Contents

1 Introduction

1.1 Introduce your technology, industry, and companies.

The Technology that been chosen here is Causal AI, the Industry chosen is Health Care → HEALTH CARE EQUIPMENT SERVICES → HEALTH CARE TECHNOLOGY. Then two companies chosen are Mayo Clinic, GNS Healthcare.

The Causal AI is another alternative type of Machine Learning which used to find reasons of "how" or "why" this certain thing happens, which makes it very different from the normal machine learning due to the fact that Causal AI uses human-mind based model system to predict and analyze data, outputs of Causal AI is more reliable[1].

The Healthcare Technology includes medicines, medical equipment, surgery, and medical treatments that been used in health care, also include complete, reliable systems or parties that provide health care services, such as health care services, preventing disease, protecting patients, recovery, health care community constructions[2]. Healthcare Technology is the newly technology that uses high techs to optimize Healthcare services and better medication-related works in any aspects of human health.

Mayo Clinic is very special American company which opens for mixing up medication-related education, researches, and health care to help people from disasters caused by diseases. The company contains over 3500 employees which many of them are scientists or physicians, and was built in 1864. As a private company, Mayo Clinic as a big company has announced work on Causal AI technology in medication areas in public[3].

GNS Healthcare is also a private American company but it's a data analysis that focuses on biology-related models about relations between gene and protein in cells. It was founded in 2000 and also another company utilizes advantages of Causal AI to do data analysis and medication researches in public[4].

1.2 State what your report will cover (i.e., introduce each section)

This report mainly talks about how the development of the chosen technology(Causal AI), potential impacts to Australia industry field, current adoption rates, dominant product determination and life cycle of the Causal AI. Lastly, the report will construct Business Model Canvas to both Mayo Clinic, GNS Healthcare.

2 Technology Industry

2.1 Define and describe your selected technology and industry

Causal AI is an emerging technology such that it majorly tackle with problems depend on the relationships which is different from normal correlation-based decision making. It can

provides solutions and deal with problems in a manner of human-like Artificial Intelligence with a complete automatic system, and it always contains cause-and-effect principle to resolve problems so that make the final decision closer to real life[1].

The conception of Causal AI was developed from Judea Pearl's books which are 'The new science of cause and effect' and 'The book of why', the most essential reason for Causal AI being an emerging technology is that causality conception beyond correlation relation among objects, the focus has transformed to thinking about "the reason why this happen" and predict the next level of data[5]. Furthermore, Causal AI usually applied in Healthcare technology aspects for detecting causality among cancers and some geom sequence detects. Plenty of medication related researches and education utilize Causal AI to develop optimal treatments, maximize medical backups, minimize side-effects of treatments.[6].

2.2 Assess the current and (expected) future development of the selected technology

The current development of Causal AI is majorly in medication-related works, such as medical experts utilize Causal AI to find confounding factors of triggers of diseases, moreover, construct a suitable model for helping medical researchers, experts to do the mappings and decision-making in a precise, trained medication-related machine learning system, then responses and analysis of responding behaviours of diseases can be revealed or detected easily[7]. Some interventional clinic predictive trained, supervised medication models need the fact that the core principle inside models must be constructed be causes and effects[8]. What's more, Causal AI has been applied to analyze blood situations of people to find out signals of potential cancers in human beings[9][10].

In the future, Causal AI can be utilized in predicting weathers in different areas, and some phenomenons of certain types of weathers due to the fact that currently different weathers has diverse portents, and also owing to complicated environmental factors it is hard to generate a biological network to different kinds of phenomenons to predict climate changes[11]. More future developments of Causal AI can be figuring out potential reasons for Covid-19 which human beings suffered for a long time and still did not get a actual, accurate adjustments of why this could happen[12].

2.3 Discuss how the technology is applied to your selected industry

Healthcare Technology currently obtains benefits from Causal AI from different ways, uses diverse methods to fit in the "causal AI" models such as K-nearest neighbour method of Causal AI[13], and Random Forest method of Causal AI which both of them are programming methods but based on the causal AI mode. Causal AI has also been used more in precise medicine which help with adjust corresponding optimal treatments for individuals with no mortality and neurological sequelae, and precise medical data conducted by Causal AI can be seen in some scientific databases[14].

Furthermore, many medication researches needs the help of Causal AI , simple correlation-

resulted predictions perform badly because either potential factors are missing or insignificant factors actually affect results the most[15]. Causal AI made the most significant changes to healthcare and medication area as Machine Learning uses correlations to predict treatments, Causal AI can give personalized treatments to avoid diseases[16].

3 Innovation Context

3.1 Discuss the current and potential future impact of the selected technology to Australia as a country

Currently Australia as a big country with large number of people did not do well in the "War of fighting Covid-19", thus Australia urgently needs a way to figure out reasons why covid-19 spread in society and what protection controls are efficient if covid-19 spread again in Australia. Also urinary tract infections is another severe problem that cost Australia a lot but Causal AI utilizes causality models to analyze reasons of how antibiotics limited when they applied in treatments of covid-19[17]. What's more, Australia is a developed country that has strong relationships with AI as it developed robotics, AI systems for a long time to increase quality of country[18]. Thus the speed of researching on Healthcare Technology are also included and they are regraded as priority things to boost which significantly prompt the development of Healthcare Technology.

In the future, Causal AI is a necessary part of Australia as Australia Digital Health Agency announced a country developing strategy that medication-related information needs to be flexible, high quality of medical treatments is a must, reliable healthcare-related models needed to be built before 2022[19] and Causal AI is one of AI models that Australia needs to pay more attentions to it. Just like what mentioned before, Australia urgently needs a way to boost their country economy, and costing part of a country is a severe problem for Australia[20], Causal AI helps reduce costing in the future.

3.2 Discuss the current and potential future role of the Australian government in the development and commercialisation of the selected technology

Australian government plays as an essential role in Australia since government provides funds and makes country development strategies. The government supports and helps developments of small companies of using AI technology which Causal AI is one part of it[21], and it also published, passed programs related with Causal AI like "Mobile Phone Detection Camera Program" to boost development of Causal AI which optimize Australian people's life qualities[22]. And some policies in Australia also helps the commercialisation of Causal AI which one example can be "Road Vehicle Standards Act 2018 (Cth)" states computer programs can be used for information collecting to make some decisions[22], and Causal AI can definitely obtain benefits from Australian policy to boost faster.

The Australian government will boost development of Causal AI and keep the balance overall influences on people as stated in AI Ethics Principles[23]. Also, there are policies about how to improve AI areas including Causal AI named "Australia's AI Action Plan". Government provides comfortable environment for AI to develop and also funds are available to engage boosting AI and Causal AI[24], which significantly help Causal AI to develop in the future.

3.3 Discuss any role of universities in the development and commercialisation of the selected technology

For universities they are also essential in the development of Causal AI as there are many researches and Causal AI-related rewards given[25]. Also for the development of Causal AI, AI-related professors and researchers are needed, thus more models and testing can be made to enrich the contents of Causal AI, such as expand Causal AI models in auto driving system[26]. Other than developing Causal AI, fund is an important factor for commercializing Causal AI. There are uncountable scholarships and rewards for students or researchers in universities, such as a PhD scholarships in The University of Abelaide which focuses on Causal AI development[27].

4 Diffusion of Innovation

4.1 Evaluate the rate of adoption of the selected technology

The rate of adoption for Causal AI should be at the beginning even people has used it for many years. For instance, the public always states that Causal AI is the missing puzzle to the traditional AI, Causality can adjust data, analyze data in a different way so that results can be diverse and reliable[28]. However, only few industries actually use Causal AI technology as their core system operation technology. Only industries like medication system, bio-medication, digital medicine and healthcare services utilize causal AI to better determine reasons of diseases and design personal treatments for patients[29].

4.2 Evaluate in which stage the selected technology lies in the Technology Adoption Lifecycle Model

It is easy to see that Causal AI is between stage Innovators and Early Adopters, but closer to Early Adopters. Due to the fact that as mentioned in part a, only few industries including bio-medication, healthcare services use Causal AI to find best intervention for patients[30]. Other than healthcare and medication-related industry, Causal AI is not the best choice for general industries to use, which directly affect the development of Causal AI and makes it still in the very early stage which is Early Adopters.

4.3 Identify any barriers to adoption that currently exist

There are many barriers to adoption of Causal AI, such as unclear boundary between human supervision and machine self-model-construction, and unclear timing of using Causal AI . The first barrier states that it is hard to use and build a reliable Causality models in AI since Causal AI needs to think questions like human beings, but if compare the reliability of model construction between computer and humans, computer must be better[31]. Thus this creates a paradox which we cannot determine when is the best time to make human helps model training, and when is the best time for computer self-training for Causality models. And unclear timing to use Causal AI is that sometimes normal AI is better than using Causal AI so this can make Causal AI a problem and delay the development of Causal AI[29].

5 Dominant Design

5.1 Define and describe a product category which is enabled by your selected technology

Mobile Health Technology(M-Health tech) is one product category that is enabled by Causal AI. M-Health tech can be defined in different ways, it can be defined as "Using mobile devices to collect medical data in public for the use of providing data to doctors to supervise health"[33], or it can be defined as "mobile high technologies to improve health system of the area"[34]. We combine them to one sentence: M-Health tech use mobile devices to collect data and provide data to doctors to prevent potential diseases that may appear. For preventing potential diseases we need to construct causality models to analyze diseases. Furthermore, M-Health tech is also a young product category, and it closely connects with healthcare system, medical information adjustments, and treatments. Thus it's important to develop M-Health tech rapidly with emerging technology Causal AI[35].

5.2 Evaluate whether there is a dominant design for the product category

5.2.1 If there is a dominant design, describe the architecture which has been adopted and another architecture which was not adopted.

The architecture(see Fig. 1) that has been adopted currently for dominant design has three "cycles": Relevance cycle, Design cycle, and Rigour Cycle. Relevance cycle states information collected by end-user and environments end-user face with are all recorded in cycle, they will be made as parts of end-user data sets to improve the M-Health tech. Secondly, Design cycle presents prototypes can be tested and diverse modes of design thinking can be reconsidered in this cycle. Testing and initial design for M-Health tech are necessary which help with create final outputs. Finally, Rigour cycle defines how to evaluate current work of Mobile Health devices. It can be split into two phases where phase one is reading and looking through

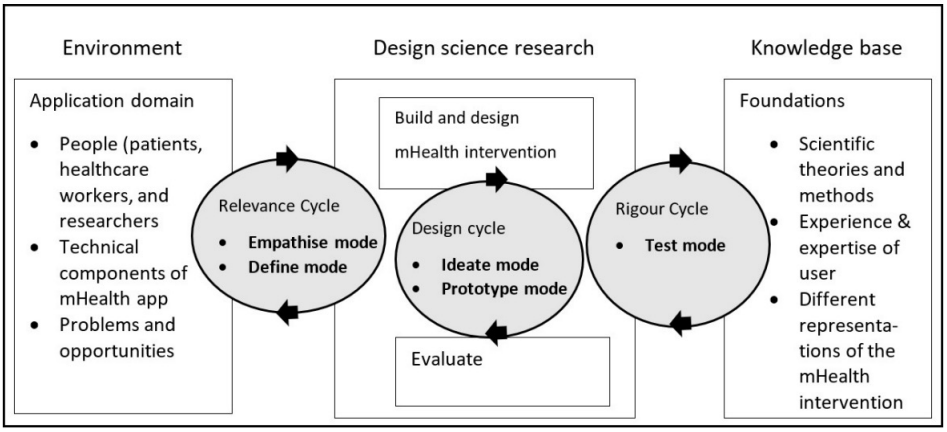

Figure 1: Architecture for M-Health tech[36]

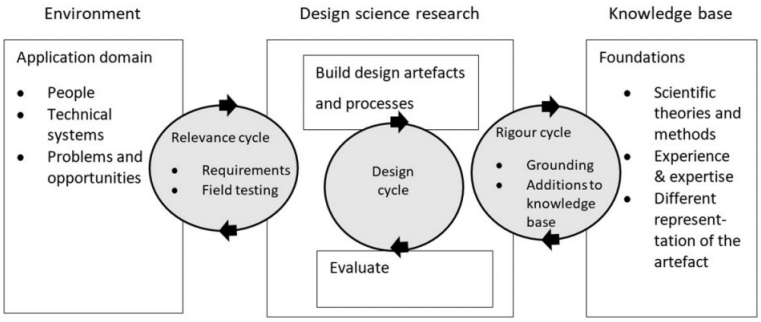

Figure 2: Architecture2(not adopted)[36]

related researches and theories to enrich knowledge so that when we are encountering some either technical problems or theoretical problem, we can handle them easily. Phase two continue testing prototypes in Design cycle. The review and test of designs are needed but reading through literature and testing will be done in different time interval as the basic principle to test prototypes are all based on the theories that looked through[36].

One architecture(see Fig. 2) that was not adopted has three same cycles. However, domain of the whole architecture is different as this architecture wastes money, time-consuming, and actual content in each cycle is different. More importantly, there is no prototypes for Mobile Health devices produced which made the whole architecture hard to derive problems of the working procedure[36].

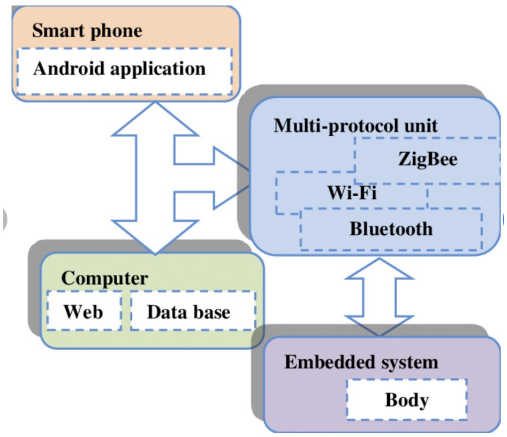

Figure 3: Architecture3[38]

5.3 Apply the Technology Cycle for the product category, including its key aspects and the variation and selection process of the design competition

If Technology Cycle is applied to M-Health tech, M-Health tech should sit in Era of Ferment which there are many competitors of product designs and these designs, architectures can be changed or substituted at any time. It is easy to see that M-Health tech has been applied in many aspects of daily life, and it creates huge values at any time, for instance, it fulfills daily life's needs(solutions to customers problems) such as mobile hospital, and virtual nursing services[37]. M-Health tech is designed with user-centered concept and experiments itself in any aspects of life thus it sits in Era of Ferment.

There are many competitors(about architecture) currently as it can be seen [38] Fig.3 there is another one architecture for M-Health tech. And one more competitor of architecture contains four parts: Service and application designs, Identity and access management, Data and records management, and Communications[39]. These two architectures are very different from the one that mentioned before in part 5 question b, but their core ideas are the same: designing mobile devices and using Causal AI with advanced machine learning technology to help with medical problems. In conclusion, M-Health tech sits in Era of Ferment which architecture is highly competitive.

6 Business Model Canvas(next two pages)

The Business Model Canvas

Mayo Clinic

Key Partners

· Cooperation: causaLens[45], Mercy[49]

· Buyer-supplier relationship: Nference[47]

· Strategic alliances: Arizona State University[48]

· Investors

· Biotechnology related companies

Key Activities

·Causal AI for cancer detection[44]
· Intellectual:College of Medicine and Science
· Diagnosis, provide personal treatment to patients
· Medical researches

Key Resources

· Technology: Causal AI
· Data: Thousands of patients medical data
· Human: Medication professors, experts
· Intellectual: College of Medicine and Science
· Financial: Hiring professors

Value Propositions

·Mayo Clinic offers medical treatment
·Gain creators: Support medication-related education, researches; Constructing diagnosis and personal treatment
Pain relievers: International services;
People are regarded as a normal person first;No.1 hospital in the nation
·Personal treatments and diagnosis, medical education provides to public[40].

Customer Relationships

· Personal Assistance:patients with the same symptoms
· Dedicated personal assistance:patient with long term disease need a professional(personal) doctor
· Communities:user community to share thoughts[42]
· Co-Creation:inviting experienced people to join medical researches

Channels

·Awareness: Advertisement: TV Commercials[41], social platform
·Evaluation: Mayo Clinic do diagnosis and recommend medicine
·Purchases: Offline/Online services,credit card, etc.
·Delivery:Online communication and diagnosis;medical treatment
·After sales:24h robot online

Customer Segments

·Type:Mass Market
·Target audiences: The public or people who are sick.
·Value provides: Finding signal of cancer, Medical Education, Medical Research, Personalized Treatment

·Reason for Mass Market: Mayo Clinic opens for everyone and everyone get the best chance of treatments[40].

Cost Structure

· Fixed Costs: 1. Employee salaries;

· Variable Costs: 1. Causal AI model payoff; 2. Advertisement Fee; 3. Cloud platform usage provided by Nference;

Revenue Streams

· Advertising: Advertisement TV Commercials[41]

· Usage Fee: 1. Medical services; 2.Surgical income[43]; 3. Mediaid Fee[43] 4. Medical cares[43]; 5.Global Consulting[46]

The Business Model Canvas

GNS Healthcare

Key Partners

· Cooperation: REFS™[53]

· Buyer-supplier relationship: The ALS Association, CHDI Foundation,Memorial Sloan Kettering Cancer Center, etc.

· Investors

· Biotechnology, pharmaceutical related companies

Key Activities

·Causal AI for cancer medicine development

· Development digital twin's functionalities

· New drug discovery[50]

Key Resources

· Technology: Causal AI, digital twins
· Data: Over one billion terabytes data has been stored and continue to increase at rate of 48%[51]
· Human: Experts in any aspects including physics, biology, computer scientist, drug developer[52]
· Financial: Investors

Value Propositions

·GNS Healthcare offers biotechnology innovation and helps with development of new medicines for companies.
·Gain creators: Helping with develop new medicines and use digital twins to do predictions

Pain relievers: Working with seven out of ten top of pharmaceutical companies; It has "Gemini" — digital twin which contains the world's most precise, correct simulations of illness progression[50]; Use 64 technologies for their own website

·Biotech and pharmaceutical companies are satisfied by high accuracy GNS Healthcare can provide

Customer Relationships

· Specify certain person to clarify certain models about how that works and what to do
· Automated Services: Whenever company buys models or services of digital twins, companies can run code and automatically get data wanted

Channels

·Awareness: Advertisement on Youtube, social platform
·Evaluation: Providing accurate models or advanced medicines
·Purchases: Offline/Online services,credit card, etc.
·Delivery: Online, sharing models, technologies in cloud
·After sales:24h robot online

Customer Segments

·Type:Niche Market
·Target audiences: Pharmaceutical and biotech enterprises
·Value provides: High biotechnology exploration, causal AI innovation

·Reason for Niche Market: GNS Healthcare only provides biotechnology to biotech enterprise and its products only support certain high level companies.

Cost Structure

· Fixed Costs: 1. Employee salaries;

· Variable Costs: 1. Loan; 2. Big Data collection for new medicine development[54] 3. New AI platform or model constructions[55]

Revenue Streams

· Asset Sale: Sells newly improved medicines[50] -> use Causal AI to develop new cancer-related medicine

· Usage Fee: 1. Gemini - - digital twin provides convenience to uncover the secret of genetic or molecular mechanisms[50];

7 Conclusion

Emerging technology talked about is Causal AI which utilizes causality models, which is different from traditional AI. And HEALTH CARE EQUIPMENT SERVICES industry is the one mainly utilizes the convenience Causal AI provides. Causal AI prompts overall development of Australia, on the other side, Australian government and universities support the development of Causal AI, thus win-win is made between this emerging technology and Australia. However, Causal AI is in early stage of development since causality models cannot benefit more than traditional machine learning. Then we find a product category called M-Health tech and described how dominant design can be. And result is so many competitive dominant designs await and M-Health tech still sits in stage where it focuses on finding solutions to customer's needs, in the Era of ferment. Finally two companies(Mayo Clinic and GNS Healthcare) were introduced in the form of Business canvas.

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Word Count: 2972