

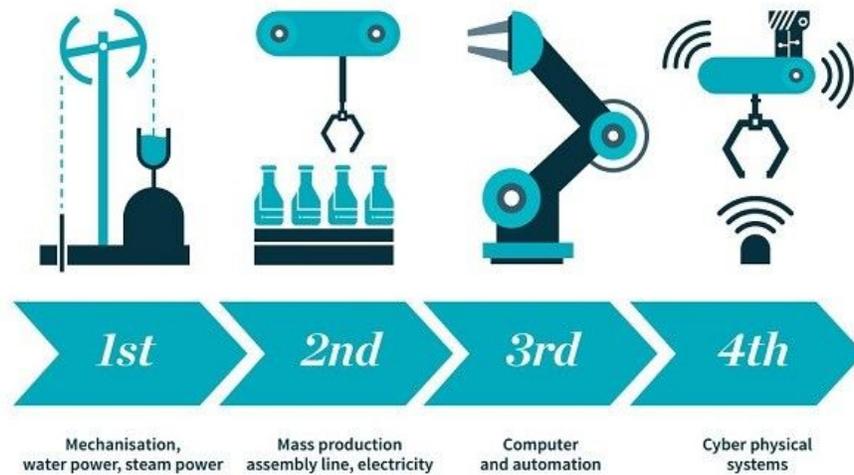
Future Trends Web Report

Group 10-38: Health 4.0

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Healthcare: Traditional Chinese Medicine

The Fourth Industrial Revolution (4IR)



The fourth industrial revolution creates a world in which virtual and physical systems of manufacturing globally cooperate with each other in a flexible way. This enables the absolute customization of products and the creation of new operating models. The fourth industrial revolution, however, is not only about smart and connected machines and systems. Its scope is much wider. Occurring simultaneously are waves of further breakthroughs in areas ranging from gene sequencing to nanotechnology, from renewables to quantum computing. It is the fusion of these technologies and their interaction across the physical, digital and biological domains that make the fourth industrial revolution fundamentally different from previous revolutions.

Specific Community Identified : Healthcare

We decided to focus on healthcare. A healthy nation is a wealthy nation. Healthcare is important to society because many people get ill, accidents and emergencies do arise and the hospitals are needed to diagnose, treat and manage different types of ailments and diseases every single day. Many of people's aspirations and desires cannot be met without longer, healthier, happy lives. The healthcare industry is divided into several areas in order to meet the health needs of individuals and the population at large. All over the world, the healthcare industry would continue to thrive and grow as long as man exists hence forming an enormous part of any country's economy. Healthcare would change significantly with the advancement of technology. Tasks usually done by humans would be slowly replaced by robots and A.I.

Specific Industry Identified : Traditional Chinese Medicine (TCM)

TCM is short for Traditional Chinese Medicine, which refers to a traditional style of medicine practiced since 2500 years ago, with main medical practices being acupuncture, herbal medicine, tui na (massage) etc.

We chose TCM as our main focus as it is an industry that can experience much impacts in the Fourth Industrial Revolution.

We conducted interviews with an employee that works at Chung Hwa Clinic, a TCM Clinic to find out her views on how TCM will be affected by the 4IR.



Adeline Lee Luo Yun, Chung Hwa Clinic

Interview Questions

1. What Smart Nation initiatives have been implemented in your hospital?
2. Do the doctors and nurses find them useful?
3. Do the patients find them useful?
4. What is your institution doing to prepare for the fourth industrial revolution?
5. Since everything is now digitalised, do you have plans/already have an online platform? What features does it/will it have?
6. What sectors of healthcare will be most affected by Industry 4.0?
7. Do you think brick-and-mortar healthcare institutions will be replaced in the future? If so, by what?
8. How will the healthcare industry cater to those of the older generation who may have an aversion to machines?
9. Will humans be still needed in healthcare?
10. Will the roles of doctors change in healthcare, since complicated tasks like surgery can already be done by robots?
11. How does the 4IR affect your business?
12. What do you think will happen when robots take over the healthcare industry, especially in the area of your expertise?

Interview Answers

1. The clinic has created online files of all patients for easy access to their health records and for better treatment.
2. Both doctors and nurses find them useful.
3. Both doctors and nurses find them useful.
4. The clinic collaborates with polytechnics in research for better development of chinese herbs
5. The clinic has its own website in both english and chinese, as well as self-serving kiosks.
6. She feels that TCM has not been deeply affected

7. No, since TCM has many specific operations and diagnosis based off of holistic treatment.
8. Accessible to the elderly as the technology used there is elderly friendly.
9. Yes, since doctor and patient interactions is extremely important.
10. Many factors affect the person's illnesses, thus having human would be better than robot
11. They could speed up logistic processes like queuing system and dispensing medicine. **(more efficient)**
12. Robots are unlikely to take over TCM since they use a holistic approach rather than the normal step by step procedure used by western medicine. Robots can only assist in treatment and diagnosis but cannot take over that area of business entirely.

Problems TCM will face in the future

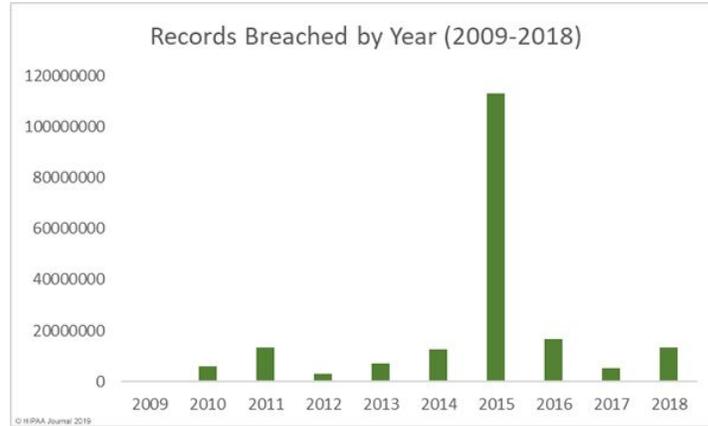
Based on the interview, we have identified 5 different problems that the TCM industry would be facing in the future.

1. Vulnerability of health data to hackers

Based on the interview we conducted, it can be seen that the clinic has created online files of all patients for easy access to their health records and for better treatment. With the availability of patients' health files online, the records might be vulnerable to online hackers. Two major problems with healthcare data hacking, mentioned by the 2014 Bitglass report: Today's health care organizations are not set up to identify illicit records activity and are therefore unable to eliminate it. Healthy patients may not learn about a breach until they have a reason to seek treatment, which is the most stressful time to have to deal with such a problem. Medical identity theft can cause difficulties like lost insurance coverage, mixed up records, higher premiums, medical harm and false diagnosis. Hacked healthcare data can be used for medical identity theft. The financial impact on patients can be significant. The Ponemon Institute calculates that the average out-of-pocket loss per victim of medical identity theft could amount to \$18,660. The stolen data can be used by criminals to make claims on behalf of a patient or to allow criminals to purchase expensive medical equipment.

Research 1:

According to the HIPAA journal (Health Insurance Portability and Accountability Act), there has been a general upward trend in the number of healthcare records exposed each year, with a massive increase in



2015. 2015 was the worst year in history for breached healthcare records with more than 113.27 million records exposed.

Research 2:

According to the HIPAA journal, these are the top 5 largest healthcare data breaches. In 2015, the year in which the most medical records was exposed, the largest healthcare data breach affected more than 78 million individuals.

Largest Healthcare Data Breaches (2009-2018)

Rank	Name of Covered Entity	Year	Covered Entity Type	Individuals Affected	Type of Breach
1	Anthem Inc.	2015	Health Plan	78,800,000	Hacking/IT Incident
2	Premera Blue Cross	2015	Health Plan	11,000,000	Hacking/IT Incident
3	Excellus Health Plan Inc.	2015	Health Plan	10,000,000	Hacking/IT Incident
4	Science Applications International Corporation	2011	Business Associate	4,900,000	Loss
5	University of California, Los Angeles Health	2015	Healthcare Provider	4,500,000	Hacking/IT Incident

Research 3:

This situation can also be seen in Singapore:

According to Channel News Asia, on October 2018, the "most serious breach of personal data" in Singapore's history took place, with 1.5 million SingHealth patients' records accessed and copied while 160,000 of those had their outpatient dispensed medicines' records taken, according to the Ministry of Health and Ministry of Communications and Information.



Among those affected was Prime Minister Lee Hsien Loong, with the attackers “specifically and repeatedly targeting” his personal particulars and information of his outpatient dispensed medicines, the ministries said in a joint release on Friday (Jul 20).

2. Patients' inability to trust robots

Robots being capable of emotions would be impossible or a far reach from now. No matter how advanced robots in healthcare become, they are unable to feel and understand what is **ethical** and the **morality** of the situation. The patient may then find it hard to trust in these robots to have control over their body.

Trust plays a central role for relationships in the healthcare domain, and the introduction of healthcare AI can potentially have significant impacts on those relations of trust.

A critical foundational relationship in healthcare interactions is trust between patients and doctors.

Patients frequently cannot predict their doctor's particular actions, precisely because the doctor has a

wealth of knowledge and skills that the patient does not. As a result, patients place understanding trust in their doctors: they make themselves vulnerable because of their expectations and beliefs about their doctor's knowledge, skills, values, and intentions.

But with the introduction of a healthcare AI or robotics system for a particular treatment or diagnosis task, this system replaces a task traditionally performed by the doctor and it potentially threatens to **displace some patient-doctor trust**. Licensure of the doctor can no longer ground understanding trust for that task, so the patient needs to know whether the AI system used is appropriately approved and is safe for the functions it performs. Patients may find it hard to shift their trust from the doctors they had much experience with, to the new robots that they don't know much about.

Research 1:

Maureen Baker, a Scottish medical doctor who was Chair of the Royal College of General Practitioners from 2013 to 2016, stated, "The role of a doctor... isn't just clinical knowledge or use of data; it's judgement, it's communication, it's diplomacy, it's tact, it's pattern recognition. Crucially, it is the ability to apply that knowledge and adapt it to suit the patient in front of you, within the prevailing ethical and regulatory frameworks... Machines are a long way off from being able to handle that complexity at the moment, and nor are they likely to. Fundamentally, no machine or programme has any 'understanding' of the human condition."

Research 2:



However, at the moment, machines can already replace some simple procedures.

A master's student in eastern China has taken the mission to modernize traditional Chinese medicine to a whole new level by building a robot that can perform acupuncture.

Named "Acubots," the robot consists of a set of cameras and a mechanical arm into which specialized needles can be inserted. Xu Tiancheng, the graduate student at Nanjing University of Chinese Medicine who initiated the project, said that he had so far received 100,000 yuan (\$15,000) in government funding, adding that Acubots' main advantage is that it can insert needles into skin faster than human hands, which he said makes the process less painful.

While logically, people may understand that the robots should be more effective than humans, they may not be able to accept it because of their fears such as the robots malfunctioning. Since, there are many needles involved, patients may not be able to trust robots with the procedure. They would much rather continue putting their faith into doctors that they have experience with and they trust.

Research 3:



Another example of robots in TCM is The Expert Manipulative massage automation.

Short for Expert Manipulative Massage Automation, Emma consists of a robotic arm extending from a white machine that is able to dole out back and knee massages. The robot was built by AiTreat, a start-up incubated by Nanyang Technological University, and was in the developmental phase for about two years. Emma the robot executes massages through soft silicon tips that are warmed to a temperature of between 38 deg C and 40 deg C to mimic human touch.

The type of massage is prescribed by the physician following a consultation, and the robot uses a camera for calibration to accurately target the acupoint.

While robots can effectively replicate humans in giving massages to a certain extent, people may not enjoy robots replacing humans, as it may make the massage seem cold and impersonal.

3. The clinic's inability to adapt to new technology

According to our interview with the staff of the TCM clinic, the TCM clinic staff believes that robots are unlikely to take over TCM since they use a holistic approach rather than the normal step by step procedure used by western medicine.

While there might be new technology that will make TCM more efficient and effective, there will still be close-minded practitioners that might not be able to accept these new technologies and would be stubborn to change the traditional methods that they have been using for the past thousands of years.

Traditional chinese medicine is advanced and requires experience. All practices have been slowly incorporated into modern day medicine and its knowledge can impact the future medical world positively and that it is enough to fit changing times, future times, and varied cultures. They are successful in what they do and have the information to help others in the future, thus technology is not necessary to them but rather a waste of money.

Traditional Chinese medicine (TCM) is a style of traditional medicine has a rich history, based on more than 2,500 years of Chinese medical practice that includes various forms of herbal medicine, acupuncture, massage (tui na), exercise (qigong), and dietary therapy.

Research 1:

The ancient practice of acupuncture started in China approximately 3000 years ago. In traditional Chinese medicine, acupuncture is linked to the belief that disease is caused by disruptions to the flow of energy, or qi, in the body. Acupuncture stimulates points on or under the skin called acupuncture points or acupressure points, releasing this qi. Practitioners and patients of tcm have much faith in the effectiveness of acupuncture.

Research 2:

Tui na is a hands-on body treatment/ massage. The practitioner may brush, knead, roll, press, and rub the areas between each of the joints, known as the eight gates, to attempt to open the body's defensive chi (Wei Qi) and get the energy moving in the meridians and the muscles.

The practices of TCM such as acupuncture and tui na have very long histories, and practitioners have been doing this job for a long time. Practitioners take pride in their work and will definitely be close minded about having robots replace these procedures.

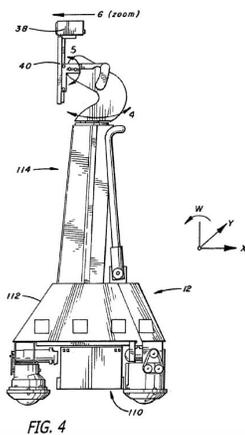
Challenge 4: The Replacement of Many Roles in the Healthcare Sector by Robots

With the advent of the Fourth Industrial Revolution, many jobs will be replaced by robots, especially those of a repetitive and/or mechanical nature. These jobs, perceived to be mundane, will be taken over by robots. This includes much of factory work. Thus, a lot of people will lose their jobs. Since this project focuses on the Healthcare industry, here are some of the jobs within the healthcare industry that can and will be taken over by robots, some of which are not repetitive and mechanical but rather require a higher degree of precision that robots can offer.

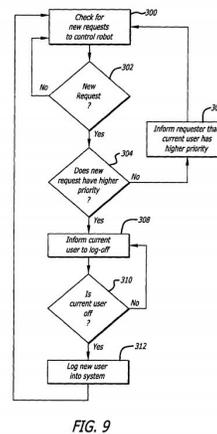
Research:

1) Telepresence

U.S. Patent Jan. 30, 2007 Sheet 4 of 10 US 7,171,286 B2



U.S. Patent Jan. 30, 2007 Sheet 9 of 10 US 7,171,286 B2



Challenge 5: TCM might be perceived as less effective compared to newer forms of treatment/medicine

As technology advances, so will the technology in the healthcare industry. Every single day, newer, better, and safer forms of treatment, procedures, and medicines are created and pushed out. TCM might thus be regarded as too “traditional” and not as effective as the new medicines.

Research:

- 1) [Used in Challenge 3] The ancient practice of acupuncture started in China approximately 3000 years ago. In traditional Chinese medicine, acupuncture is linked to the belief that disease is caused by disruptions to the flow of energy, or qi, in the body. Acupuncture stimulates points on or under the skin called acupuncture points or acupressure points, releasing this qi. Some people however are skeptical of the idea of qi, as it is an idea that originates from ancient China. Critics argue that there is no physiological evidence that qi or meridians exist, and scant evidence that TCM works. There have been just a handful of cases in which Chinese herbal treatments have proved effective in randomized controlled clinical trials.

Underlying Problem

Given that there are new technology being created to assist in TCM clinics, there would be some people who would be unable to accept the new technology. How might we educate patients and practitioners on the effectiveness and safety of these technologies to allow the better integration of new technology in TCM clinics in the years 2030 and beyond?

Solutions

1. TCMuseum

We, the TCM Practitioners Alliance, shall, in the span of three years, collaborate to create a gallery exhibition on permanent display at the Chinese Cultural Heritage Museum. This museum will include the history of TCM, and how far it has progressed. There will be a section of the future of TCM and how robots can be integrated into TCM. A few model machines can be added so that the public can see how the machines work. Not only will this raise awareness of TCM to the public, it also shows them the effectiveness and possibilities of the robots, encouraging patients and practitioners to be more open-minded about the use of new technology in TCM.

Research 1:

The Chinese traditional medicine (TCM) evidence-based medical center, the world's first organization of such kind, was officially established in Hangzhou, Hu Qing Yu Tang Chinese Medicine Museum.

"Evidence-based medical studies evaluate the clinical verifiability and effectiveness of a medical theory with scientific examination and analysis," said Huang Luqi, academician with the Chinese Academy of Engineering and head of CACMS. TCM still lacks evidence justifying its clinical effectiveness, which according to experts, "is stopping it from going global". Under this approach, clinical evidence from well-designed and well conducted research can serve as the main basis for evaluating effectiveness and safety of treatment.

If there are more of such museums in the world, they can spread awareness of the effectiveness of the use of robots in TCM.

2. TCMVR

We, the developers of Vive, will in the span of 5 years, develop and launch an interactive Virtual Reality (VR) programme. This programme will allow patients and unconvinced TCM practitioners to experience the procedures conducted by the TCM machines in VR. Furthermore, they will be able to take a “tour” inside of the machine itself, learning its different components and functions, as well as its safety procedures, thereby increasing awareness of TCM technology’s safety and effectiveness, increasing positive reception towards the technology.

Research 1:

Surgeon Simulator VR: Meet the Medic. This simulator allows players to step into the shoes of a surgeon and perform surgery on patients. It is a clear example of how one can utilise VR to create a surreal experience which feels realistic to a small extent. We can utilise VR in a similar way and create a simulator to simulate the using of TCM machines. This allows TCM practitioners to experience using these machines and the effectiveness of them. With proper and sufficient funding of the simulator, it can be updated to make the simulation more realistic and educational.



Research 2:

The capabilities of Virtual Reality have improved vastly over the years. For example, MasterpieceVR is a technology company that is developing the most intuitive and powerful social 3D content creation platform using virtual reality. *MasterpieceVR* is also a cross-platform and comprehensive 3D sculpting and painting tool that opens up new ways for rapid ideation, creation and collaboration in virtual space.



This shows that a VR simulation of TCM procedures being realistic is a very achievable goal.

3. TCMore

We, the developers of Yelp, will, in the span of two years, develop and launch an application available on computers and mobile phones. This application will provide an introduction to the different types of machines used in TCM and will provide the nearest TCM locations where the public can visit, to learn more about the machines by watching them in progress. It will also contain videos of scientists around the world endorsing TCM machines and its effectiveness.

Research 1:

Yelp is a location-based business directory service and crowd-sourced review forum. The company develops, hosts and markets the Yelp.com website and the Yelp mobile app, which publish crowd-sourced reviews about businesses. This app uses GPS to detect businesses near a user and we can use the same system to detect TCM locations.

4. TCM ‘Gram

We, Singapore TCM Practitioners, will set up various social media accounts on Facebook, Instagram, Twitter, LinkedIn and the like. These accounts are meant to spread publicity for TCM machines and provide the average consumer with facts about their effectiveness and safety. With such a great media outreach, TCM patients would have been educated on how safe and effective these machines actually are and have no qualms about using it. This includes any practitioners themselves who are skeptical of these new machines as compared to their years of hard work and experience.

Research 1:

Social media are interactive computer-mediated technologies that facilitate the creation and sharing of information, ideas, career interests and other forms of expression via virtual communities and networks. We can use these accounts to share information about TCM machines effectively and quickly to a large audience.

Research 2:

The number of internet users worldwide in 2019 is 4.388 billion, and the number of social media users worldwide in 2019 is 3.484 billion. That means more than $\frac{3}{4}$ of internet users use social media, making it one of the largest platforms for publicity campaigns such as this. Facebook also has an 8% average post reach versus page like, which is quite a substantial number given that many people regularly reach posts by scrolling past them without liking. This shows that social media does indeed reach a lot of people and can effectively publicise TCM machines and their safety and effectiveness.

5. TCM Land

We, the developers of Carousell, will organise a carnival similar to Carouselland to advertise and spread awareness about TCM machines. This carnival will have normal carnival booths selling food and playing games, but its main highlight will include talks by famous practitioners; TCM machine booths where you can see these machines at work; and also free health checkups by TCM practitioners. This way, both practitioners and patients will be able to enjoy the carnival and learn how effective and safe these machines actually are, giving them a peace of mind when using the machines.

Research 1:

Carouselland 2018 was a massive success. It was touted as one of the biggest indoor bazaars in Singapore with over 300 curated vendors selling things that cannot be found anywhere else. The bazaar was held over three days and saw an extremely large turnout that rivalled bigger conventions such as the annual IT show at Suntec City. This shows that carnivals such as these tend to draw a lot of people to come and attend and thus will increase the publicity the machines receive and educate event-goers on their effectiveness and safety.

Decision Criteria

- 1) Which solution will be the **most effective** in allowing TCM practitioners to understand and use the new technology, so that they can adapt in the 4IR?
- 2) Which solution will be the **least expensive** to implement, to convince the TCM practitioners and patients, so that they are more willing to use the new technology of the 4IR?
- 3) Which solution will be **quickest to implement**, such that the technology of the future can be utilised as soon as possible, so that they can appeal to both TCM practitioners and patients?
- 4) Which solution will be the **most attractive** to the customers, such that more people will engage in TCM services?
- 5) What would be the **most creative** solution to convince TCM practitioners and patients of the effectiveness of the use of new technology in TCM?

Decision Matrix

Solution	Alternative Solutions	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Total
1	TCMuseum	4	4	5	4	4	21
2	TCMVR	5	3	4	5	5	22
3	TCMore	3	5	3	3	3	17
4	TCM Gram	2	2	1	1	2	8
5	TCMLand	1	1	2	2	1	7

Final Solution: TCMVR

Action Plan

WHO:

- 1) Vive - a technology healthcare company specialising in virtual reality
- 2) Singapore TCM Practitioners Association
- 3) Manufacturers of the TCM Machines

WHAT WILL BE DONE:

Singapore TCM Practitioners Association will, in 1-2 years, develop a virtual reality application called TCMVR that allows patients and practitioners to understand how TCM machines work and convince them on its effectiveness and safety.

DETAILS ABOUT HOW THIS WILL HAPPEN:

We, the Singapore TCM Practitioners Association, will collaborate with Vive to produce a virtual reality application called TCMVR which showcases the different TCM machines. It will allow patients and practitioners to understand the inner workings of the machines and will demonstrate how it is effective in helping patients. It will also show them the different safety measures that makes the machine safe for commercial use, as this is a major concern for many patients. If need be, this application can also be used not only in conjunction with a virtual reality headset, but also a haptic-feedback suit, so that patients who are worried about the invasiveness or the pain involved in the procedure can put their worries to rest.

TCMVR will be advertised on social media and other more traditional forms of media, such as holographic television. It will be available for download on all the newest devices, including mobile phones, holographic computers, and the like. Vive will also send free virtual reality headsets to those who cannot afford one so they can also utilise the application and clear their doubts about these new machines.

TCMVR's home page will be a scroll-through menu of different TCM machines and their 3-Dimensional renders, and users are free to scroll and click on any of the machines. Once they have selected one, they will be brought to a page where they can choose to either:

- 1) Explore the inner workings of the machine when it is in use
- 2) Check out some of the safety measures it has
- 3) Undergo the procedure itself (only available when connected to the haptic-feedback suit)
- 4) Learn how to use the machine (Game mode, more geared towards the doctors themselves or children)

Etc. TCMVR will be updated regularly to showcase the newest machines technology has brought to the world of TCM and provide the users of these machines with peace of mind. The realism of the virtual reality experience will also be enhanced.

IMPLEMENTATION SCHEDULE:

Firstly, we would develop TCMVR. Along with the application's development, we will publicise it with advertisements on the Internet, holographic television, and traditional print media. We will also work closely with the manufacturers of the machines so that we will be able to give the most accurate virtual reality replication of the machine and the experience it provides patients.

Next, we will launch the application on all major application stores for free, and intensify our advertising. The application will be available to anyone of any age. In addition, a game mode, where players can act as a doctor and go through a series of missions will also be implemented, so that children will be more inclined towards downloading it, piquing their parents interests at the same time, creating more publicity for the app.

POSSIBLE PROBLEMS:

1. The public's reluctance to download TCMVR.

We will increase our publicity measures on print and digital media. To reach out to even larger demographics, we will be rolling out a game mode for children to complete missions in the game and get rewards. We will also have elderly-friendly settings such as less haptic-feedback for vigorous procedures. Furthermore, we will also place a few headsets with this application downloaded at all TCM clinics for patients to try.

2. People may not be convinced that TCMVR works like the real thing and may think that VR can never truly replace physical interaction with the machines.

TCMVR, like all VR applications, involves putting on a headset and not physically operating the machines. Because of this, users will not be convinced that TCMVR is effective in letting them experience how to use these real life machines. To solve this, we, the developers of TCMVR would get trained engineers who have worked on TCM machines and real TCM practitioners to test out our application to see whether it is accurate and realistic.

3. Public's inability to adapt to technologies.

Some difficulty will be faced including the public's inability to accept the usage of VR to learn about TCM and understand that TCM machines are more effective. To solve this problem, we would increase our publicity and make use of television commercials to advertise our VR application, so the public would be convinced to use TCMVR.

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