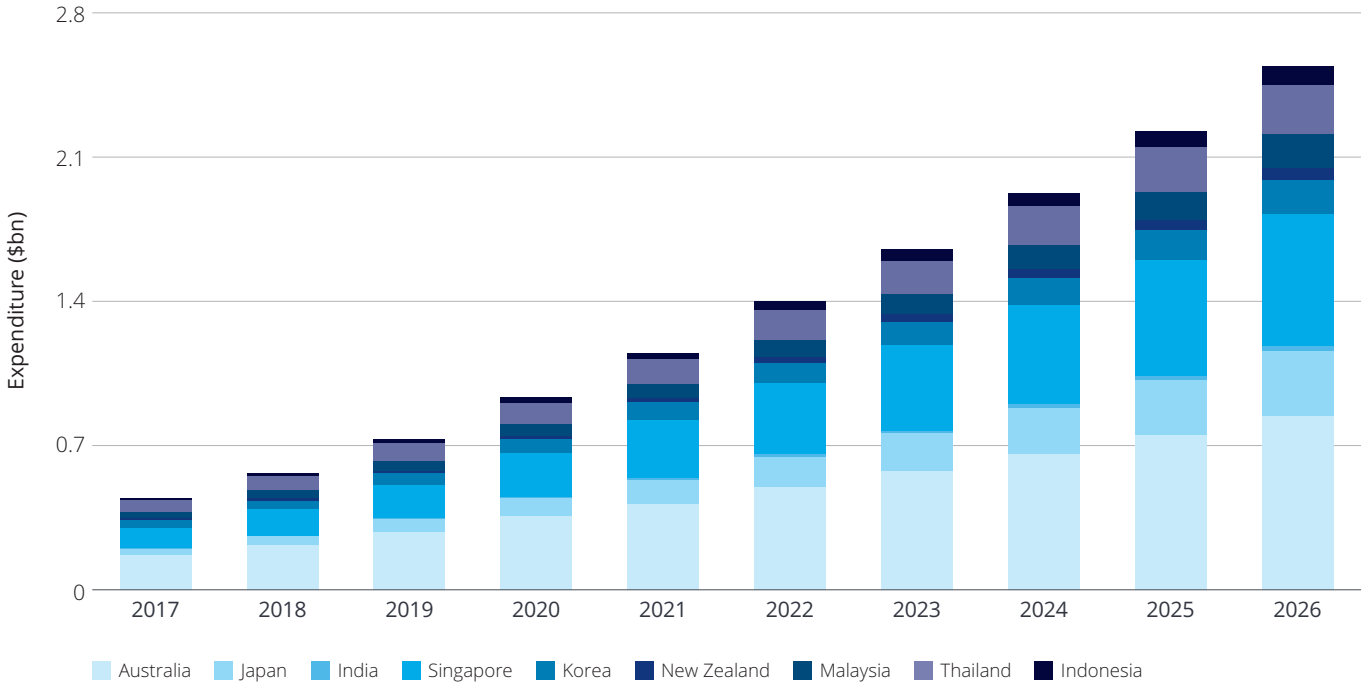
Despite this growth, relative to the total investment in cloud technology in the region, healthcare only comprised approximately 2.9% of total spending on cloud technology in 2022, with the share expected to continue its decline over the next four years. This indicates significant benefits could be realised if barriers to cloud technology investment are removed in order to incentivise spending in the region.



There is also disparity in investment across countries. High income countries have the largest per capita spend on cloud technology in healthcare - with Singapore ($24 per person), Australia ($18 per person), and New Zealand ($16 per person) and are all spending more than five times the next nearest country in per capita terms.

While investment in cloud in healthcare is expected to increase across Asia-Pacific, the forecast to 2026 indicates that the gap in spending between developed and developing countries will remain significant.

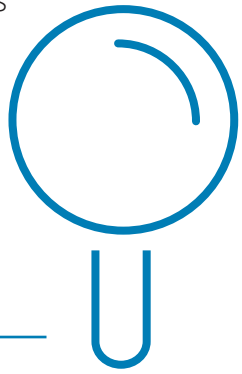
Chart 3: Cloud expenditure in health, 2017-26



Source: IDC data

Key findings

- Government decision makers need to consider the business case for cloud technology that considers incremental costs and benefits of investments. Our research finds cloud technology adoption in healthcare is associated with 17 key benefits including greater productivity in healthcare organisations, improved patient outcomes and supporting efforts to address health equity.
- For patients, cloud enabled machine learning was found to detect an additional 7.6% of cardiovascular disease events relative to clinician assessments. Nearly 60% of cardiovascular diseases occur within Asia-Pacific.
- Healthcare organisations could see substantial reductions in direct operating costs from transitioning to cloud. There could be $31.6 billion in cost savings if hospitals across the nine Asia-Pacific countries transitioned to the cloud.
- Cloud also enables quick responses to major health events. The cloud-based platform CoWin has led to 2.2 billion vaccine rollouts across India.



Economics of cloud in healthcare

Economics of cloud technology

Investment decisions for the use of cloud technology in healthcare settings, typically involve a cost benefit analysis. This section of the report examines evidence and use cases that can be used to support undertaking this analysis.

CBA involves a comprehensive framework to identify the **incremental costs and benefits from various investment options relative to a base case for the relevant appraisal period**. While the base case, costs and benefits will largely depend on the individual context of the investment decision some overarching themes are identified in this report.

The base case for the investment is likely to involve the use of on-premise data storage, a hybrid environment involving a concurrent use of cloud and on premise data storage or the absence of particular use cases for cloud technology. The trends identified in the case for change section – rising health expenditure caused by ageing populations and rising expectations for healthcare among citizens should be built into the base case.

The cost benefit analysis examines the incremental monetary and non-monetary costs and benefits to a society.

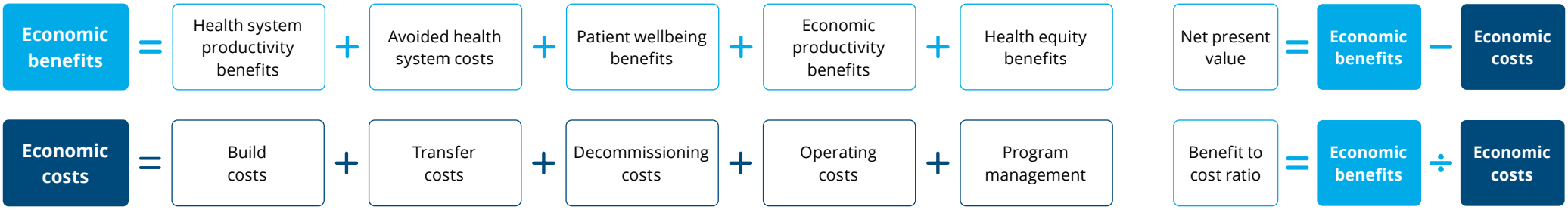
Benefits of investment in cloud include higher productivity of the health organisations and the health system, improved patient outcomes and greater health equity that come from using cloud technology (these benefits are examined throughout this section).

Relevant costs for the investment in cloud includes the build costs of the cloud platforms, transferring existing applications to cloud, decommissioning technology costs, ongoing operating cost of cloud and management of the transition (these costs are explored in page 38).

While costs tend to be relatively easier to estimate as they often have established commercial benchmarks, health benefits associated with improved patient outcomes can be difficult to quantify in monetary terms and therefore cost effectiveness measures – identifying the outcomes achieved for the associated cost of the relevant option.

Investment decisions based on the cost benefit analysis should consider the benefit to cost ratio (BCR) and net present value (NPV). While both the BCR and NPV are important decision making tools to ensure the efficacy of any government investment, there is need to consider how investments also align to broader government strategies (such as supporting digital government) and any benefits that have not been able to be quantified due to lack of information.

Figure 3: Economics of cloud technology, benefits and costs



An economic benefits framework for cloud investments

There are a range of economic benefits identified from the use of cloud technology and its applications in healthcare yet there have been relatively few studies quantifying the impacts. To fill this gap, a bespoke database of cloud use cases was developed for this report to support the case for investment in cloud technology.

Figure 4 shows the range of key benefits that cloud supports for patients, healthcare organisations and the broader health system. Given the broad array of potential cloud applications that may not even be currently realised yet, this benefit framework is not intended to be exhaustive but to capture those that are most significant or common. The listed benefits are also not necessarily independent from one another.

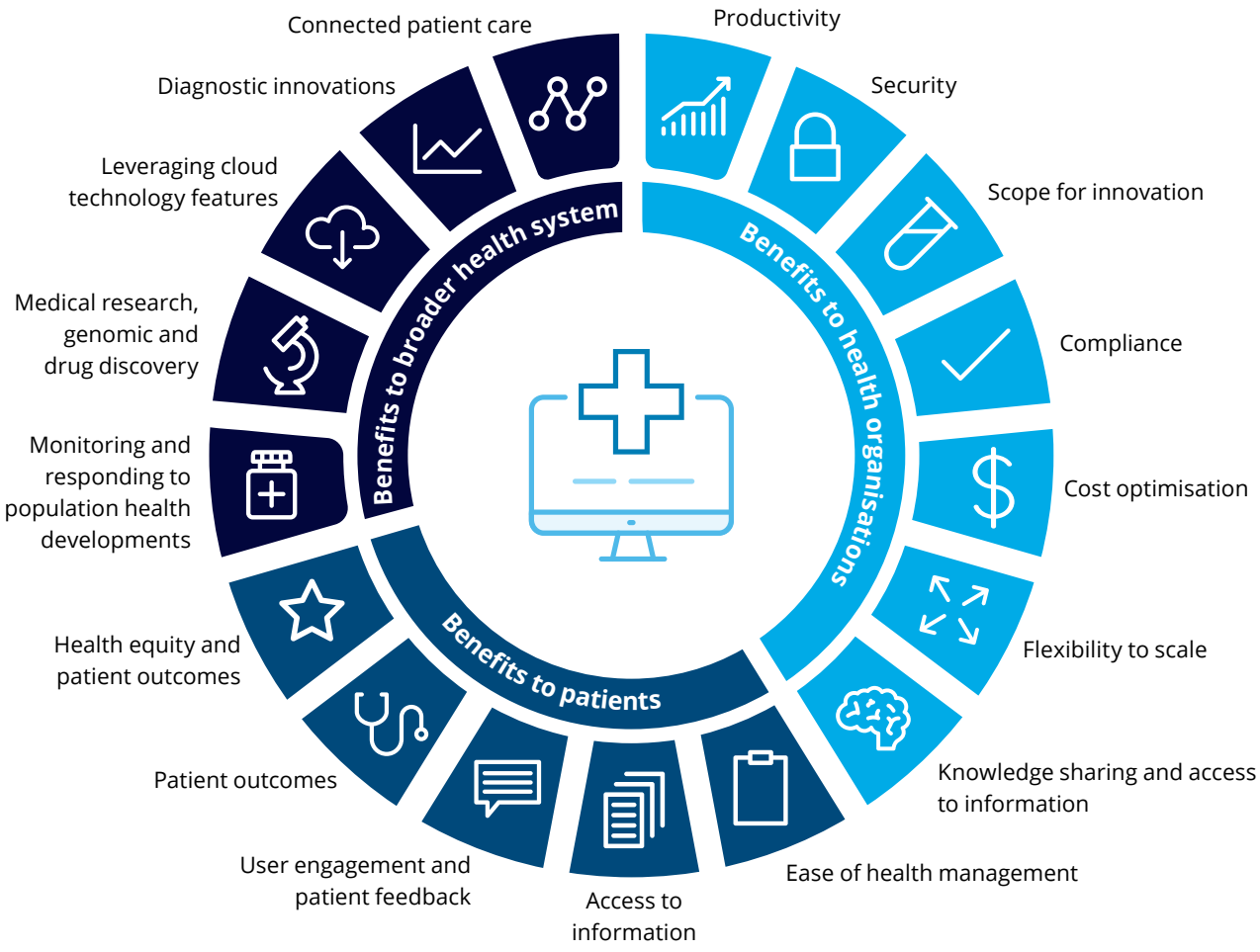
Use of cloud technology benefits **patients** by improving their experience through greater access to information and ease of health management, as well as improvements in health outcomes such as through remote monitoring of health.

The benefits realised by **health organisations** mostly relate to improved efficiencies (through flexibility to scale and cost optimisation) in addition to greater scope for innovation and improved security.

In reference to the **broader health system,** benefits often relate to improved capacity to monitor population health, benefits in research and diagnosis and interoperability of data and systems.

This remainder of this section explores the benefits accruing to each of these three groups in detail and presents case studies of organisations implementing cloud to realise the benefits before identifying relevant cost categories.

Figure 4: Cloud technology benefits



Improved patient outcomes

There are a range of ways cloud enabled technology can improve patients interactions with the health system. In the use case database developed for this report, **patient outcomes were identified as a primary benefit of approximately 21% of all cloud use cases**. This was often related to cloud enabled remote monitoring of health and preventative care.

Patient outcomes: Early diagnosis and risk stratification

Machine learning algorithms which can be enabled by cloud can be used to better predict population health outcomes. **Machine learning is capable of predicting 7.6% more cardiovascular disease (CVD) events with 1.6% fewer false alarms relative to clinician assessments.[35]**

CVD is the leading cause of death and premature death globally. Among the 18.6 million CVD deaths worldwide in 2019, 58% occurred in Asia.[36]

The cloud based Apollo Cardiovascular Disease Risk tool used in India has been used to more accurately predict individuals with a high risk of heart disease. The tool uses data relating to 400,000 individuals based on attributes such as lifestyle, diet, and psychological stress and anxiety. The AI-predictive tool will help drive India towards the World Health Organisation's goal of reducing the risk of premature mortality from non-communicable diseases by 25% by 2025.[37]

ClosedLoop.ai also uses machine learning to predict high risk populations on a cloud-based platform. One application of ClosedLoop identified patients at risk from COVID-19. The platform was found to improve the accuracy of its risk stratification by 63% and the incidence of false positives decreased by more than 80%.[38]

Ease of health management

Use of cloud can increase convivence when interacting with the healthcare system. For example, the Singaporean Ministry of Health uses cloud-enabled technology for a Health Hub which patients can use to access hospital discharge summaries, test results and upcoming appointments.[39]

Another example in Australia is the cloud-enabled Genie Solutions, which simplified the process of engaging with virtual healthcare for its patients. The use of Amazon Chime allowed patients without technology skills to avoid the complexity of app downloads and logins, opening up access.[40]

In New Zealand, Southern Cross Healthcare is able to engage patients more effectively through cloud-enabled platforms with enhanced communications through digitisation of their customer journey.[41]

User engagement and patient feedback

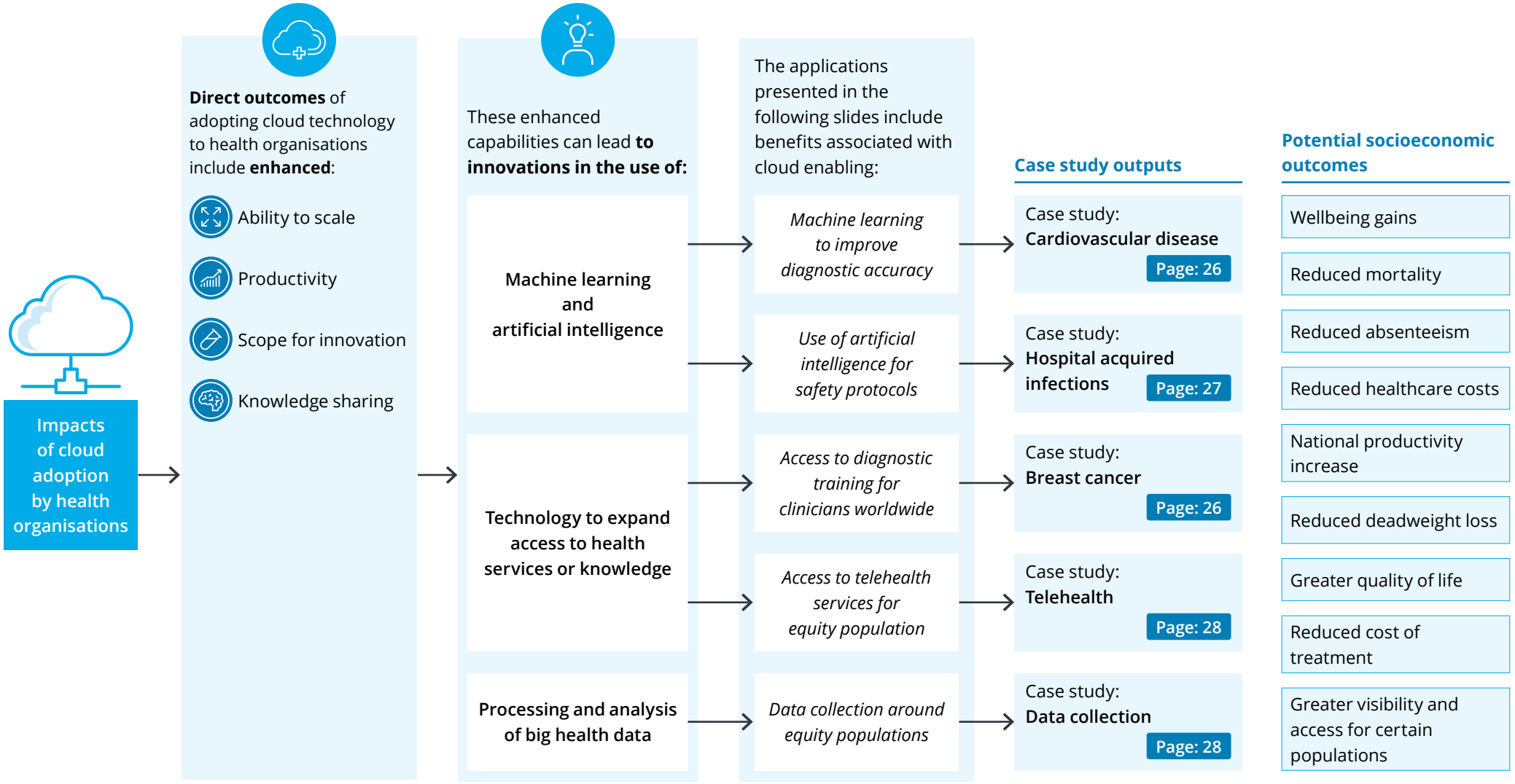
Cloud based applications have also been used to improve engagement with patients. Nib health funds was the first Australian health insurer to introduce artificial technology to assist Australians with their health insurance enquiries. The chatbot nicknamed 'Nibby' is capable of moving customers to the right sales or claims consultant as the matter becomes more complex. Nibby has handled more than 50,000 member interactions with an 85% success rate, saving 1,500 hours of handling time.[42]

Access to information

Cloud based platforms has also been used to improve patient access to information. For example, in Australia, NSW health pathology developed an automated system to deliver COVID-19 test results at scale during the pandemic in Australia. The automated SMS notification service is capable of delivering test results to patients in under 2 hours – compared to a 10 day waiting period prior to the service. Reducing the waiting period for test results allowed for shorter isolation periods and helps reduce patient anxiety.[43]

Estimating socioeconomic benefits of improvements to patient outcomes

One of the most significant benefits of integrating cloud technology into the health system is the improved patient outcomes. In addition to this benefit and others identified in this report, there are significant flow on benefits from adopting technologies leveraging the cloud, referred to as 'socioeconomic' benefits in this report.



Cloud enabling the flow-on benefits of early diagnosis and detection

Accurate and early detection of disease or disease risk factors can be useful in reducing the severity or instances of disease through more timely and effective treatment and management. Early detection can hence lead to a number of associated flow on benefits for patients, health organisations and health systems. The below diagram provides two examples but the use cases have revealed many more instances of accurate and early detection of disease which have similar flow on benefits.

Cloud-enabled interventions can improve **ACCURATE DETECTION AND DIAGNOSIS**:

- Cloud-enabled machine learning was found to detect an additional 7.6% of cardiovascular disease events.[44]
- Cloud-enabled training improved the accuracy of diagnosing clinicians in breast cancer screenings by between 21% to 31%.[45]

Early detection of these diseases can lead to a reduction in severity, leading to reduced costs and positive impacts on health, productivity, and wellbeing.

Cardiovascular disease (CVD)

Benefits of accurate detection and subsequent treatment of CVD include:

Patient (P) and patient employer benefits (E)

Wellbeing gains: Treatment can reduce hospitalisations by up to 50% and improve quality of life[46]

Reduced mortality: Earlier prevention for people at risk can reduce life threatening complications[47]

Reduced absenteeism: Treatment can reduce rates of absenteeism and presenteeism[48]

Health system (H) and government benefits (G)

Reduced direct health system costs: Costs escalate following preventable complications[49]

National productivity: India lost $1.3bn in productivity due to CVD[50]

Reduced deadweight loss associated with lost tax revenue[51]

Breast cancer

Benefits of early detection and subsequent treatment of breast cancer include:

Patient benefits (P)

Quality of life: Early detection lowers the likelihood of needing a mastectomy[52]

Reduced mortality: Early detection and treatment increases chances of survival[53]

Reduced absenteeism: Treatment can reduce rates of absenteeism and presenteeism[54]

Health system (H) and government benefits (G)

Reduced direct health system costs: More advanced cases incur a higher cost[55]

Reduced productivity losses associated with reduction in premature mortality[56]

Reduced deadweight loss associated with lost tax revenue[57]

Cloud mitigating the impacts of preventing hospital acquired infections

Prevention of disease is key to improving wellbeing, reducing mortality, improving productivity and reducing health system costs. As demonstrated in the Blue Mirror's case study, PPE buddy can be useful in reducing the incidence of hospital acquired infections (HAI). Mitigating HAIs can lead to a number of associated flow on benefits for patients, health organisations and health systems. The below diagram provides a breakdown of this example, however the use cases have revealed many more instances of disease prevention which have similar flow on benefits.

The cloud-enabled PPE buddy can be useful in **PREVENTION** of hospital acquired infections (HAI).

Prevention of hospital acquired infections is key to reducing associated **health, productivity, wellbeing costs.**

Benefits of reduced HAIs include:

Patient (P) and patient employer benefits (E)

Wellbeing gains associated with 18.1 days reduced time in hospital[58] — P

Reduced mortality: In the UK, the rate of deaths was 3.5% of those with HAIs[59] — P

Reduction in absenteeism among patients during recovery time (borne by patients or employees depending on sick leave entitlements)[60] — P, E

Reduced mortality: In the UK, the rate of deaths was 3.5% of those with HAIs[61] — P

Health system (H) and government benefits (G)

Reduced direct health system costs: $44,900 AUD per patient in 2022, equating to $7.6 billion AUD across Australia[62] — H

Reduced absenteeism among healthcare workers: mean of 5 days absence in the UK associated with HAIs[63] — H

Reduced deadweight loss associated with lost tax revenue[64] — G

Cloud enabling the flow-on benefits of health equity improvements

Health inequities are detrimental to population health and costly to the health system. Without targeted investment in improving access for and collecting comprehensive data around equity populations, improvements in equity can prove challenging. Cloud can play a key role in opening access and enhancing identification of equity populations in data. The nature of these effects are explored below:

By improving accessibility to healthcare and identifying population segments, cloud technology can alleviate the impacts of health inequity.

Benefits of telehealth include:

Patient benefits

- **Reduced cost of treatment:** 30% lower in one Australian study of ENT examinations[65] (P)
- **Enables access:** for patients who are unwell or otherwise unable to travel[66] (P)
- **Opens health services:** to patients in regional and remote areas[67] (P, E)
- **Reduced hospital time:** a reduction in 14.7 days with remote monitoring[68] (P)

Health system benefits

- **Reduced health system costs:** through reduced facility cost, and time savings[69] (P)
- **Increased health system productivity:** because of increased patient volume[70,71] (P)

Benefits of enhanced data collection around equity populations include:

Government benefits

- **Improved visibility:** of key equity populations to policymakers.[72] (H)
- **Improved understanding:** of the nature of need and the key drivers of inequities.[73] (H)
- **Targeting of priorities to need:** of the key drivers of inequities.[74] (G)

Case study: Cloud-enabled radiology training worldwide

DetectedX provides a radiology training program which allows clinicians to test and improve their skills diagnosing breast and chest images, using real images. Based in Australia, the program is used by national screening programs, Universities and clinical centres. It has over 3,500 users in 150 countries worldwide.[75]

Undertaking the approach provided by the program has been shown to improve the accuracy of diagnosing clinicians by between 21% to 31% in clinicians completing the program. In fact, 83% of radiologists achieved higher performance in diagnosis after they completed the first read.[76]

Cloud enables rapid scaling internationally and to developing countries

DetectedX CEO and cofounder Professor Patrick Brennan believes cloud technology has been key in allowing the training program to expand both within Australia and worldwide and be instantly available to those who want or need it. During the COVID-19 pandemic, the team rapidly developed a similar training tool for diagnosis based on lung CTs. Professor Brennan recalls that within just four weeks, this training program was scaled up from being delivered in four countries to being used in over 150 countries.

Cloud technology has been key in expanding the training to developing countries. Professor Brennan notes that "cloud has made it so easy, as long as people have the internet of a reasonable speed, they can access instantly the training material we develop." DetectedX has worked hard to reduce dramatically the internet speed necessary to access the training, in order to promote its use in a wider range of countries. This means that with any reasonable internet connection, even the largest case files can be examined rapidly at full resolution.

To promote the use of DetectedX training internationally, the organisation has partnered with Radiology Across Borders to deliver training to thousands of clinicians.

Security is ensured using AWS services

Given academics and clinicians have used the DetectedX platform to store their educational materials along with actual images of patients, security is a priority. This was a crucial offering provided by AWS services and has been an important feature in promoting the use of DetectedX to other healthcare providers and educational institutions.

Using artificial intelligence to tailor education

Cloud technology also enables the use of AI to complement the training program. Given the range of users, from undergraduate students to practicing and experienced radiologists, there is a wide range of expertise in diagnosing images. Artificial intelligence is used to ensure that all users can choose recommended modules that contain images that focus more on previous errors or missed key features. This innovative use of AI ensures that every user continues to learn and improve rapidly rather than repeatedly being asked to use skills they have already mastered.

Key benefits

- Flexibility to scale
- Health equity and patient outcomes
- Knowledge sharing and access to information

Case study: The Clinician supporting the delivery of value-driven healthcare

The Clinician supports healthcare organisations deliver proactive and personalised healthcare by enabling real time transfer of data on health outcomes, experiences and educational information.[77] The Clinician provides these services across Asia-Pacific and the Middle East.

Mike Merry the Chief Technology Officer and Dr Koray Atalag the Chief Health Informatics Officer at The Clinician explain how their digital health platform, ZEDOC, enables clinicians to connect with patients at any time and anywhere. ZEDOC gives clinicians the opportunity to collect and analyse health data sourced directly from patients, which can be used to improve patient outcomes and lower costs within the health system.

Cloud technology provides the necessary scalability for ZEDOC, enabling the provision of services to more than one million people while remaining capable of handling spikes in data usage that could not be accommodated through on premise infrastructure.

Virtual Emergency Department Triage

The Victorian Virtual Emergency Department (VVED) uses the ZEDOC platform to ease emergency department pressures by allowing patients to digitally register themselves for the virtual service from home and receive quick non-critical emergency care via connectivity with a telehealth provider.

The service enables clinical teams to triage patients more quickly and is delivered in 22 languages to increase access for people across the State. Since April 2022, more than 35,000 patients have registered through ZEDOC. Wait times to see the VVED nurse average around 15-30 minutes, compared with the average four to six hour wait times at emergency departments. Approximately 87% of patients have been discharged from VVED rather than presenting to an emergency department.[78]

Patient reported experience and outcome measures

The Clinician has deployed ZEDOC to collect patient reported experience measures (PREMs) and patient reported outcome measures (PROMs) in hospitals across Asia Pacific.

PREMs help identify strengths and weaknesses in care delivery from the patient's perspective. This can include experience domains like the level of communication and trust between the professional and patient and the level of coordination of the care pathway. Research has revealed a positive relationship between patient experiences and achieving better health outcomes.[79] Boosting patient experience by delivering patient-centred care and by addressing care quality concerns is key to optimising patient outcomes.

PROMs capture data on health status from the patient's perspective, including symptom burden and quality of life as well as a physical and emotional function. This enables healthcare organisations to detect and address patients with a high risk of experiencing complications while simultaneously delivering more personalised care. This can help improve quality of life for patients while avoiding preventable emergency department visits and/or readmissions. For example, perioperative quality of life assessment can provide an early indicator for patients at risk of complications following colorectal surgery.[80]

A leading public hospital in Singapore implemented ZEDOC to digitally collect validated PROMs one day prior to their outpatient visit to the clinic. Having captured the key patient-centred outcomes including symptom and quality of life, clinicians were able to quickly hone into the most pertinent problems during their short consultations.

Other ZEDOC digital care pathways have been developed for patients with colorectal cancer, lung cancer, localised prostate cancer, inflammatory arthritis and diabetes and for patients who have received hip and knee surgery or cataract surgery. ZEDOC digital care pathways can also be used to measure quality of life across the general patient population.

Key benefits

- Leveraging cloud technology features
- Cost optimisation
- Connected patient care

Health organisation benefits

Cloud technology enables health organisations to deliver more efficient, innovative and safer care. The use case database found that **flexibility to scale and/or cost saving was noted as the primary benefit to health organisation in 45% of all use cases**. Improved productivity was also a recurrent theme within the use case database, with organisations reporting improved capacity to process and analyse data efficiently.

Cost savings

As health costs rise across Asia-Pacific, achieving cost savings is a critical priority. While on-premise data storage requires accurately predicting technology needs and procuring equipment to meet those needs with an appropriate contingency if needs change (around 20-50% over peak requirements), cloud offers a scalable data storage that organisations pay on a user basis.[81]

AWS Cloud Economics Centre analysis across six continents found significant cost savings from transitioning to cloud ($5,963 per hospital bed over five years).[82] If all hospitals across the nine countries transitioned to cloud, this would be equivalent to $21.6 billion in cost savings.

This estimate is based on comparing the cost of on premises IT infrastructure to equivalent costs of required data infrastructure using cloud and the reduction in overprovisioning of IT resources. Further details on the methodology and additional country breakdowns are available overleaf.

The cost savings from transitioning to cloud is supported by use cases in the database, (see Appendix A). For instance, AlteaCare Telemedicine in Indonesia undertook service digitisation using cloud solutions, leading to 30% cost savings while Halodoc observed a 20% decline in processing costs.[83] In New Zealand, Ventures Health leveraged cloud technology to reduce the costs associated with their storage of patient data by around 90%.[84]

Flexibility to scale

As highlighted by the pandemic, demand on health system resources can change quickly and without warning. Given this, the scalability offered by cloud technology offers significant benefits to health organisations. In Australia, NSW Health Pathology leveraged this scalability to create an automated notification service to deliver COVID-19 test results. This allowed them to scale the system to deliver 4.25 million results as of mid-November 2021.[85]

Productivity

The productivity and efficiency of the health system plays a key role in determining patient outcomes. Cloud technology increases productivity by streamlining processes, enhancing care delivery models and opening up information to users. Examples of cloud applications enhancing productivity include See-Mode in Australia in the context of Augmented Vascular Analysis (AVA). Cloud technology improved scalability and efficiency in running machine learning models to analyse medical images and predict risk of stroke. It also provided ease of management and compliance with the centralised platform. As a result of the cloud technology, 50-100 images were able to be processed within seconds with reports being generated in under a minute.[86]

Security

Privacy, and in turn security, play key roles in the management of patient data in the healthcare setting. As such, there are benefits to be gained by health organisations in leveraging the security advantages of cloud technology. These include the comprehensive nature of platforms, leading to integration of data and fewer risks of data breaches. For example, in the United States the Mayo Clinic provides access to data and analytics tools without data having to leave the platform, ensuring data security and patient privacy.[87]

Knowledge sharing and access to information

Knowledge sharing and opening up access to information have the potential to add significant value in health systems, however they require an integrated and easily accessible information system. Cloud technology can play a key role in enabling this. For instance, in the Singaporean Ministry of Health, cloud technology was used to share information and best practices across healthcare institutions nationally.[88]

Cost savings from cloud technology are significant across Asia-Pacific

AWS Cloud Economics Centre analysis on cost savings from transitioning to cloud is based on 28 healthcare organisations across six continents.[89] Across the nine countries in scope for this analysis, if all hospitals transitioned to cloud, the reduction in operating costs would be approximately $21.6 billion in savings over five years.

AWS Cloud Economics Centre methodology

The analysis examined 28 healthcare provider business cases commissioned by AWS customers between July 2019 and March 2022. The following steps were taken to evaluate each organisation:

1. Collect data on the healthcare provider's existing IT infrastructure, and utilisation data to inform the existing overprovisioning of resources.
2. Map existing resources to AWS equivalents
3. Eliminate overprovisioning
4. Quantify the forecast costs of this infrastructure in AWS.
5. Compile comparative on-premise costs.

The combined five-year, on-premises forecast IT infrastructure spend for these providers was €447 million. The forecast cost saving from moving IT infrastructure to cloud was an average of 44% of the on-premises forecast cost, or a combined saving of €198 million.

Estimating savings across Asia-Pacific

To estimate savings across Asia-Pacific, it was assumed that the same cost savings from transitioning to cloud per hospital bed were realised. Data from the World Health Organisation indicates that there are approximately 3.6 million hospital beds in the in scope countries.[90]

Figure 5: Estimated operating cost savings of transitioning to cloud technology

Case study: Blue mirror improving Personal Protective Equipment safety through artificial intelligence

The spread of COVID-19 led to personal protective equipment (PPE) becoming ubiquitous in most clinical settings. The process of putting on ('donning') and taking off ('doffing') PPE is completed several times a day. Without sufficient training, mistakes are common and can spread infections to other healthcare workers, other staff and patients.

Blue mirror is a New Zealand based company which developed a 'personal protective equipment (PPE) Buddy' to assist with training healthcare workers to safely when donning and doffing PPE equipment. The technology is delivered via a wall-mounted tablet with a camera and can be uniquely adapted to the clinical environment of the healthcare organisation.

Rommie Nunes, an artificial intelligence specialist at Blue Mirror acknowledges that while not essential for the application itself, cloud technology vastly increases the scalability and speed with which the technology can be rolled to new healthcare organisations.

The benefits of artificial intelligence-powered PPE training have been evaluated at Bradford Teaching Hospitals NHS Foundation Trust. The evaluation found that 100% of users felt that Blue Mirror supported their memory around proper PPE procedure (compared with 65% with previous PPE training methods), 100% of users had an improved sense of safety (compared with 75%) and 95% of users agreed that Blue Mirror was easy to use. Similar findings were achieved in an evaluation at Worcestershire Acute Hospitals NHS Trust.

Infection control and prevention

Studies have estimated that on nine out of ten occasions, healthcare workers make an error donning their PPE, potentially exposing them to infection.

There are an estimated 170,000 hospital acquired infections that occur in Australia each year.[91] Each infection results in a hospital stay approximately 18 days longer on average.[92] This has been estimated to be associated with $44,900 AUD in additional costs in 2022. The total cost of hospital acquired infections could be as large as **$7.6 billion** AUD within Australia. These infections are largely preventable, and ensuring best practice management of infection control is an essential step to reducing this burden.

Training time

Senior nurses are required to run PPE training programs, yet many healthcare organisations do not have the resources available to run these programs. Appropriate donning of PPE is essential for infection prevention and control.

The PPE buddy can save senior nurses 10 to 15 minutes in training time per staff worker.[93]

The PPE Buddy delivers clear step-by-step instructions and can be used to deliver one-to-one training to staff. Training is reinforced consistently every day, improving a person's PPE compliance. The PPE buddy is capable of detecting common errors and prompting corrections. This includes:

- The hand hygiene was too fast
- The back of the gown is open
- The mask does not cover the nose
- A hand touched the face.

While there are minimum requirements for training once per year, Rommie indicated that training is often conducted via a PowerPoint presentation or a demonstration, often delivered in large groups. Healthcare workers may have never had one-on-one training.

Blue Mirror provides a critical tool to improve PPE procedures that will help minimise the potential for hospital acquired infections and improve the efficiency of training.

Key benefits

- Patient outcomes
- Cost optimisation
- Ease of health management

Broader health system benefits

Broader health system benefits often relate to improved capacity to monitor population health, benefits in research and diagnosis and interoperability of data and systems. **Around half of the use cases identified in the database had applications which improved the national approach to healthcare.**

Monitoring and responding to population health developments

Cloud technology is uniquely well-adapted to assist governments in understanding population health. Health systems generate huge amounts of data, much of it often underutilised. Cloud technology can play a key role not only in managing this data, but generating valuable insights into the state of population health. For example, cloud technology has brought together ophthalmologists across Korea to make diagnoses of vision impairment, with the aim of understanding the prevalence of vision impairment in South Korea.[94]

In addition, the automated system to deliver COVID-19 test results developed by NSW Health (mentioned previously in patient outcomes) via the cloud saved over **1 million hours for frontline healthcare workers** manually notifying patients of negative results. This time saving is equivalent to about 480 full time equivalent roles or 0.5% of the total NSW health workforce, which could be used for other purposes.[95]

Similarly, Halodoc in Indonesia was able to massively scale up the reach of its platform throughout the pandemic due to cloud, and now supports over 500 vaccination centres across 14 cities.

Leveraging cloud technology features

Cloud technology offers several features which can provide enhanced value in a health system context. For instance, cloud can provide support around public health insurance systems, including claims management, fraud detection and user verification. Cloud can also support interoperability of patient records across devices.

Connected patient care

Following the COVID-19 pandemic, care is becoming more flexible and less constrained by geography. Telemedicine played a significant role in connecting patients during the pandemic, and will continue to grow in health systems globally. However, the complexity of connection and the care journey in the digital space requires sophisticated solutions, which cloud technology can offer governments.

Medical research, Genomics and drug discovery

Medical research can generate significant benefits through enhancements to treatment practices globally. Within Australia, it has been estimated that medical research generates an economic return over four times the size of initial investment.[96] Cloud technology can be used to transform the drug discovery process. Prior to testing compounds in a research environment, the most promising compounds must be selected – from a molecular universe of close to 10 billion compounds. Cloud computing can be used to analyse more than one billion compounds in a single day, a process, which would normally take months. Insilico medicine in Hong Kong is one such example where the average drug discovery process was accelerated by 3 years, with average costs reducing by $650 million.[97]

Diagnostic innovations

Artificial intelligence is becoming an increasingly important diagnostic tool. Within some areas of diagnostic imaging, artificial intelligence has the power to transform the ease and accuracy of diagnoses. However, sophisticated systems are required to support the data and processing associated with AI diagnosis. Cloud technology will play a key role in ensuring the capabilities of AI are leveraged to improve diagnostic capacity.

Reduced carbon footprint

In addition to direct health objectives of a healthcare system, a number of governments have set sustainability goals and carbon footprint reduction for the public sector and their economies. Improving energy efficiency in healthcare will be critical to achieving these sustainability goals with hospitals emitting 2.5 times more green house gases than average commercial buildings.[98] Transitioning to cloud and software based solution can save materials needed for on-site enterprise hardware reducing carbon emissions. Studies have shown that 80% less power is consumed when customers use centralised, cloud based data centres instead of on-premise infrastructure.[99]

Case study: Simplifying access to healthcare at Halodoc

As a country with over 17,500 islands and 270 million people, Indonesia faces unique barriers to ensuring citizens have access to healthcare services. There are only three doctors per 10,000 people in the country (the lowest in Asia-Pacific) and there is a high concentration of the country's healthcare specialists on particular islands such as Java and Sumatra, resulting in difficulty accessing healthcare in some parts across the archipelago.

Halodoc has tried to address this issue with its mission to 'Simplify access to healthcare' by providing end-to-end healthcare services. The centralised healthcare service now supports over 20,000 doctors, 4,000 licensed pharmacies, 20 leading insurance providers and over 2,000 hospitals, clinics and labs. These health providers are connected to over 20 million users each month on an affordable and remotely accessible cloud-based platform, simplifying access to healthcare across the country.

Halodoc is a cloud native company founded in 2016, and now utilises over 50 different services from AWS. Ramkumar Durgam (Vice President of Engineering at Halodoc) and Lenish Namath (Vice President of Cloud Infrastructure at Halodoc) acknowledge the important role cloud has had in enabling the rapid growth at Halodoc.

COVID-19 and the associated restrictions saw a dramatic increase in dependency and demand for the digital provision of crucial health services such as telehealth consultations and online prescription ordering management. Halodoc was able to respond by dramatically scaling up the reach of its platform within a very short period of time.

Ramkumar acknowledged that Halodoc was able to successfully serve their clients throughout the pandemic and achieve a market leadership role. This was largely due to the public cloud infrastructure that their platform is hosted on. In fact, Halodoc were able to launch a new service for drive through users in three days that provided users with COVID-19 test results.

Lenish believes that demand for digital health services following the onset of COVID-19 will continue. This may result in a long-term shift in preferences toward digital access to healthcare services as people have a positive online health experience. Lenish also highlighted that Halodoc's user base is only a small percentage of the overall Indonesian population, demonstrating that the market is still under-served.

More generally, cloud platforms enable quick setups for the platform that can be easily updated or removed for comparatively low cost compared to on-premise data storage which requires significant infrastructure costs in expanding or changing service offerings. This allows Halodoc to be nimble in responding to changing needs of businesses and markets. These features have been critical for Halodoc to expand the geographic reach of its services and launch new features and services.

The use of cloud to deliver telehealth consultations has assisted Halodoc to maintain and provide a high level of service availability for its users while containing costs. Lenish notes that following the adoption of the AWS Graviton2 processors, processing costs fell by about 20% which helps to ensure Halodoc products and services remain affordable.

Halodoc's service offering was built on a cloud based platform to help ensure data security when handling vast quantities of often sensitive health data. This is because public cloud systems offer in-built security benefits enabling the ability to build and maintain flexible and scalable cloud infrastructure without compromising security. Further, by being able to leverage multiple tools within the one secure public cloud ecosystem, security is easier to manage and maintain across Halodoc's full service offering.

Key benefits

Patient outcomes

Flexibility to scale

Connected patient care

Case study: Supporting advancements in medical diagnosis

Globally, there is a recognised data gap around prevalence of vision impairment, with around half of nations globally not collecting robust data, and a further 15% lacking national data completely.[100]

Without comprehensive and contemporary eye data, it is impossible to design an eye health system which meets the needs of a population.

Research to understand eye health in Korea

Research conducted by Park, Sang Jun, Professor at Seoul National University Bundang Hospital, aims to develop a national eye health dataset for Korea based on the government-led nationwide survey conducted by the Korean Ophthalmological Society (KOS) and Korea Disease Control and Prevention Agency (KDCP). This involves over 100 senior ophthalmologists working in tertiary hospitals across Korea being brought together to examine images and make diagnoses.

The data is based on 4,000 to 6,000 detailed ophthalmic examinations conducted by the KOS on participants nationwide annually. These examinations involve visual acuity assessments, refractory error assessments, intraocular pressure measurements, retinal fundus photography, optical coherence tomography, IOL Master measurements, visual field tests, and others. Previously, this meeting had occurred in person, with the ophthalmologists travelling across the country. By leveraging cloud technology, these diagnoses can happen virtually, all over Korea at any time. Cloud technology has played a key role in overcoming challenges in the research. It has integrated legacy IT systems with virtual databases, and reduced costs associated with the research.

Challenges of legacy systems

One challenge associated with the research was the legacy IT systems used to operate the hospital machinery. AWS AppStream was used to link the legacy IT systems into the cloud, enabling researchers to transform data and outputs from the previous system. Replacing legacy IT systems can be expensive and time consuming. This often means that while more fit-for-purpose systems are available, the associated transition costs prevent healthcare researchers from upgrading their systems. The ease of moving to the cloud was a key factor for Professor Park, Sang Jun to change systems while conducting the research.

Enabling access across the country

Key to this research was bringing together expertise across Korea. This had proven complex and costly in previous stages of the research, particularly given need for privacy when using participant data. However, with cloud technology, it was possible for the specialists to connect from their laboratory and make a diagnosis in real time. Another issue the researchers had encountered previously was that systems could not transmit images at any time and place with the required bandwidth for images high quality enough to make a diagnosis. This was overcome with cloud technology, which was able to transfer high quality images at high speed.

Importance of cost effectiveness in research

Professor Park, Sang Jun also noted another key constraint in this project was the need to optimise the allocated funding to achieve the best possible outcomes. Cloud played a key role in this aim, given it has opened up considerable cost saving opportunities, and was itself low cost, freeing up resources to be invested elsewhere in the research.[101]

Key benefits

- Leveraging cloud technology features
- Cost optimisation
- Knowledge sharing and access to information

Case study: Leveraging cloud for vision-related research

Fujita Health University is the leading primary health care university in Japan, with over 3,000 staff including doctors and researchers and over one million electronic medical records (EMRs) maintained each year. Fujita is set to grow significantly with a number of new clinics to be opened over the next three years. As Fujita expands, so does the need for effective and optimised data storage and management, which have been the main motivations behind the plans to transition Fujita's information to the cloud.

Director Kobayashi is the Chief Information Officer at Fujita Health University hospital overseeing this current transition and shared a number of insights regarding the drivers of transitioning to cloud. Director Kobayashi noted the mission of Fujita to build a medical information system that is cost-effective and supports research and development particularly in relation to medical diagnosis.

Limits of on-premise data storage

Director Kobayashi highlighted that the limitations of on-premise data management systems have been evident in many organisations across Japan's healthcare system. This was noted in relation to issues of data standardisation or interoperability due to systems not being cloud or web-based, particularly at hospitals.

Given that Fujita is a global organisation, these issues are particularly pertinent in consolidating and analysing data across health systems from different sources.

Director Kobayashi suggested that COVID-19 was a catalyst for change in this regard, as it naturally drew attention to nation wide data management practices across the health system and highlighted the importance of data accessibility.

Drivers of cloud adoption for Fujita

Director Kobayashi identified a number of key drivers behind the University's decision to adopt cloud to manage large volumes of health data. These include:

- **Data standardisation and interoperability –** Director Kobayashi described challenges in connecting the University's datasets with other data sources (i.e. data interoperability). The ease of data standardisation a cloud system offers is expected to significantly accelerate and enhance research analysis by enabling greater data interoperability. In particular, Fujita will be able to link EMRs with other available health data sets such as cost of illness studies. Fujita is also looking to link other data to improve collaboration with other hospitals, clinics and regions in Japan.
- **Enhanced security –** transitioning to cloud is expected to significantly increase security and reduce the risks associated with the collation of EMRs across the University and clinics. Cost optimisation – given the flexible and scalable nature of cloud, it is expected that cloud will enable Fujita to effectively optimise costs associated with their EMR database.

Moving forward

Moving forward, Fujita aims to become an advanced university in relation to medical diagnoses and transitioning to cloud will be a key enabler of this. Shifting to cloud will enable the development of a standardised data collaboration platform capable of combining Fujita's EMRs with secondary data sources to advance research and innovation in medical diagnoses as well providing consolidated access to important patient health data in the hope of making a patient centred system rather than an organisation centred system of data management.

Key benefits

Leveraging cloud technology features

Cost optimisation

Knowledge sharing and access to information

Effectively managing costs of transitioning to cloud

While adopting cloud is likely to result in lower operating costs for an organisation in the long term, the extent of cost savings relies on effective management of the upfront costs associated with transitioning to cloud (identified in Figure 6). The cost categories and their shares are based on averages informed by Deloitte's cloud transformation team. In addition to the costs identified in Figure 6, costs associated with training and ongoing staff using the IT system will be incurred by the organisation transitioning to cloud.

The application factory migration costs have been estimated to be about 40%, however this component of costs can vary depending on the nature of the transition. For example a transition requiring 'relocation' means that infrastructure can be moved to the cloud without purchasing new hardware and with no code changes required. In comparison, 'replatform' or 'refactor' approaches involve more significant alteration of the existing applications.

Deloitte's Cloud transformation and strategy team suggest that as a benchmark, medium sized healthcare organisations may incur costs ranging from $3.4 million to $6.8 million transitioning to cloud. Organisations of this size would typically be shifting 100-200 applications onto the cloud. The costs of transitioning and operating in the cloud need to be balanced against the counterfactual costs of continuing to operate and invest in new on-premise capabilities.

The relative costs of cloud relative to on premise also varies between countries. Developing countries have low infrastructure costs for their on-premise set ups. This may mean that shifting to the cloud results in higher operational costs.

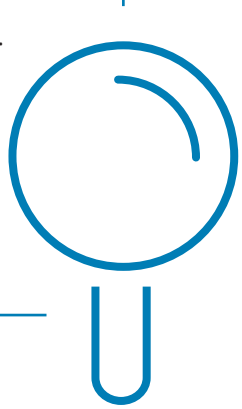
However, when the additional benefits accrued by patients and the broader health system are considered, the additional costs of shifting to cloud technology are likely to be outweighed. This also highlights the importance of program governance costs. While these only account for 10% of the estimated costs, the design of the transition is essential to the downstream health benefits that can be achieved.

Figure 6: Cost components of transitioning to cloud

Build – (20% of costs)	Establishing the cloud platforms to enable the onboarding of applications.
Application factory migration – (40% of costs)	Transitioning existing applications (such as the patient administration system, patient records, other data and physical structures) to the cloud.
Decommission technology – (15% of costs)	The process of decommissioning platforms and applications. This process results in fewer assets to maintain, reduced labour force and reduced regulation and compliance issues to manage.
Parallel transition run cost (15%)	Transitioning to cloud can take a period of years, during which time both the existing platforms and data centres as well as the new cloud capabilities are required. Running both systems in parallel leads to significantly higher costs during this period.
Program governance office – (10% of costs)	Transitioning to cloud requires program governance to coordinate activities and manage dependencies. Activities may include program establishment, operating model, governance, procurement, landscape assessments, migration factory establishment, cloud platform readiness.

Key findings

- Health inequities account for a significant portion of overall healthcare costs, with one estimate suggesting this portion could be as high as 20%.
- Cloud technology provides a means to improve health equity by identifying key population segments and improving accessibility to healthcare.



Implication of cloud for health equity

Health inequity remains a challenge across Asia-Pacific

Health equity is defined as a state where everyone does not face unfair, avoidable or remediable differences and is able to attain their full potential for health and wellbeing.[102] The WHO captures a range of measures of health equity in the *Health Inequality Monitor* for lower and middle income countries. However, there is no index to compare or evaluate health equity internationally. In the table below, World Bank data has been used to proxy health equity, benchmarked against averages in the countries' respective income groups. Some indicators represent equity of healthcare access, such as the share of the population spending more than 25% of income on out of pocket health expenditure, the share of births attended by skilled health staff, and the number of hospital beds per thousand people. Other indicators point to equity in health outcomes, such as the share of deaths caused by preventable causes.

Table 1: Health equity measures compared with averages among countries' income groups (based on most recent year of available data).

	Share of pop. spending >25% of income on out-of-pocket health care expenditure (%)	Divergence from income-based average	Births attended by skilled health staff (% of total)	Divergence from income-based average	Hospital beds (per 1,000 people)	Divergence from income-based average	% of total deaths caused by communicable diseases and maternal, prenatal and nutrition conditions	Divergence from income-based average
High income countries								
Japan	2%	0.0%	100%	1.0%	13	145.3%	10%	42.9%
South Korea	3%	33.3%	100%	1.0%	12.4	57.3%	13%	46.2%
Singapore	1%	-100.0%	100%	1.0%	2.5	-112.0%	21%	66.7%
New Zealand	-	-	97%	-2.1%	2.6	-103.8%	4%	-75.0%
Australia	0%	-	97%	-2.1%	3.8	-39.5%	5%	-40.0%
Upper middle income countries								
Thailand	0%	-	99%	1.0%	2.1	-85.7%	14%	50.0%
Malaysia	0%	-	100%	2.0%	1.9	-105.3%	18%	61.1%
Lower middle income countries								
Indonesia	1%	-400.0%	95%	21.1%	1	20.0%	19%	-42.1%
India	7%	28.6%	81%	7.4%	0.5	-60.0%	24%	-12.5%

Source: World Bank (2022). Note: While the number of hospital beds required per capita can be reduced with improved preventative care, there remains identified shortages in the number of hospital beds available even in countries with mature health systems like Australia, limiting access to health services.

As seen in the table above, there is room for improvement in at least one aspect of health equity among almost all of the target countries. For instance, Australia performs better than average among high income countries when it comes to the share of the population spending more than 25% of income on Out of Pocket (OOP) health expenditure and share of preventable deaths, but 2.1% worse than the average for high income countries when it comes to hospital beds per 1,000 people and births attended by skilled health staff.

Health inequity remains a challenge across Asia-Pacific (cont.)

Despite health inequity presenting challenges across the region, the drivers of these inequities vary significantly. For instance in Australia, the health system faces inequities driven by geographic low population densities in regional areas, increasing rates of chronic disease, limitations in health data, and long hospital waiting times.[103] For India, the key health system challenges are around awareness of health issues, access for those in rural areas or living in poverty, and workforce maldistribution.[104] However, other Asia-Pacific nations face significantly different drivers of health inequity. Some of the drivers of health inequity revealed in a study by Meyer et al drawing survey data around health access are explored for selected countries in the figure below:[105,106]

Australia
Regional and rural Australians have difficulty accessing services due to distance.

Thailand
Individuals who work for their family, do part time work, work within the household or are unemployed were found to have difficulty accessing services.

Korea and Japan
People who spent savings or borrowed money in the year prior to data collection were found to have difficulty in accessing care due to cost.

New Zealand
Māori, Pacific peoples, and those with lower socioeconomic status experience higher levels of chronic illness.

One driver of inequity presenting a challenge for many countries, particularly in Southeast Asia, are inequities associated with a decentralised health system. In some cases, decentralisation of the health system can lead to different levels of funding or different approaches to healthcare strategy between higher-income and lower-income regions. Further, healthcare workers can be distributed unevenly between regions, with a more limited workforce in rural or lower-income jurisdictions which fail to attract a skilled health workforce.[107]

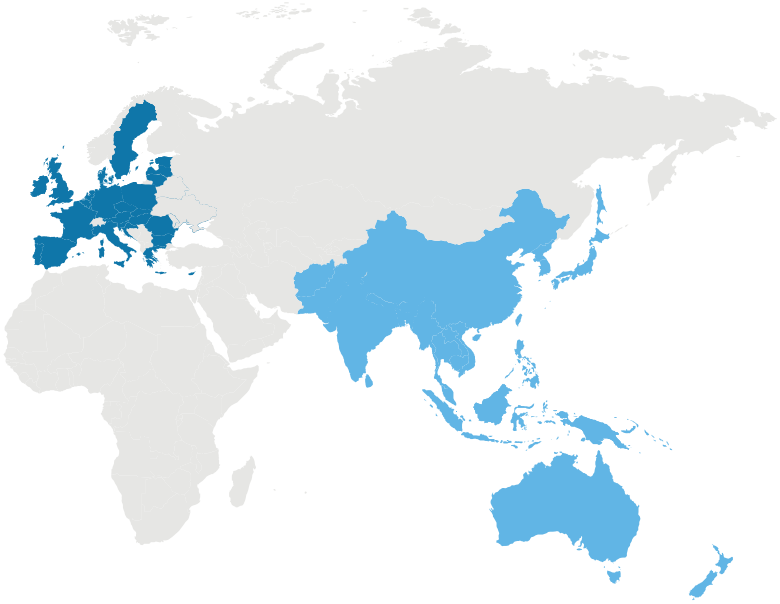
Key to eliminating these health inequities is a focus on codesign in the health system, and creating systems which encourage and allow access by excluded groups.

The economic implications of health inequity are significant

There are significant economic costs associated with health inequity. While a figure is not available globally or for the Asia-Pacific region, estimates have been made around the costs of health inequity in the European Union. Inequity explained 20% of total healthcare costs, and 15% of social security costs. Every year, the reduction in productivity caused by health inequities accounted for 1.4% of GDP. Further, the welfare losses associated with health inequality accounted for 9.4% of GDP annually.[108] As shown in the figure below, inequities in health are generally higher in the Asia-Pacific region when compared to the European Union. As such, the costs of inequity in the region are likely to be even higher than those in Europe.[109]

Cloud technology plays a key role in reducing the costs of these inequities by facilitating policies which alleviate inequity. Without the capacity to identify key populations for equalising interventions, and without those populations being able to access those interventions, alleviating health inequity is not possible.

Figure 7: Health equity measures compared between East Asia & Pacific and the European Union.



	East Asia and Pacific	European Union
Cause of death by communicable diseases and maternal, prenatal and nutrition conditions (% of total)	8%	6%
Births attended by skilled health staff (% of total)	95%	99%
Hospital beds (per 1,000 people)	4.5	4.6

Cloud technology can drive improved health equity outcomes

Cloud can improve health equity outcomes through two channels, identification and access to health services for equity populations.

Identify equity populations in data

The key to health equity is visibility of key populations, which requires complete and detailed health data. As such, health equity outcomes can easily be inhibited by data gaps or siloes. The WHO has identified timely, high-quality and disaggregated data as key to identifying inequities, however 49% of countries globally are capable of producing such data.[110]

Cloud can play a key role in linking, or in cleaning or consolidating, datasets. Where identification and reporting around these populations improves, decisions will be more informed and lead to better outcomes.[111] Cloud technology can also play a key role within health organisations in leveraging data to identify patients at risk. Around 23% of the cloud applications identified in the database relate to health equity in that they enable the identification of vulnerable people within populations, either by remote monitoring or data/research.

In South Korea, cloud technology has brought together ophthalmologists across the country to make diagnoses of vision impairment, with the aim of understanding the prevalence of vision impairment in South Korea. This will provide a key tool for policymakers in meeting need.[112]

Improve access to health services

Equity in health requires flexibility, given the key barrier for equity populations in accessing health systems can be the standardised nature of their design. Digital health can play a key role in expanding access, by allowing health systems to adapt to the needs of users.

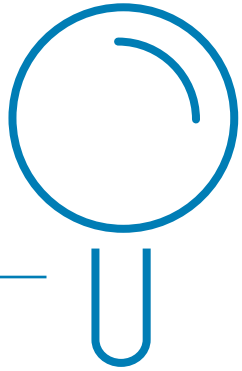
Adaptability can mean adapting to the person's geography, where digital health can enhance and expand health connection. Language can also present a key access barrier which can be overcome with digital health.[113] In addition to improving the ability to identify equity populations, cloud can improve access to health services. Around 22% of the cloud applications identified in the database relate to health equity in that they enable access to health services, by telehealth or remote monitoring.

In Indonesia, differences in healthcare access across the country have been reduced with Halodoc, a healthcare service leveraging cloud technology and connecting patients, doctors, hospitals, pharmacies, clinical labs and insurance companies.[114]

It should also be acknowledged, however, that health inequities can be linked to inequities in access or understanding of technology, and that these must be overcome for these benefits to be realised. In Japan, for example, only 49% of people aged more than 74 years access the internet. Similarly only 39% of the rural population across Asia and the Pacific use the internet relative to 75% of urban dwellers.[115]

Key findings

- Barriers to cloud adoption include legacy IT systems, shortage of skills, inadequate existing infrastructure, resistance to change, data security and regulatory requirements, low awareness of benefits and digital literacy
- These barriers may explain the slowing growth in cloud readiness as cloud expenditure in healthcare grew by 26% over the 2017-22 period, while this is expected to slow to 16% from 2022-26.
- The four key priority areas to accelerate deployment and adoption of cloud technology are: Develop and tracking progress against a digital health strategy, building digital skills in the healthcare workforce, ensure regulatory and privacy settings are appropriate and get started with foundational dataset.



Unlocking the potential of cloud in healthcare

Preparing for cloud in healthcare

To drive future expenditure in cloud technology, countries need to have the resources in place to implement the technology, and appropriate structures in place to fully utilise the applications cloud can enable.

The Asia Cloud Computing Association (ACCA) publishes the cloud Readiness Index (CRI), which has since become the definitive reference point to assess the readiness of Asia-Pacific markets to adopt cloud computing technologies.[116]

The CRI score is shown in Chart 4. It is a composite measure of four key parameters – infrastructure, security, regulation and governance.

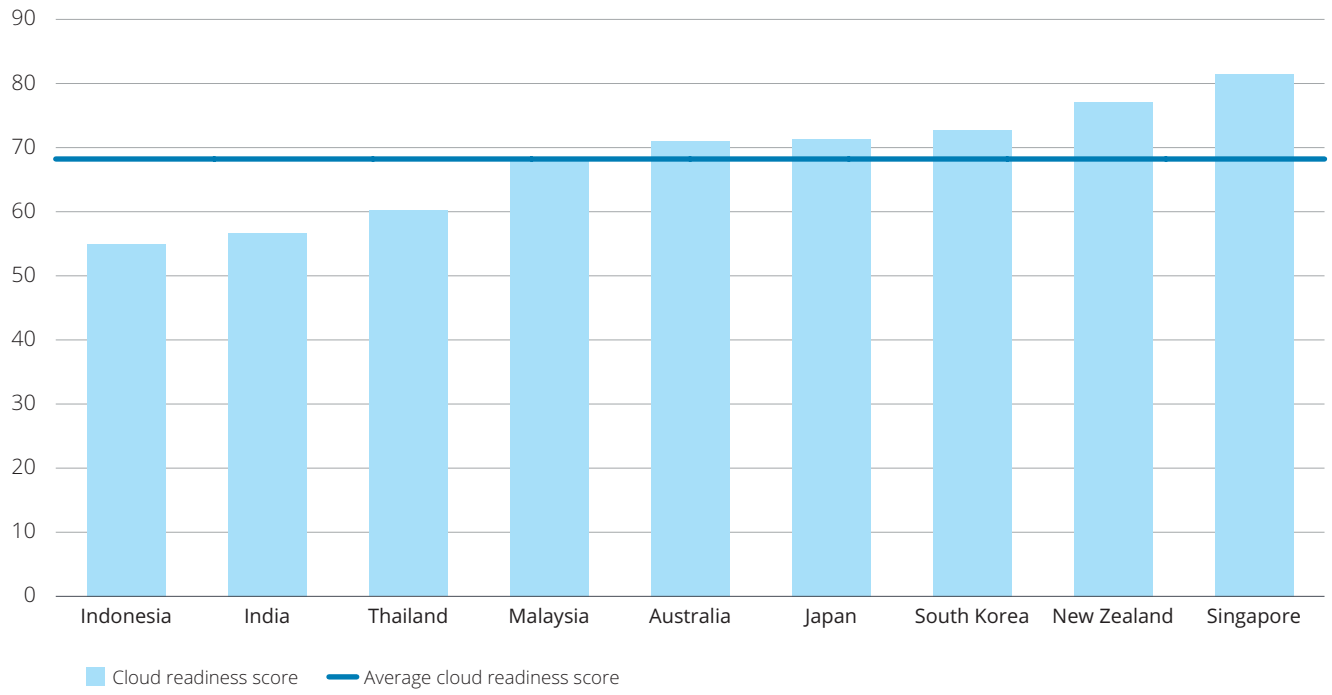
Cloud readiness is tied to the level of development in a country, with lower middle income countries Indonesia and India viewed as the least ready for cloud technology uptake (average score 55.9). Upper middle income countries Thailand and Malaysia are considered to be further progressed in cloud readiness with an average score across the two countries of 64.4. The remaining high income countries have the highest levels of cloud readiness, with an average score of 74.7.

The 2020 CRI observed that while cloud readiness continues to advance in the region, the pace of progress is stalling. This is reflected in healthcare investment in cloud growing slower in high income countries over 2022-26 relative to the 2017-22 period. For example, Japan's cloud expenditure in healthcare grew by 28% over the 2017-22 period, but is expected to slow to 17% from 2022-26.

Compared with the CRI in 2018, the gap between the CRI scores of high income and developing countries has narrowed. However, the gap is still significant, and core capabilities such as managing natural risks, privacy and cybersecurity remain fragile in developing countries.

With cloud readiness stalling in many countries, the opportunity to fully capitalise on the technologies enabled by cloud may be missed.

Chart 4: Cloud readiness index score (2020)



Key barriers to cloud implementation in health

Several key barriers prevent the realisation of significant benefits from cloud enabled healthcare.

Complex legacy IT systems

For many senior health decision makers, large outdated legacy systems and outdated IT systems are seen as too complex and too costly to change. A survey of healthcare organisations indicated that 55% had concerns over the cost of transitioning, while 7% indicated that there was no budget available to transition.[117] This is despite the upfront costs of cloud being offset lower operating costs over time.

Shortage of cloud skills

There is a significant shortage of advanced cloud and security skills, particularly within healthcare workers. Lack of skills was highlighted as a barrier to cloud adoption by 46% of survey respondents across Indonesia, Malaysia, the Philippines, Singapore and Thailand.[118] If cloud technology is adopted, the benefits may not be fully realised if digital literacy of staff is limited.

While the level of required cloud or digital skills varies depending on the occupation, all healthcare roles are increasingly requiring these skills. For example, frontline healthcare workers (like doctors and nurses) may require data skills to use applications on the cloud, researchers and hospital IT workers will need greater understanding of the back-end cloud infrastructure. There is also need to upskill healthcare management staff in cloud finance and opportunities to improve management of health providers.

Inadequate existing infrastructure

Cloud technology requires stable and sufficient internet connectivity. For some low income countries this is a prominent challenge, and may contribute to the gap in cloud readiness relative to high income countries. Infrastructure challenges may include IT systems that are poorly implemented, sub-standard hardware and insufficient internet bandwidth. Servers may be interrupted by power outages without backup servers available.

Resistance to organisational change

Following the COVID-19 pandemic, a significant share of healthcare workers are feeling strained from increased work pressures, with one study finding over half of all healthcare workers are feeling burnout. Senior decision makers also face competing priorities for time and resources that may prevent transformation project, even with long term productivity benefits, from being completed.

Data security and government regulatory requirements

Healthcare data is highly sensitive, leading to significant apprehension around data security and privacy. Based on nearly 40 interviews with healthcare policy makers across Asia-Pacific, data security and privacy was the most common barrier to adopting cloud.[119] In developing countries such as Malaysia, the lack of guidelines around cloud service standards has led to lower trust in the security of cloud services. Similarly strong regulations are required to ensure the necessary protections are in place to share medical records across organisations.[120]

There is a lack of clarity in data protection regulations, with uncertainty around how healthcare data should be transmitted through and stored in the cloud. This arises when regulation are ambiguous or complex, or where the regulations fail to mention the use of cloud technology. In South Korea there were strict data storage regulations in place requiring health data to be stored on premises. Once these regulations were lifted, there was a significant uptake of cloud storage by more than 100 hospitals in South Korea.[121]

Low awareness of cloud benefits

For some policymakers, healthcare management and staff, there is limited knowledge of how cloud works and the benefits that can be derived. In particular the benefits of sharing data with other healthcare organisations may be underestimated. Data in healthcare is often siloed – which may limit the ability to perceive the benefits gained from transitioning to cloud based technology.

Digital health literacy of patients

Digital health literacy refers to a patients' ability to find and understand health information from electronic resources. This barrier is more likely to affect whether the benefits of cloud are realised. For example, increasing the implementation of cloud enabled electronic health initiatives could result in a larger gap in health outcomes between people with high digital literacy and people with low digital literacy. People with socioeconomic disadvantage have higher rates of chronic disease and mortality, yet they access electronic health services at lower rates.[122]

Priority areas to accelerate the transition to cloud technology

Increasing investment and improving the adoption of cloud technology will require senior government healthcare officials to make strategic actions to address the barriers discussed above and unlock the potential of cloud. We have identified four priority areas for decision makers to focus on:

1. Develop a digital health strategy with funded initiatives supporting cloud deployment and adoption and track progress

The majority of countries considered in this report are yet to have cloud technology included in their digital strategies and only three have funded initiatives. When incorporating cloud into digital strategies, the use of **cloud first policies backed by a digital health authority** for new digital health infrastructure would avoid transitioning from legacy systems in the future and earlier use of cloud enabled technology.

Specific cloud related health policies have been adopted by high income countries across the Asia-Pacific. For example, Australia adopted a Cloud First Policy in 2014 requiring Commonwealth entities to use cloud services for new ICT services and when replacing existing ICT services. Singapore adopted a cloud first policy in 2018. Thailand and Indonesia are yet to implement a cloud first policy.[123]

For those countries with a digital strategy, implementation is critical. Traditional funding models for health infrastructure often involve specifying physical requirements before considering digital service delivery methods.

Consideration of digital services delivery in initial health infrastructure planning will encourage greater efficiencies and ensure new infrastructure is fit for purpose for digital health delivery.

Encouraging greater digital service delivery will also require **removing funding arrangement that may create disincentives to delivering healthcare services through digital means.** Until recently, Australia's Medicare Benefits Schedule (MBS) funded phone consultations more than virtual telehealth conferences. At least equalising incentives for physical or digital service delivery should be considered by health decision makers to support digital adoption.

For existing infrastructure, **specified timeframes for transitioning from legacy IT systems** is required to ensure change in a timely manner. In addition, a well developed strategy should **identify and prioritise the cloud enabled applications that would have the largest impact** on the health system. For those countries that do have cloud included in strategies and funded initiatives, **evaluating progress** against stated objectives and identifying areas where progress has stalled (e.g. in regional or remote areas) will be key.

2. Building digital and cloud computing skills in the healthcare workforce.

Cloud computing alongside broader digital skills are some of the most in-demand skills across all industries. Healthcare must compete with other industries for this talent, which may be hard as it has not been traditionally seen as digitally leading industry.

While efforts to **attract workers into the sector with key capabilities** will be important, **incentivising existing staff** to upskill and reskill through short-course or **microcredentials** will be necessary to fully utilise cloud enabled technology.

Promoting awareness of relevant courses that provide digital and cloud skills that are suited to the role for the specific cohorts of health workers (such as doctors and nurses, researchers, ICT roles) would also make sure skills learnt are relevant.

Partnering with external organisations or outsourcing can also help health organisations and systems access key capabilities.

Australia's Digital Transformation Agency provides for cloud skills uplift programs as part of its secure cloud strategy. The cloud skills uplift program aims to increase digital skills and cloud competencies for the public sector.[124]

Partnering with external organisations or outsourcing can also help health organisations and systems access key capabilities. Recent research shows that 18% of organisations across Asia Pacific are looking to outsource to other organisations to build their data and analytics capabilities, while 17% are looking to partner with another organisation.[125] Internationally, research suggests that workforce shortages facing healthcare providers will lead to increasing back office tasks or business processing (BPO), with the value of BPO growing nearly 9% per year on average over the next five years out to 2027.[126]

Priority areas to accelerate the transition to cloud technology

3. Make sure regulatory settings are open to innovation and clear on data security standards

Broader regulatory environments influence the willingness of organisations to experiment and innovate. The use of **principle based regulations** to encourage innovation may create a healthcare culture conducive to adopting cloud enabled technologies.

Consultation and engagement with the broader health industry, including pharmaceutical companies, MedTech and other industry associations will also be important to ensure regulatory settings are fit for purpose and do not have unintended outcomes.

The existence of **clear data protection laws and a privacy enforcement authority**, as well as **adherence to internationally recognised privacy principles and best practices** can help to increase trust in the use of cloud and address misperceptions around security.

While data protection laws encompassing cloud for healthcare exist across high-income Asia-Pacific countries, Access Health International has identified gaps in data protection laws across Malaysia, Thailand, Indonesia and India.[127]

For those countries where these laws and enforcement agencies already exists, the healthcare authority must work with regulatory bodies and healthcare organisations to develop, update and provide training on regulations related to data security, data privacy and protection.

4. Get started

Healthcare decision makers should identify priority areas to transition to cloud and take action. This may include **foundational datasets or operations** can be better stored and analysed in cloud. Telehealth consultations are a key example of a healthcare service that has been shown during COVID-19 to operate better in a cloud environment to accommodate surges in demand.

For example, Australia and New Zealand have already taken steps to transition core healthcare functions to the cloud. These include online portals hosted on the cloud that provide easy access to health information – such as My Aged Care in Australia or Manage My Health in New Zealand. Telehealth consultations are now provided and receiving government funding across both countries.[128]

There is a strong case for investing in cloud in a healthcare setting based on the numerous applications and benefits identified in this report. By focusing on the four priority areas, governments will help health systems across Asia-Pacific to manage the challenges facing the sector and improve the quality of life for citizens.

Appendix

Appendix A: Outline of key benefits

Benefits to patients

Key benefits to patients include:

- **Health equity –** cloud can increase accessibility of healthcare and increasing awareness of health equity across demographics through data
- **Access to information –** through cloud based digital health platforms and increased synthesis of information patients are able to access more information about their health
- **Ease of health management –** with centralised health platforms offering a range of health services
- **Patient outcomes –** through enhanced and more efficient care
- **User engagement and patient feedback –** cloud based innovations to assist patients with health related questions

Benefits to health organisations

Key benefits to health organisations include:

- **Flexibility to scale –** through scalable data storage and computing power
- **Cost optimisation –** largely through flexibility to scale in addition other efficiencies realised through various cloud applications
- **Productivity –** through increased computing power and time saved through advanced and integrated systems
- **Security –** cloud systems are generally built with data security and privacy front of mind
- **Scope for innovation –** cloud enables innovative app development and the deployment of complex AI and ML tools
- **Knowledge sharing and access to information**
  - through interoperability, integrated data systems and platforms facilitating communication and the transfer of data, health professionals are better able to share knowledge and information to build capacity
- **Compliance –** cloud systems are built to ensure ease of compliance with data privacy laws

Benefits to the broader health system

Key benefits to the broader health system include:

- **Monitoring population health –** through collating and managing the huge amounts of data health systems generate
- **Leveraging cloud technology features –** such as through increased data interoperability across entire health systems and supporting public health insurance systems
- **Connected patient care –** cloud solutions support health systems in meeting growing demand for patient care delivered digitally
- **Medical research, genomics and drug discovery**
- **Diagnostic innovations –** cloud maximises the capabilities of AI to improve diagnostic accuracy and capacity across the health system

Appendix B - Cloud in healthcare use case database

A database of over 60 unique use-cases specific to cloud in healthcare was developed to inform this research and demonstrate the range of cloud enabled applications and the particular benefits they deliver. While there was a focus on Asia-Pacific and the in-scope countries in the research, use-cases based in other countries were included in cases where it was relevant to inform the analysis. The database was built on the following sources of information:

- a broad scan of academic literature
- global organisations such as the World Health Organisation, the Organisation of Economic Cooperation and Development, and the World Economic Forum case
- research and studies provided by cloud providers (including AWS)
- case studies of organisations using cloud enabled technologies provided specifically to Deloitte to inform this report.

					Beneficiary		
#	**Organisation**	**Country**	**Application**	**Description**	**Patient benefits**	**Health organisation**	**Health system benefits**
1	Ministry of Land, Infrastructure and Transport[A1]	Republic of Korea	COVID-19 response	A system to make contract tracing more efficient.	Improved patient outcomes	Flexibility to scale	Leveraging cloud technology features
2	UK Health[A2]	UK	COVID-19 response	Early identification of COVID-19 clusters.	Improved patient outcomes	Flexibility to scale	Leveraging cloud technology features
3	Healthcare New Frontier[A3]	Japan	Remote monitoring	A database of personal health records to enable preventative care and monitor population health.	Improved patient outcomes		
4	Halodoc[A4]	Indonesia	Telehealth/tele-medicine	A mobile health platform providing end-to-end healthcare service.	Continuity of care	Flexibility to scale	Connected patient care
5	Ministry of Science, ICT and Future Planning[A5]	Republic of Korea	Data analytics and research	A precision medicine hospital information system.		Increased productivity	
6	Ministry of Health[A6]	Singapore	Health databases	H-Cloud, a central database of medical records.	Access to information	Cost optimisation	Leveraging cloud technology features
7	Blue Mirror[A7]	New Zealand	COVID-19 Response	PPE training through AI.	Improved patient outcomes	Cost optimisation	Ease of health management

Appendix B - Cloud in healthcare use case database

#	Organisation	Country	Application	Description	Beneficiary		
					Patient benefits	**Health organisation**	**Health system benefits**
8	Ministry of Health[A8]	Singapore	Telehealth/tele-medicine	A high quality secure health video consultation platform.	Continuity of care	Flexibility to scale	Connected patient care
9	U-Health[A9]	Republic of Korea	Remote monitoring	Remote monitoring of patient health through wearable devices.	Continuity of care	Cost optimisation	
10	Seoul National University Bundang[A10]	Republic of Korea	Data analytics and research	A national eye health dataset.	Access to information	Cost optimisation	Leveraging cloud technology features
11	Apollo Hospital[A11]	India	Remote monitoring	Applying AI and machine learning to cardio-vascular health records.	Continuity of care		Diagnostic innovations
12	Salesforce[A12]	Australia	Data analytics and research	A platform to review service providers, manage personal data etc.		Increased productivity	
13	Collaborate[A13]	Greece	Interactive health platform	A platform to improve patient care through team-based and patient-centric diagnoses	Continuity of care		
14	Partners HealthCare[A14]	USA	Remote monitoring	Remote health monitoring and care coordination.	Improved patient outcomes		
15	Ministry of Health[A15]	Singapore	Data analytics and research	Platform to facilitate access to information and best practices across healthcare institutions.		Knowledge sharing and access to information	Medical research, genomics and drug discovery
16	Google[A16]	N/A	Interactive health platform	Enhanced customer service through AI.	User engagement and patient feedback		

Appendix B - Cloud in healthcare use case database

#	Organisation	Country	Application	Description	Beneficiary		
					Patient benefits	Health organisation	Health system benefits
17	Athenahealth[A17]	USA	Data analytics and research	Services to track performance data, process claims, manage patient records etc.		Increased productivity	
18	Mayo Clinic[A18]	USA	Health databases	Access to data and analytical tools to advance healthcare.		Improved security	Leveraging cloud technology features
19	Huawei[A19]	China	Remote monitoring	Real time tracking and identification of heart health risks.	Improved patient outcomes		
20	Salesforce/MIMIT Health[A20]	USA	Interactive health platform	Centralization of patient data on a single digital platform.	User engagement and patient feedback	Cost optimisation	
21	Genie Solutions[A21]	Australia	Telehealth/tele-medicine	Platform to deliver a seamless patient experience.	Continuity of care	Flexibility to scale	
22	nib[A22]	Australia	Interactive health platform	Automated and enhanced customer service.	User engagement and patient feedback	Increased productivity	
23	HealthPlix[A23]	India	Data analytics and research	Clinical decision support - faster, more precise prescriptions.	Continuity of care	Increased productivity	
24	Orion Health[A24]	New Zealand	Health databases	More efficient and scalable patient data collection and storage.	User engagement and patient feedback	Cost optimisation	
25	Climedo[A25]	Europe	Remote monitoring	Enhanced capture and management of clinical data to accelerate customers' clinical trials.	User engagement and patient feedback	Increased productivity	Medical research, genomics and drug discovery

Appendix B - Cloud in healthcare use case database

					Beneficiary		
#	**Organisation**	**Country**	**Application**	**Description**	**Patient benefits**	**Health organisation**	**Health system benefits**
26	ICHRCloud[A26]	India	Interactive health platform	Platform for both the doctor and the parents of child patients.	Continuity of care		Monitoring population health
27	NSW Health Pathology[A27]	Australia	COVID-19 response	SMS automated notification service that can deliver COVID-19 test results.	Improved access to information	Flexibility to scale	Leveraging cloud technology features
28	Insilico Medicine[A28]	Hong Kong	Data analytics and research	AI and ML capabilities to accelerate drug development processes.		Flexibility to scale	Medical research, genomics and drug discovery
29	Australian Unity[A29]	Australia	Remote monitoring	Remote monitoring of therapeutic process'.	Continuity of care	Increased productivity	
30	The Clinician[A30]	New Zealand	Interactive health platform	Timely exchange of health outcomes, experiences and educational information.	Continuity of care	Cost optimisation	Connected patient care
31	Lira Medika[A31]	Indonesia	Health databases	Patient centred care centred on a cloud-based database.	User engagement and patient feedback	Flexibility to scale	
32	Telkomsigma[A32]	Indonesia	Health databases	Automated analytics platform applied to health data.	User engagement and patient feedback	Cost optimisation	
33	See-Mode[A33]	Australia	Data analytics and research	Machine learning to analyse medical images and predict risk of stroke.	Improved patient outcomes	Increased productivity	
34	Gold Coast University Hospital[A34]	Australia	Data analytics and research	Integration of data from multiple sources to produce dashboard and monitor illness.	Improved patient outcomes	Increased productivity	Medical research, genomics and drug discovery

Appendix B - Cloud in healthcare use case database

					Beneficiary		
#	**Organisation**	**Country**	**Application**	**Description**	**Patient benefits**	**Health organisation**	**Health system benefits**
35	Caring Pharmacy[A35]	Malaysia	Data analytics and research	Cloud-based enterprise resource planning system.		Flexibility to scale	
36	Southern Cross Healthcare[A36]	New Zealand	Health databases	Single view of patient data and management of entire patient journey.	Continuity of care	Flexibility to scale	Connected patient care
37	AlteaCare Telemedicine[A37]	Indonesia	Telehealth/tele-medicine	Healthcare app that connects patients with doctors from hospitals.		Cost optimisation	
38	Healthvana[A38]	USA	Interactive health platform	Rapid delivery of test results and health records, ML to extract patient data from uploaded images.	Improved access to information	Cost optimisation	Leveraging cloud technology features
39	Indivumed[A39]	Europe	Data analytics and research	Database to store thousands of tissue samples for medical research and generate insights.		Increased productivity	Medical research, genomics and drug discovery
40	Froedtert & Medical College of Wisconsin[A40]	USA	COVID-19 response	System for screening staff and complying with COVID-19 guidelines.	User engagement and patient feedback	Increased productivity	Leveraging cloud technology features
41	MTG[A41]	Europe	Data analytics and research	Process and analyse large amounts of data required for studies.		Increased productivity	Medical research, genomics and drug discovery
42	Omada Health[A42]	USA	Data analytics and research	App to help healthcare professionals provide informed care.	Improved patient outcomes	Increased productivity	

Appendix B - Cloud in healthcare use case database

#	Organisation	Country	Application	Description	Beneficiary		
					Patient benefits	**Health organisation**	**Health system benefits**
43	Benchling[A43]	USA	Data analytics and research	Standardisation of data from multiple sources to support research.		Increased productivity	Medical research, genomics and drug discovery
44	MathWorks[A44]	USA	Data analytics and research	Remote and scalable data environment with high computing power.		Improved security	Medical research, genomics and drug discovery
45	Blyott[A45]	Europe	Health databases	IoT solution to track thousands of medical assets in real-time.		Increased productivity	
46	QT Medical[A46]	China	Data analytics and research	Measuring electrical activity in hearts via electrocardiograms.		Cost optimisation	
47	Relay Therapeutics[A47]	USA	Data analytics and research	Increased CPU enabling screening of billions of medical compounds daily.		Cost optimisation	Medical research, genomics and drug discovery
48	axialHealthcare[A48]	USA	Remote monitoring	Early identification of opioid misuse.	Improved patient outcomes	Greater scope for innovation	Diagnostic innovations
49	ClosedLoop.ai[A49]	USA	Remote monitoring	Patient risk prediction and stratification.	Improved patient outcomes	Cost optimisation	Diagnostic innovations
50	DetectedX[A50]	Australia	Interactive health platform	A radiology training program.		Knowledge sharing and access to information	Leveraging cloud technology features
51	Circle of Life[A51]	India	Data analytics and research	Analytics tools to facilitate data-driven decision-making.		Increased productivity	Medical research, genomics and drug discovery

Appendix B - Cloud in healthcare use case database

					Beneficiary		
#	**Organisation**	**Country**	**Application**	**Description**	**Patient benefits**	**Health organisation**	**Health system benefits**
52	Healthdirect[A52]	Australia	Interactive health platform	Australia's National Health Services Directory.	Access to information	Flexibility to scale	Leveraging cloud technology features
53	CoWIN[A53]	India	Interactive health platform	End-to-end vaccination platform.	User engagement and patient feedback	Flexibility to scale	Leveraging cloud technology features
54	Ventures Health[A54]	New Zealand	Health databases	Primary care provider network.		Cost optimisation	
55	Piedmont Healthcare[A55]	United States	Health databases	Electronic health record environment.		Cost optimisation	
56	Babylon Health[A56]	United Kingdom	Interactive health platform	AI-based health services, including a chatbot to help diagnose ailments.	User engagement and patient feedback	Increased productivity	Leveraging cloud technology features
57	eSanjeevani[A57]	India	Telehealth/tele-medicine	National teleconsultation service.	User engagement and patient feedback	Increased productivity	Leveraging cloud technology features
58	Songklanagarind Hospital[A58]	Thailand	Health databases	Delivers cloud ready infrastructure combining compute, storage virtualisation and networking	Improved patient outcomes	Flexibility to scale	
59	Ministry of Public Health[A59]	Thailand	Data analytics and research	AI and machine learning to identify public health risks	Improved patient outcomes	Flexibility to scale	Monitoring and responding to population health developments

Appendix B - Cloud in healthcare use case database

					Beneficiary		
#	**Organisation**	**Country**	**Application**	**Description**	**Patient benefits**	**Health organisation**	**Health system benefits**
60	Singapore Government[A60]	Singapore	COVID-19 response	Mobile app to trace covid-19 exposure and notify users if they have are a close contact	Improved patient outcomes	Cost optimisation	Monitoring and responding to population health developments
61	Ministry of Health[A61]	Singapore	Interactive health platform	Patients are able to access hospital discharge summaries, test results and upcoming medical appointments	Access to information	Knowledge sharing and access to information	
62	Microsoft Malaysia and CREST[A62]	Malaysia	Interactive health platform	Digital health hub to focus on five core virtual health scenarios, including telehealth and remote monitoring	Continuity of care	Cost optimisation	Monitoring and responding to population health developments
63	Ministry of Health[A63]	Malaysia	Health databases	A national healthcare information gathering and reporting system for both government and private sectors		Knowledge sharing and access to information	Monitoring and responding to population health developments
64	Artificial Intelligence in Medical Epidemics[A64]	Malaysia	Remote monitoring	Platform to support management of dengue outbreaks	Improved patient outcomes		Monitoring and responding to population health developments

Appendix B - Cloud in healthcare use case database

#	Organisation	Country	Application	Description	Beneficiary		
					Patient benefits	Health organisation	Health system benefits
65	Tokumei Bank[A65]	Japan	Secure collection and storage of clinical data	Information management service for the secure collection and storage of clinical data from medical research, stored centrally on the cloud.		Security	Medical research, genomic and drug discovery
66	Japanese Government[A66]	Japan	COVID-19 Public Health Centre Business SupportCloud Package	The support package aims to reduce the administrative and operational tasks of public health centers while easing the sharing of information.		Productivity	Monitoring and responding to population health developments

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