DigiHealth-Asia

Deliverable D1.2: Analysis of the skill requirement and priorities in Asian partners for the implementation of digital health care and monitoring system

Work package	WP1
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Executive Summary

This deliverable is related to 'WP1 – Preparation' and 'Task 1.2 Identification of skills and training requirements for ICT, healthcare practitioners. The core aim of this task is to thoroughly understand the levels of skills in ICT among health care professionals in each Asian partner country and to identify their training needs in order to bring them up to speed with latest technologies for remote health monitoring. In order to assess the readiness level of each Asian partner country (Pakistan, Mongolia, Thailand) to deploy innovative technologies for implementing digital health solutions, this deliverable facilitated collecting vital information through survey questionnaires as well as workshops organized at each partner country. For each partner country, key highlights of the workshop activities and results of the survey questionnaire are presented. The information in the deliverable will be helpful in the design and developing process of the pilot cases in the Asian countries.

1. Introduction

ICT skills of health care professionals is a key factor in implementation and deployment of modern digital health care solution which rely on workers' skills to produce, analyze, disseminate and use of health information in a reliable and timely manner. According to WHO, the World Health Organization's (WHO) framework for strengthening health systems [1], "health information" is one of the building blocks which also informs decision-making in each of the other building blocks, namely, health workforce; health services; health financing; governance and leadership; and medical products, vaccines and technologies. If equipped with appropriate ICT skills, health care professional can harness the power of modern technologies such as patient data collection through remote monitoring, AI based analysis etc. for making clinical decisions.

For the DigiHealth-Asia project, a pragmatic approach is adopted in order to identify the key issues regarding the information and ICT skills of health professionals. Indeed, this deliverable progressively builds on the work completed in Task 1.1 which carried out a thorough review on digital health care and monitoring technologies in Asia and EU. Targeting the three pilot cases, the review focused on 1) key available solutions, 2) system components, and 3) use of AI/ML for the three pilot cases (cardiovascular monitoring, mobility disorder monitoring, and remote patient consultation) in Europe and Asia. Building of this information, the current task aims to focus on the ICT readiness as well as the limitations in health professionals' information and ICT skills, i.e., the skills required to collect, report, understand and utilize data required in the health systems. To this end, workshops were organized by each partner Asian country to seek input from the stake holders which include university academics, health care professional from local institutions, tech industry professionals as well as the end users. A survey questionnaire was also developed to collect data to evaluate the ICT readiness, current skill levels and intertest in learning about applied courses in artificial intelligence (AI), embedded systems and Internet of Things (IoT).

In the following sections, a report from each partner country is provided which highlights the current view of ICT skill in health care workers, workshop report and the results from the survey questionnaire.

2. Identification of Skills and Training Requirements in Pakistan

2.1. Current View of ICT Skills (from Published knowledge sources)

The expansion of Information and Communication Technology (ICT) around the globe has set up an unprecedented opportunity for delivery of healthcare facilities and infrastructure to resolve problems of accessibility and timely health care service provision. Just like other developing economies, digital health can play a vital role to help address key issues of the health sector in Pakistan. Pakistan's health sector is faced with challenges of poor infrastructure, acute shortage of medical professionals, inadequate medical facilities in rural areas, high cost of health services and low government spending in the sector. Digital health can help reduce inefficiencies in healthcare delivery, improve access, reduce costs and increase quality of life.

In Pakistan, some of digital health's initiatives have been introduced at both national and provincial levels. For instance, the Government of Pakistan has launched an e-Card solution [2] to store health histories and patient data securely so that doctors and insurers can have access to consistent patient histories to make informed decisions. Such government initiatives are also coupled with existing health policies, such as the Prime Minister National Health Program [3], which provides health facilities to underprivileged citizens of the country. Although E-health service program has its own challenges; it has directly impacted 3.1 million families in 40 districts living below the poverty line of Rs. 200 per day by providing them a benefit of 0.3 million rupees per family per year [4]. At the provincial level, the provinces are financially more autonomous and more powerful to decide their own health system and health policies. Provinces are now responsible for providing the right growth mechanism and strategy to their respective health sectors, in addition to the earlier service delivery role. Digital health strategies have been established and pilot d-health projects have been witnessed in Punjab, Sindh, Khyber Pakhtunkhwa and Baluchistan.

However, digital health is still in its infancy in Pakistan. Pakistan is a country where the ICT environment and enabling environment for eHealth are both in their early stages. Within this national context, eHealth is project-based, featuring a few small initiatives that are seldom connected to each other. Projects tend to be time-limited, proof-of-concept pilots, where ICT is introduced (or imported) to demonstrate a technology in a limited context. The ICT applications used may themselves be innovative, but the projects are rarely sustainable. They fail because of a lack of infrastructure and skills, a narrow focus on one particular aspect of eHealth that disregards other concerns and impacts, and a lack of ownership by the health entities involved. The use of ICT in the general population in Pakistan is limited as well. The commercial ICT market is fragmented, with little local expertise available [5]. Many pilots are not followed by full-scale implementation due to a lack of sustainable financing, high risks for individual stakeholders and long time-to-market for commercial solutions. There is no one standard implementation model, which can be considered a one-stop-shop solution for Pakistan's healthcare issues. Government needs to develop a comprehensive digital health strategy, a pro-active mindset and an effective public-private partnership model to address the health sector problems through emerging technologies [6].

2.2. Workshop on skill and training identification in Pakistan

Capital University of Science and Technology (CUST), Pakistan, organized a workshop on March 4, 2021 to identify the skills gap in ICT and the training requirements of healthcare practitioners in Pakistan with respect to cardiovascular diseases. The workshop was aimed for finding out the parameters essential to be monitored in cardiac patients, available sensors and monitoring systems, skills gap, and prospects of these systems in Pakistan. The findings of the workshop enabled participants to be

updated to the latest developments, tools and technologies typically used in remote monitoring and care of cardiac patients and will be used to guide the development of monitoring systems for Cardiovascular patients in Pakistan.

Figure 1: Group Photo of Workshop Participants.

Professor Dr. Naseem Rauf, a member of Science at Pakistan Council of Science and Industrial Research, Ministry of Science and Technology, Pakistan, graced the event and highlighted that the Pakistan government is devoted to promoting the state-of-the-art and emerging technologies for betterment in health domains. She appreciated the efforts of the team and participants, and acknowledged that the Erasmus plus programs in general and this project in particular would be contributing a lot in improving Science and Technology in Pakistan. Professor Dr. Sahar Fazal, Head Department of Bioinformatics and Biosciences also participated in the event and offered her support in completion of the project. Professor Dr. Amir Qayyum welcomed the participants and gave an introduction to the Erasmus Plus, Digi Health-Asia project. Mr. Muhammad Hamza highlighted the project activities and expected outcomes. Dr. Marriam Bakhtiar, explained the goals and objectives related to this pilot case i.e., cardiovascular diseases.

2.2.1 Presentation by Dr. Salik Javed Kakar

The workshop started with a talk by **Dr. Salik Javed Kakar** who works as an Assistant Professor in ASAB, National University of Science and Technology NUST Islamabad. Dr. Kakar is a medical doctor who later obtained his MSc from the University of Leicester, UK, and PhD from the University of Manchester, UK. His PhD research and two post-doc experiences were in viral as well as non-viral gene therapies in cardiovascular diseases. His talk was focused on pathophysiology diagnosis and available treatments for various cardiac diseases. In his talk, he explained the structure and functional aspects of heart as an organ; what a physician means when it comes to cardiovascular diseases and what heart diseases do not fall into this category; how these diseases originate and how we can diagnose these diseases. The talk emphasized the significance of measuring the blood pressure and what can be inferred from it. He also explained the significance of measuring electrocardiography (ECG), especially 6-lead ECG and gave examples of a few devices available to measure ECG. During the discussion

session, it was concluded that to have a good picture of cardiovascular patients, we should at least monitor

- Blood Pressure Variations
- ECG

In addition to these two meaasurements, a variety of factors could be added including exercise (step counter), oxygen saturation level etc. He shared his experiences with various patients in his practice and elaborated that timely and accurate monitoring of these patients could save lives. The need of portable and easy-to-manage devices was highlighted, and it was appreciated that due to COVID-19, tele-medicine has gained acceptance in Pakistan with practitioners and patients being more open towards it.

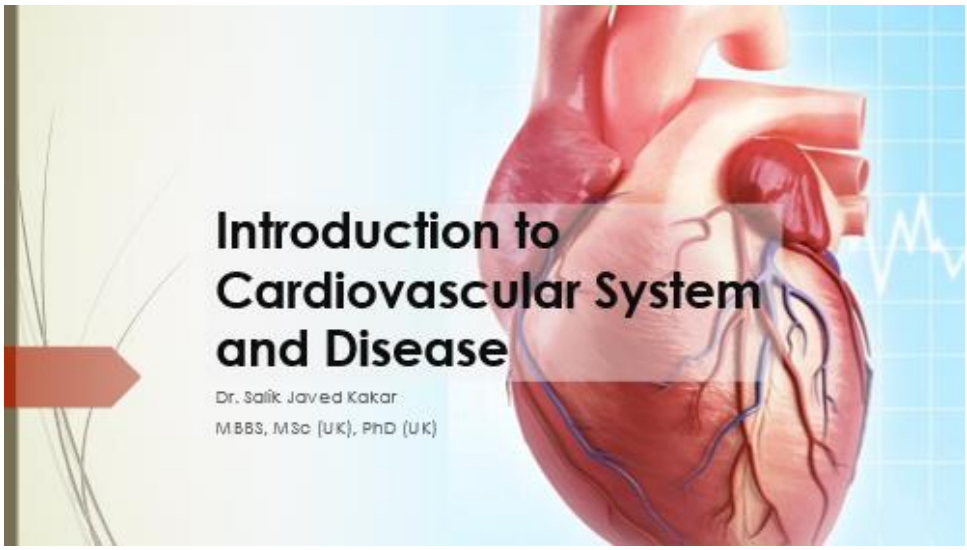


Figure 2: Title of introductory talk to have an overview of Pilot case.

Figure 3: Devices available to detect ECG.

Figure 2: Dr. Salik Javed Kakar at the workshop of DigiHealth Asia in Pakistan, 2020.

2.2.2 Presentation by Dr. Asim Rasheed

In order to understand the needs of the market, **Dr. Asim Rasheed** from a non-governmental organization named *Meethi Zindagi* was invited. Dr. Asim Rasheed has a Ph.D Degree in Electronics Engineering. He is an E-Health researcher and also the co-founder of Meethi Zindagi. Meethi Zindagi strives to provide quality healthcare to Pakistanis from the comfort of their homes through effective technologies. They have launched a service called *Diabetes Virtual Clinic (DVC)*. Diabetes Virtual Clinic is powered by the state-of-the-art and secure (HIPAA compliant) telemedicine solution providing 24/7 primary healthcare helpline for diabetes management as well as access to specialist care facility. Regardless of the location, if you have an internet connection on your phone or computer, one can access *Diabetes Virtual Clinic* anytime of the day. *DVC* has a team of leading endocrinologists and dialectologists (for adults and children), nephrologists (dealing with kidney and urine tract problems) and neurologists (dealing with neuropathy and foot complications) to provide professional healthcare services for patients. Dr. Asim Rasheed believes that technologies for assisting the diseases management and improving access to health care systems can greatly improve the quality of patients. He shared his experiences in portable sensors for diabetes, the feedback he receives from patients, caretakers, stakeholders in market and health care professionals. He also shared his experiences related to various sensors available in market and the use of reverse engineering. He pointed out the need for purpose-built sensors and highlighted that the placement of sensor, type of sensors, data recording and data acquisition from sensors should be kept in mind in design of the patient monitoring system. He also mentioned that the alarm system for data collection sometimes irritates patients.

Figure 3: Meethi Zindagi - a Successful Remote Monitoring System for Diabetes.

Figure 4: Dr. Asim Rasheed at the workshop of DigiHealth Asia in Pakistan, 2020.

2.2.3 Presentation by Dr. Khalid Yazdani Shah

Dr. Khalid Yazdani Shah is a medical doctor with an MSc in Medical Administration, an MSc in Human Resource Management and a diploma in Aviation Medicine. He completed his MBBS from Army Medical College Rawalpindi, Pakistan. Dr. Shah represented *Cognitive HealthCare International* and introduced their Cognitive Healthcare's Analytical Remote Monitoring System (CHARMS). CHARMS provides a state-of-the-art framework for care providers to monitor patients remotely which can range from basic vital signs to ECG and lab tests can be performed at home without patients having to visit the care provider. Dr Shah also shared the list of available sensors and their successful three-tiered model for remote sensing based on integrity, availability and confidentiality.

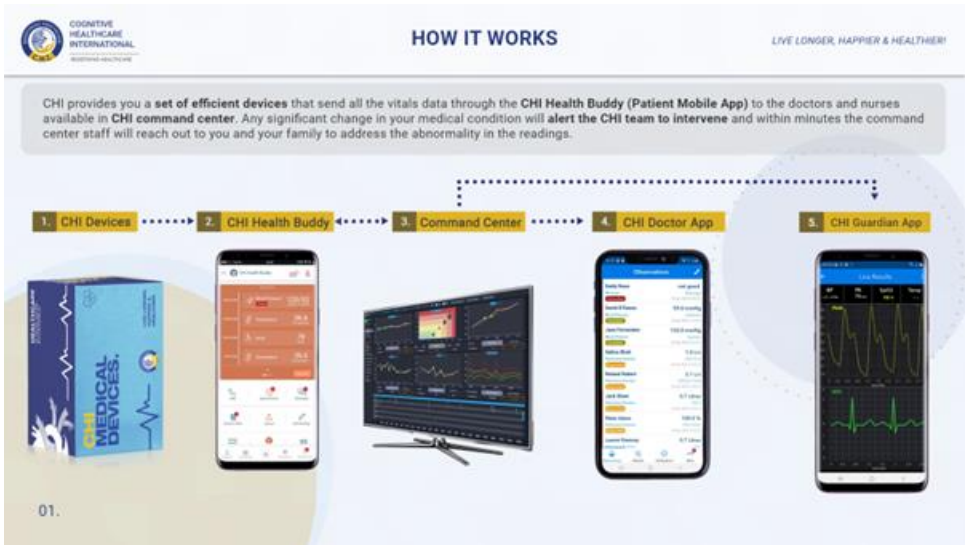


Figure 5: The working mechanism of Cognitive Health Care international.

Figure 6: Available devices/ Sensors for Remote sensing.

Figure 7: Dr. Khalid Yazdani Shah at the workshop of DigiHealth Asia in Pakistan, 2020.

Pilot case needs for the market and scope of commercialization were discussed with Dr. Asim from Meethi Zindagi as well as Dr. Shah from Cognitive HealthCare International. They both highlighted that the devices should not be put on the target market as they cannot afford to buy. These sensors need to be rented for a short period of time. There is a dire need in market for these devices and the integrated system for data analysis.

2.2.4 Presentation by Dr. Arshad Gillani

Dr. Arshad Gillani highlighted the trends in relevant market during his talk. Dr. Gillani is an experienced IT professional with background in a variety of roles in energy, revenue, development, media and ICT sectors. His experience includes all aspects of formulation of national IT development planning, strategy development, technology evaluation/analysis and project management. He has a very strong interest in foresight and futuristics, especially focusing on developing and emerging countries, and is currently engaged in promotion of entrepreneurship amongst youth and education for less privileged children. He has worked as Director ICT in Planning Commission of Pakistan. He explained the global market for IoT based health care systems. It was again highlighted that in countries like Pakistan, post COVID-19 situation where chronic disease patients are not able to regularly visit hospitals has enhanced the acceptance for remote medicine, remote health monitoring and tele-medicine. He also highlighted the emerging sciences such as computational biology and bioinformatics have a high scope for remote health care systems. He enlisted various domains where work could be done and also highlighted existing skill gaps.

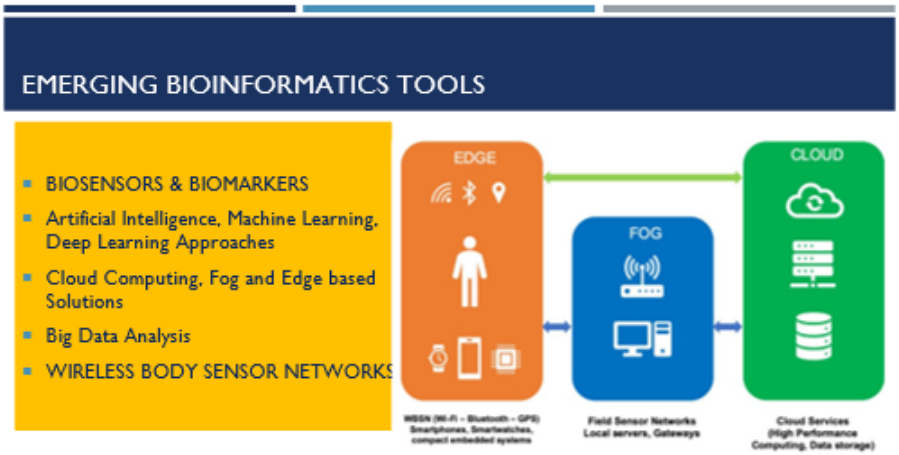


Figure 8: Scope of Bioinformatics and Computational Biology.

Figure 9: Dr. Arshad Gilani at the workshop of DigiHealth Asia in Pakistan, 2020.

2.2.5 Presentation by Dr. Sadia Shakil

To cover the aspect of artificial intelligence (AI) and machine learning (ML) and to have an input on the pilot case of cardiovascular diseases, **Dr. Sadia Shakil** was invited as a guest speaker. She is working as an Assistant Professor at Institute of Space Technology, Islamabad. She has a doctoral degree in Electrical and Computer Engineering from Georgia Institute of Technology, USA. Her PhD research focused to analyze the dynamics of resting-state functional connectivity. She used multiple algorithms and methods from various domains such as signal processing, machine learning, information theory, and pattern recognition to study functional magnetic resonance imaging (fMRI) data. She did her Postdoc in 'Computational Connectomics' from Baycrest Health Sciences, Canada, where she worked on understanding the relationship between brain and behavior using EEG data. Currently, she is collaborating with different hospitals to design and develop low-cost systems involving EEG and EMG signals for rehabilitation and diagnostics.

Dr. Sadia discussed ML approaches towards health care systems. She discussed various case studies on which she has worked successfully. She highlighted her projects on:

- Visual light communication-based heart-rate monitoring
- IoT-based heart-rate alert generator

She also discussed major challenges she faced and also discussed the future research opportunities.

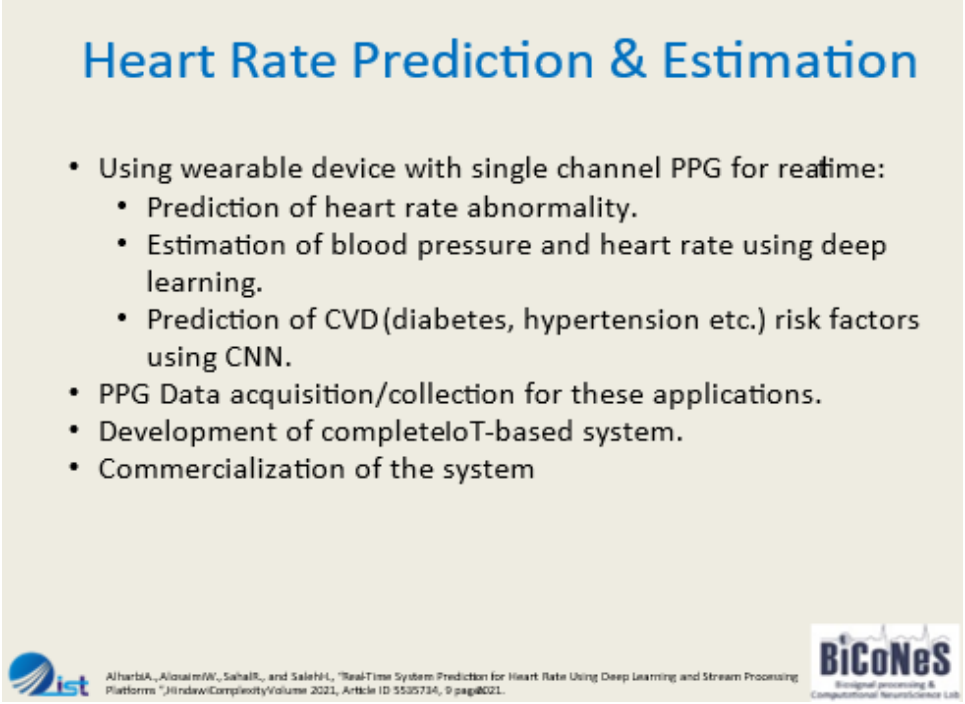


Figure 10: Case study by Dr. Sadia on monitoring of Heart Rate.

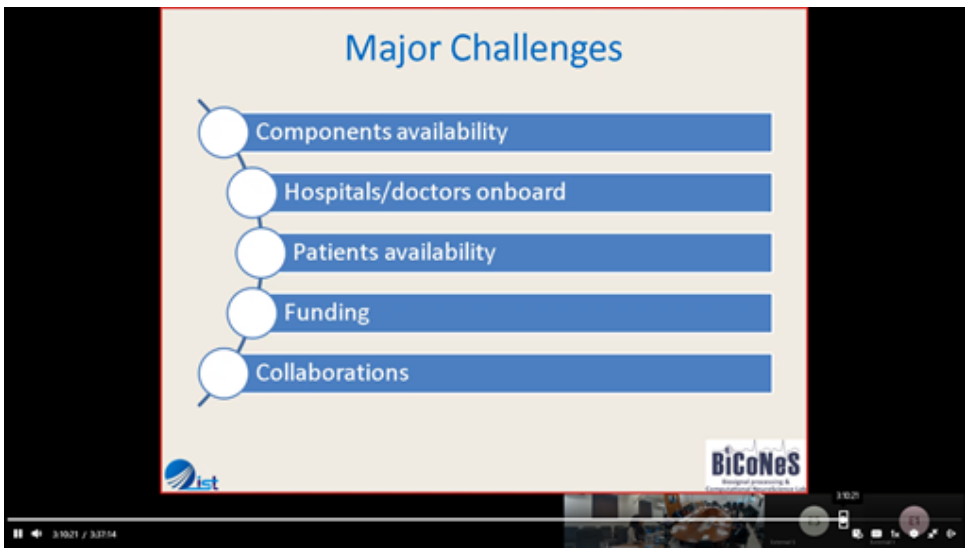


Figure 11: Dr. Sadia highlighted major challenges in ML in health care.

Figure 14: Sadia Shakeel at the workshop of DigiHealth Asia in Pakistan, 2020.

2.3. Results from the Survey Questionnaire

A survey questionnaire was developed as part of project deliverable in WP3 (Task 3.2) to gather data related to participants' background, identification of skill sets, relevance of the pilot study and potential of digital health care technologies.

The questionnaire for healthcare practitioners was designed using Google forms and was disseminated through email. There were in total 37 responses received from individuals in various disciplines. The personal information of responders has been kept confidential. The results of the questionnaire are summarized as below:

Question 1

Your area of specialty

- **Health Care practitioner**
- **Health Care Application Developer**
- **ICT (Information Communication Technology) specialist**
- **ML (Machine Learning)/AI (Artificial Intelligence) specialist**
- **Student**
- **Other**

The analysis of responses collected using the questionnaire showed that the majority of the responders were health care practitioners (32.43%), followed by the ICT (information communication technology) specialists (18.92%), students (18.92%), ML (machine learning) or AI (artificial intelligence) specialists (16.22%) and health care application developers (13.51%) respectively.

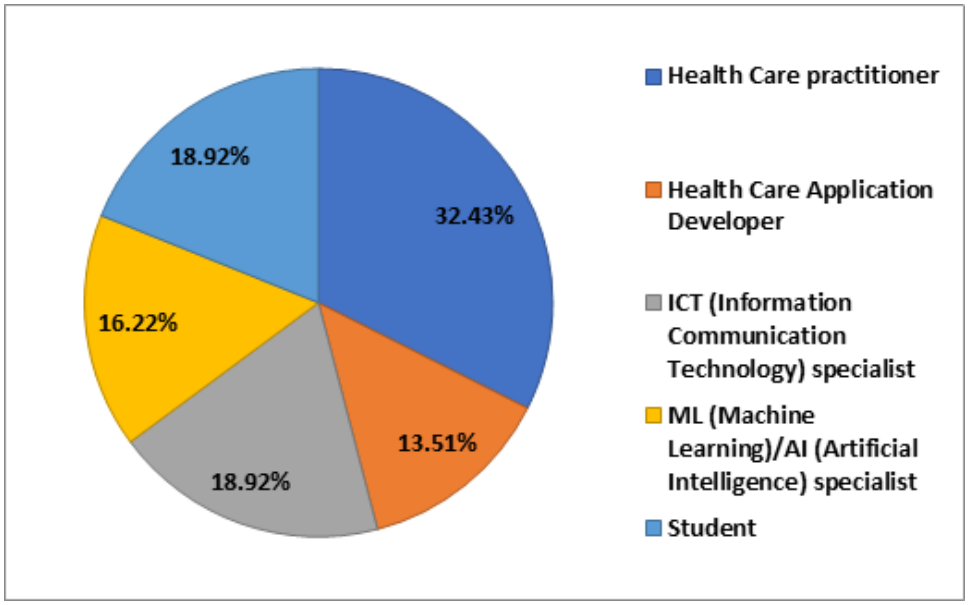


Figure 15. Percentage of responders belonging to different areas of specialization.

Question 2

Have you attended the workshop organized by Capital University of Science and Technology (CUST), related to the DigiHealth-Asia Project?

- **Yes**
- **No**

Among the responders of the questionnaire, 64.86% did not attend the workshop on DigiHealth-Asia project organized by CUST, whereas 35.14% showed their presence either physically or virtually.

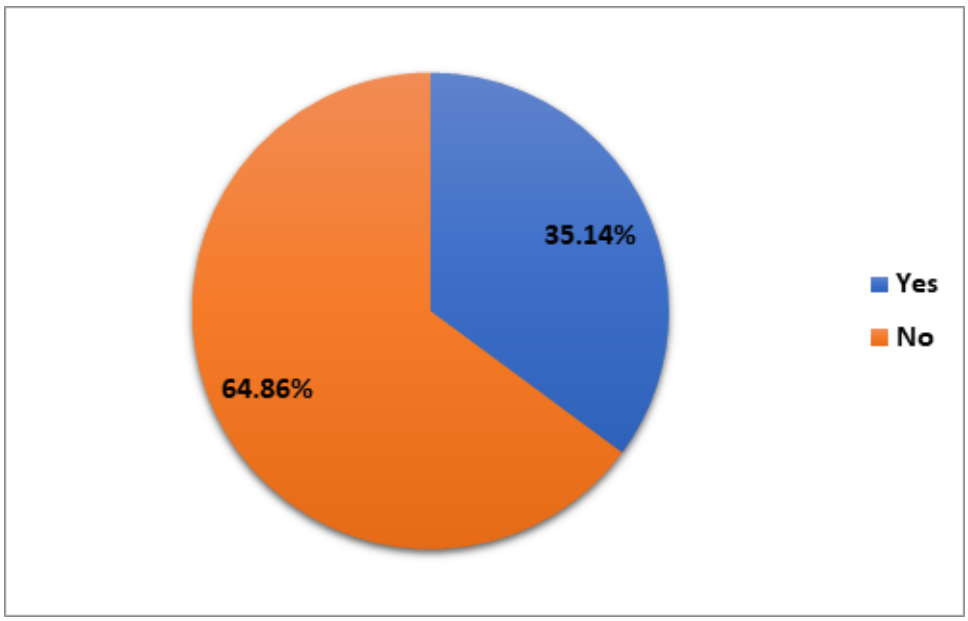


Figure 16. Relative proportion of responders with respect to their attendance in workshop in CUST.

Question 3

Was attending the workshop beneficial in introducing the aims and objectives of Capacity Building for Digital Health Monitoring and Care systems in Asia (DigiHealth-Asia)? Please answer in the scale from 1 (not beneficial) to 5 (very beneficial)

- **1**
- **2**
- **3**
- **4**
- **5**

A high proportion, 41.67% of people found this workshop very beneficial (5) in getting familiar with the aims and objectives of Digihealth-Asia, whereas, 50% of individuals rated it as 4 (beneficial) and 8.33% rated it 3 (moderately beneficial).

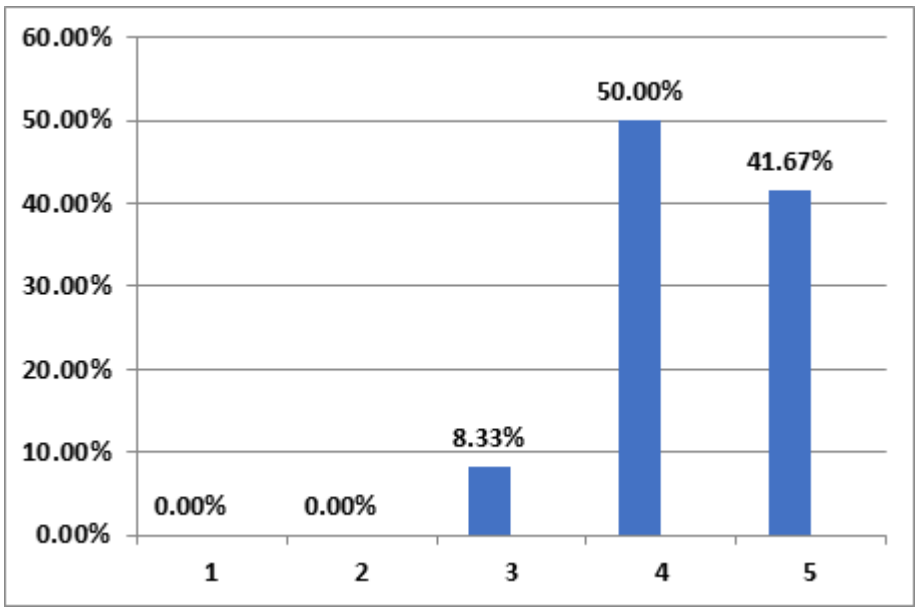


Figure 17. Percentage of responses on the significance of workshop in the scale 1(not beneficial) to 5(very beneficial).

Question 4

The idea of introducing new courses such as: IoT for healthcare, AI/ML for healthcare, and embedded systems for healthcare will be useful in Pakistan? Please give answer for each course specifically in coming questions

- **Yes**
- **No**

More than 97% of people responded positively towards the addition of new courses such as IoT (Internet of Things), AI/ML (Artificial Intelligence/Machine Learning), and embedded systems for healthcare in view their efficacy in healthcare in Pakistan.

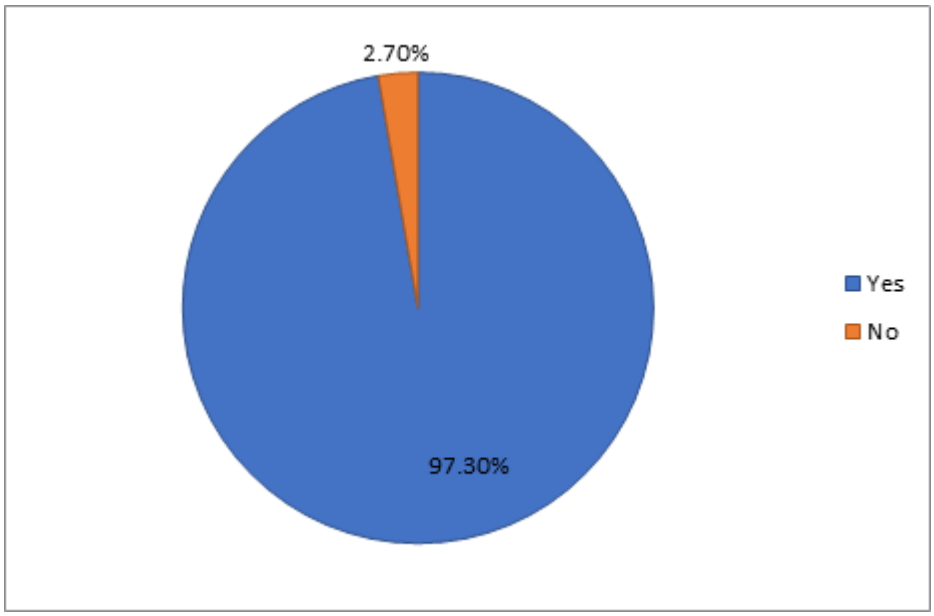


Figure 18. Percentage of positive and negative responses towards introduction of new courses like IoT and ML in healthcare in Pakistan.

Question 5

IoT (Internet of Things) for healthcare – The course will focus on different kinds of IoT sensors for healthcare from physical to application level.

- **Yes**
- **No**

The responses collected show that the majority (91.89%) of the responders favored the introduction course of IoT (Internet of Things) in healthcare. Some participants indicated concerns over the availability of Internet and Wi-Fi in remote areas of Pakistan.

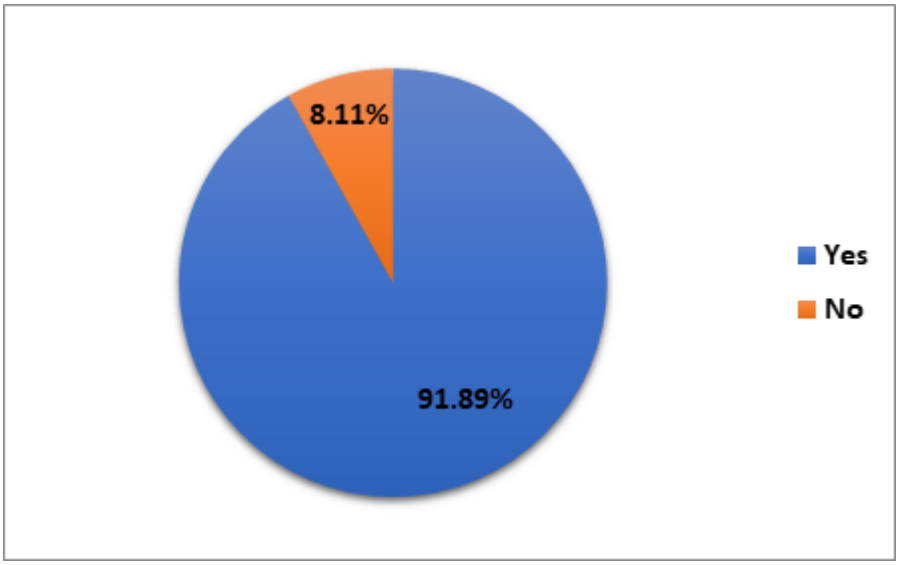


Figure 19. Percentage of positive and negative responses towards introduction of IoT (Introduction of Things) in healthcare in Pakistan.

Question 6

AI/ML for healthcare – This course will focus on learning and developing AI and ML techniques for healthcare scenarios including cardiovascular, mobility disorder and remote patient monitoring, etc.

- **Yes**
- **No**

The introduction of AI/ML (Artificial Intelligence/Machine Learning) course in healthcare gained 97.30 percent affirmative replies. A small number of participants (2.70%) were not in the favor of addition of this course.

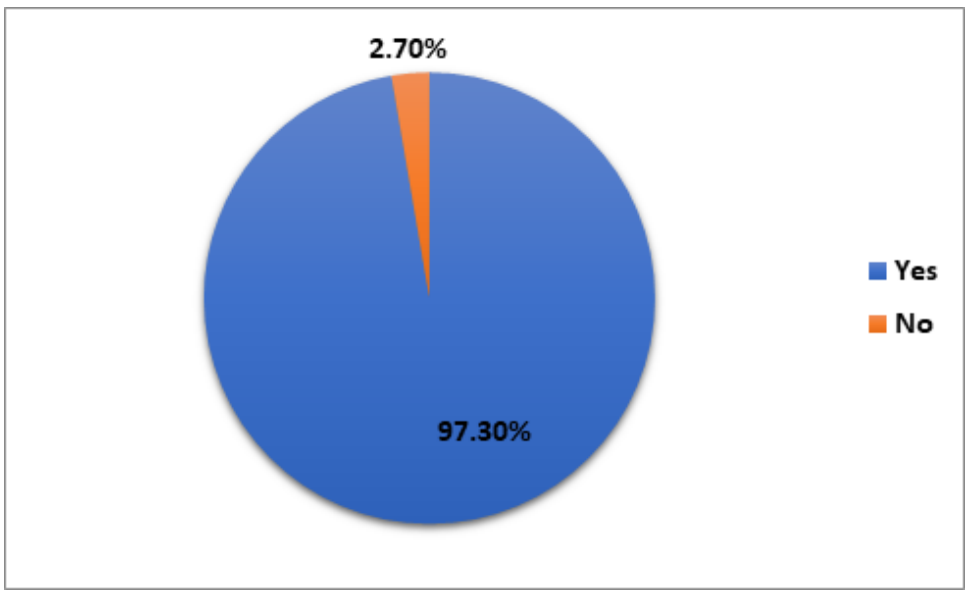


Figure 20. Percentage of responses against introduction of AI/ML Artificial Intelligence and Machine Learning techniques for healthcare in remote patient monitoring.

Question 7

Embedded systems for healthcare – This course will focus on design and implementation of various proofs of concepts for healthcare scenarios including cardiovascular, mobility disorder and remote patient monitoring, etc.

- **Yes**
- **No**

The analysis of responses shows that there were 89.19 percent positive responses while 10.81 percent negative responses. Some of the responders explained the reason for their objection to the introduction of the above-mentioned course. They claimed that medical field people might find it difficult as it is an engineering-based course.

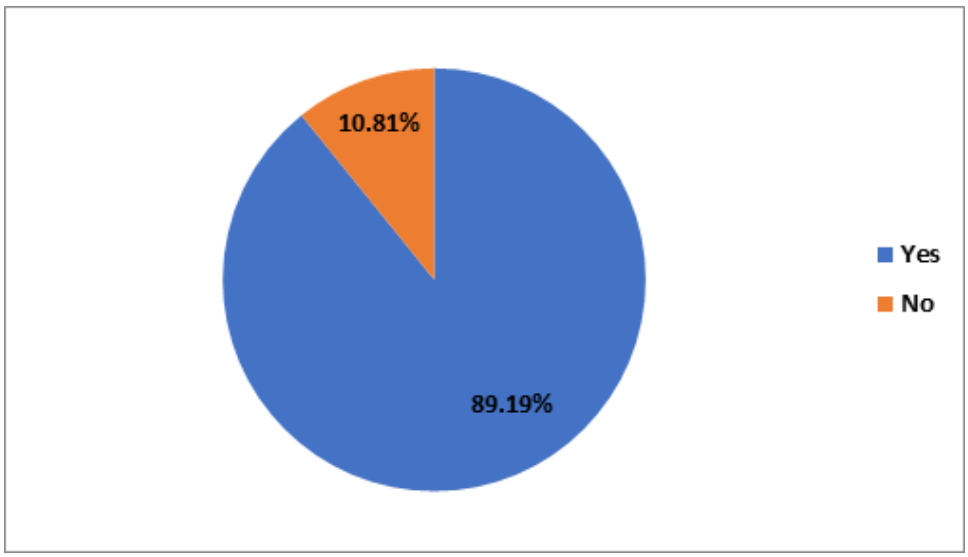


Figure 21. Percentage of responses against introduction of embedded systems for healthcare in remote patient monitoring.

Question 8

What skills sets are deemed to be important for the next few years in digital health? Please rate their importance from low (1) to high (4).

- **Artificial Intelligence/Machine Learning**
- **Hardware and IoT skills**
- **Software skills**
- **Any other relevant skill sets**

The analysis of the ratings given to the above-mentioned skillsets on the scale from 1 (low) to 4 (high) presented that 51.35% people opted for Artificial Intelligence/Machine Learning as the most important skill set for the coming few years in digital health, followed by Hardware and IoT skills (24.32%), Software skills (16.22%) and any other relevant skill sets (8.11%).

The importance level of 3 was assigned to Hardware and IoT skills by 43.24% participants, to software skills by 29.73%, to AI/ML by 21.62%, and to any other skill sets by 5.41% participants respectively. In

the case of level 2, the order for skill sets obtained was: software skills (45.95%), hardware and IoT skills (32.43%), while AI/ML and any other relevant skillset earned the same weightage (10.81%).

Among the four mentioned skill sets, any other relevant skillset was found least important by a major proportion (75.68%) of individuals. Out of the remaining proportion, 16.22% people were of the view that AI/ML is the least important, while 8.11% of people considered software skills as the least important.

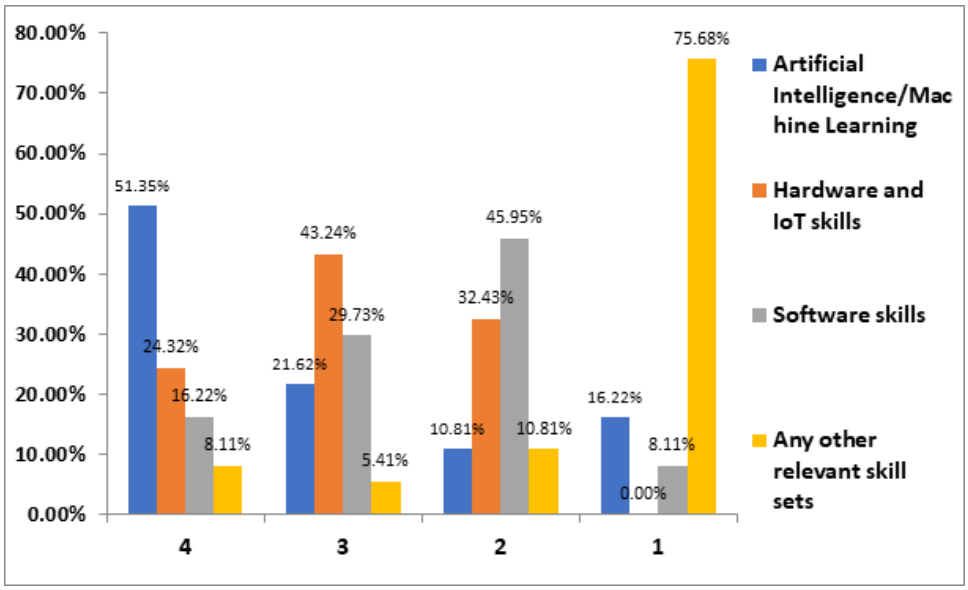


Figure 22. Percentage of responses showing importance of given skill sets rated from 4(high) to 1(low).

Question 9

Is the developed pilot study on cardiovascular diseases is beneficial in relevance to Pakistan

- **Yes**
- **No**
- **Maybe**

By evaluating the questionnaire data, it was found that 89.91% of people believed that the idea of developing a pilot study on cardiovascular diseases is constructive in relevance to healthcare in Pakistan. 2.70% people negated this idea while 8.11% were not sure about the utility of pilot study on cardiovascular diseases in Pakistan.

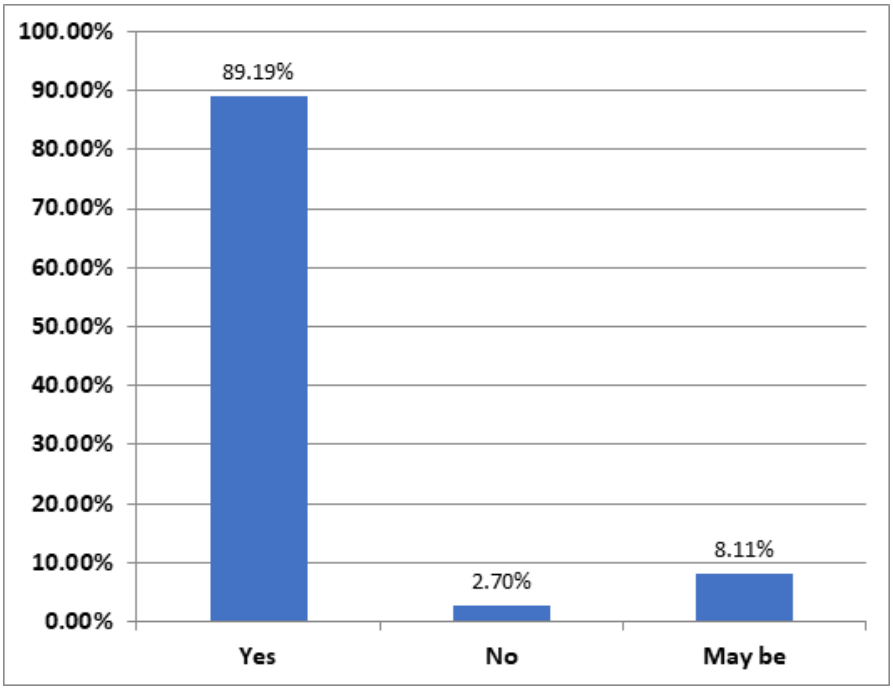


Figure 23. Percentage of responses on the significance of pilot case study on cardiovascular diseases in relevance to Pakistan.

Question 10

Are the new courses recommended above would be beneficial for cardiovascular diseases?

- **Yes**
- **No**
- **Maybe**

The results showed that 83.78 percent of participants considered the new recommended courses significant for cardiovascular diseases, while 5.41 percent of people opposed this idea, and 10.81 percent of people were doubtful about the practical worth of these courses with respect to cardiovascular diseases.

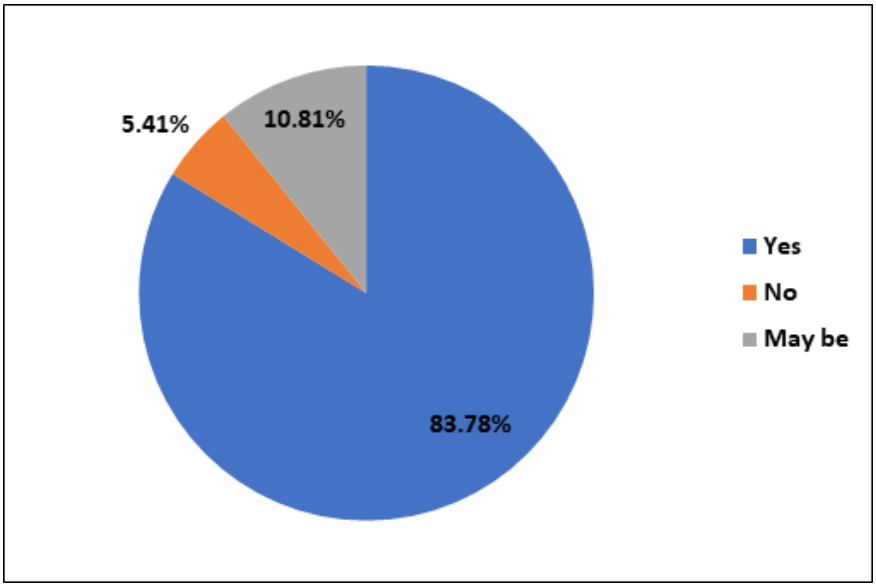


Figure 24. Responses regarding the utility of the recommended new courses in cardiovascular diseases.

Question 11

How you foresee the scope of digital healthcare technologies in next 20 years? Rate the importance of the statements from low (1) to high (4).

- **Digital healthcare is a basic human need and deserves a high priority in educational programs.**
- **Digital healthcare should be high on the agenda at the government level.**
- **There are other human needs that are more important than digital healthcare.**
- **Digital healthcare should go hand in hand with offering internet access to all citizens.**

The acquired results from this questionnaire showed that 32.43 percent people gave level 4 to the high priority of digital healthcare in educational programs, 29.73 percent considered that it should be high on the agenda at the government level, 21.62 percent were of the thought that there existed other human needs more important than digital healthcare, and 16.22 percent acknowledged the need of offering internet access to all citizens.

The importance level 3 was selected for high priority of digital healthcare in educational programs, by 32.43% participants, for other human needs are more important by 27.03%, for digital health at the government level by 24.32%, and for offering internet access for digital healthcare by 16.22%.

The percentage of responders who gave less importance by assigning 2 to the above-mentioned statements was highest (35.14%) for digital healthcare at the government level, followed by the importance of other human needs (32.43%), internet access (18.92%), and its high priority in education 13.51%.

Nearly half of the participants (48.65%) considered that internet access should go side by side with digital healthcare as the least important, followed by 21.62% considering its priority in education, 18.92% considering the importance of other needs, and 10.81% chose that digital healthcare should be high on the agenda at government level as the least important.

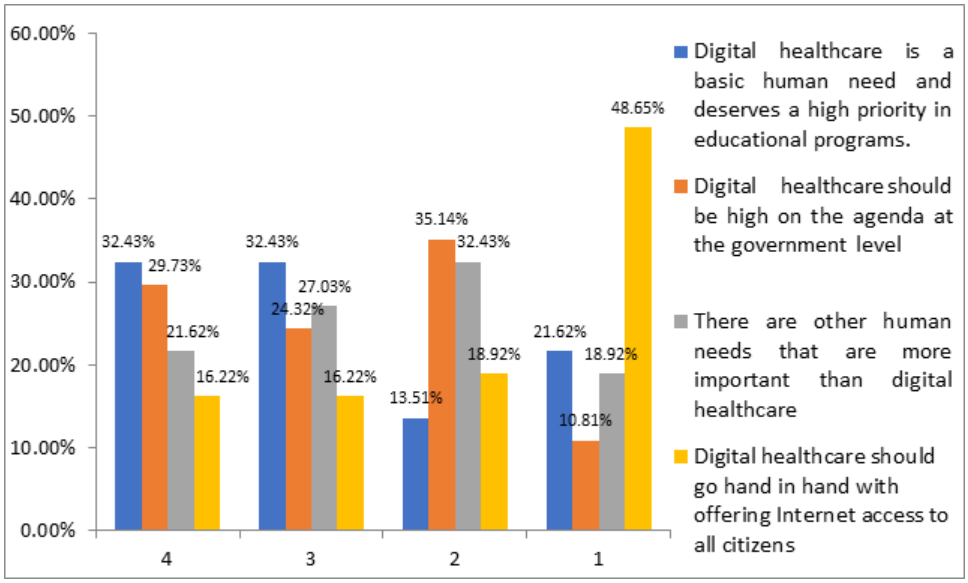


Figure 25. Percentage of responses against the scope of digital healthcare technologies from 4 (high) to 1 (low).

2.4. Summary

The important highlights of the workshop include discussion sessions with experts from various fields including health care professionals (Dr. Salik Javed Kakar and Dr. Khalid Yazdani Shah), ICT Professionals (Dr. Arshed Gelani and Dr. Asim Rasheed), and machine learning in health care experts (Dr. Sadia Shakeel). Graduate students and participants from departments of Bioinformatics, Computer Science and Electrical Engineering attended and participated in the workshop online. Healthcare practitioners highlighted the parameters that need to be monitored and their experiences, constrains and success stories while working with patients in Pakistan. Dr. Salik shared the importance of continuous monitoring for cardiovascular patients. Dr. Asim shared his experience and selection of sensors for remote monitoring while working in Meethi Zindagi. Dr. Yazdani shared success stories of Cognitive HealthCare Solutions and explained how people prefer to rent the sensors instead of purchasing them. The business and working models of Meethi Zindagi and Cognitive HealthCare Solutions emphasized the scope of commercialization and market demands. Dr. Arshed Gelani shared his experience of planning division and explained how bioinformatics and computational biology as well as health Informatics can cover this skill gap. There is a dire need of degree programs / crash courses to teach health care practitioners about AI and ML as well as integrative biology domain should also be focused.

The survey questionnaire results collected from healthcare partitioners and ICT specialists demonstrate that the idea of introducing new courses including IoT for healthcare, AI/ML for healthcare, and embedded systems for healthcare is welcomed by the majority; and the developed pilot study on cardiovascular diseases and recommended course is beneficial in relevance to Pakistan.

3. Identification of Skills and Training Requirements in Thailand

3.1. Current View of ICT Skills (from Published knowledge sources)

Thailand's government policy seeks to develop the country towards driving Thailand to Health 4.0 which is essential to integrate eHealth strategy into a framework for moving in the same direction in order to be successful in the long run. In digital health, the government has begun development of its telemedicine programme at 32 hospitals in rural areas in eight provinces, encouraging adoption of new technologies and remote medical care, since October 2019 [7]. This programme is a joint effort of the Public Health Ministry and the National Broadcasting and Telecommunications Commission (NBTC) regarding a vital part of addressing concerns over rising medical costs and deficient healthcare access in rural areas. As per the eHealth strategy (2017 – 2026) [8], Healthcare IT is registered as the 2nd most sector with regards to the need of innovation and new technologies to modernise the overall system.

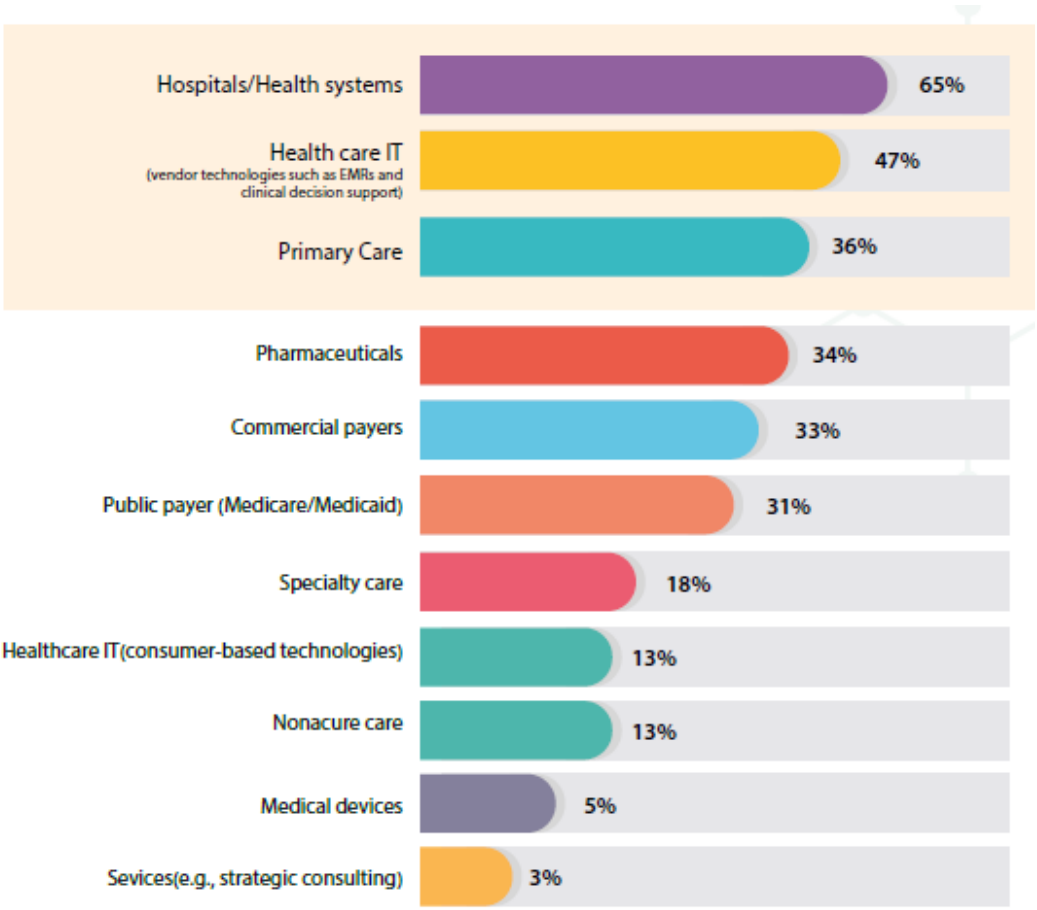


Figure 26: Healthcare Sector Most in Need of Disruptive Innovation [8].

Telemedicine is expected to reduce expenses for both patients and state-run hospitals by a combined 38 billion Baht annually after full implementation within four years. This project will focus on four illness types: high blood pressure, diabetes, eye disease and skin disease. These four ailments account for over 70% of current hospital cases.

However, this telemedicine project has not focused on mobility-based ailments, since it is more expensive to invest on the equipment and there are insufficient physiotherapists to support the population. Therefore, this is a gap in development plan which leads to an uncompleted vision to modernise the healthcare systems in rural Thailand.

In order to evaluate the readiness assessment for deployment and implementation of modern ICT based systems, the Ministry of Health carried out a survey of Health IT (hardware, software, network, peopleware) from 12,380 hospitals & health stations. Figure 15 shows the results of assessment, readiness in information technology and communication using a scale between 0 to 5 (score of 0 as the least ready and the score of 5 as the most ready).

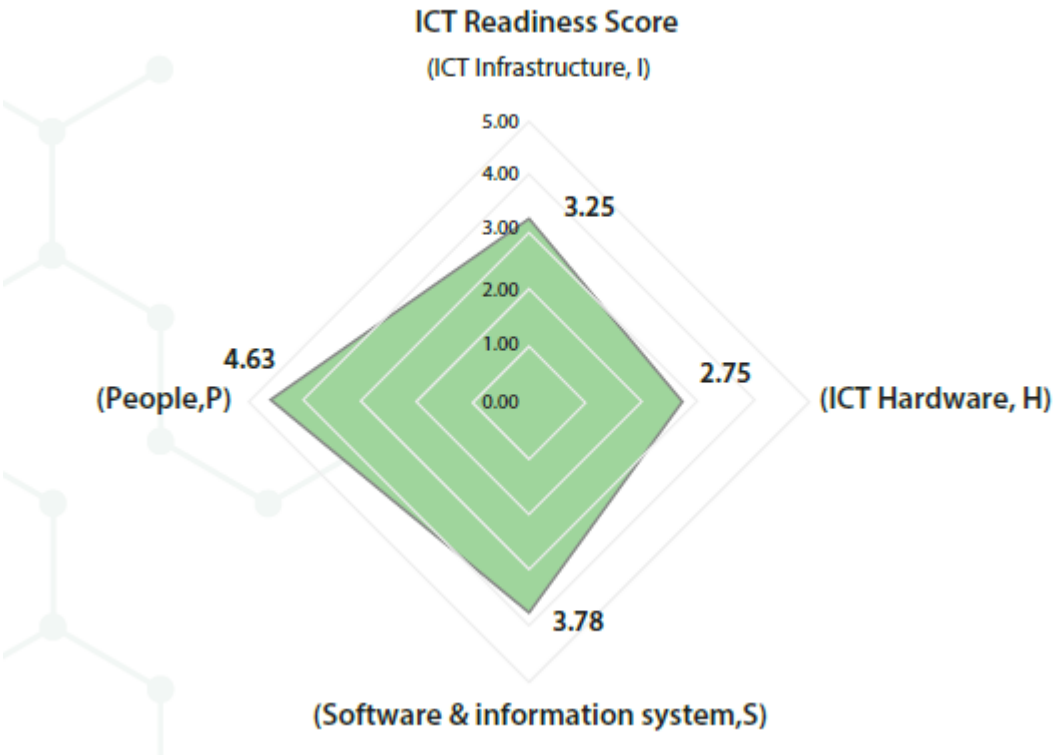


Figure 27: Chart showing scores, results of assessment, readiness in information technology and communication[8].

3.2. Workshop on skill and training identification in Thailand

To identify the skills gap and training requirement for the ICT and healthcare practitioners, the Thailand partners (MFU and CMU) together with the Pilot Case #2 leader (UNN) agreed to organize two sessions of the workshop for gathering the adequate requirements from different groups of healthcare practitioners. The practitioners have different expertise, experiences, and are working in two distinct geographical areas (Chiang Rai and Chiang Mai provinces). The details of the organizing and analysis of each session can be explained as follows.

A) 1st session of workshop @MFU

Mae Fah Luang University (MFU) organized the 1st session of the workshop on March 11th, 2021, at Chiang Rai city. This part of the workshop was participated by several stakeholders which are listed as follows: 1) Physiotherapists and Healthcare practitioners from Mae Fah Luang University Integrative Medicine Hospital, 2) Lecturers from the School of Integrative Medicine, Mae Fah Luang University, 3) DigiHealth-Asia partners from both Chiang Mai University (CMU) and the University of Northumbria at Newcastle (UNN), and 4) Private Sectors.
Prof. Nauman Aslam (UNN), who is a coordinator of pilot case #2, gave the welcome speech and introduction to the DigiHealth-Asia project.

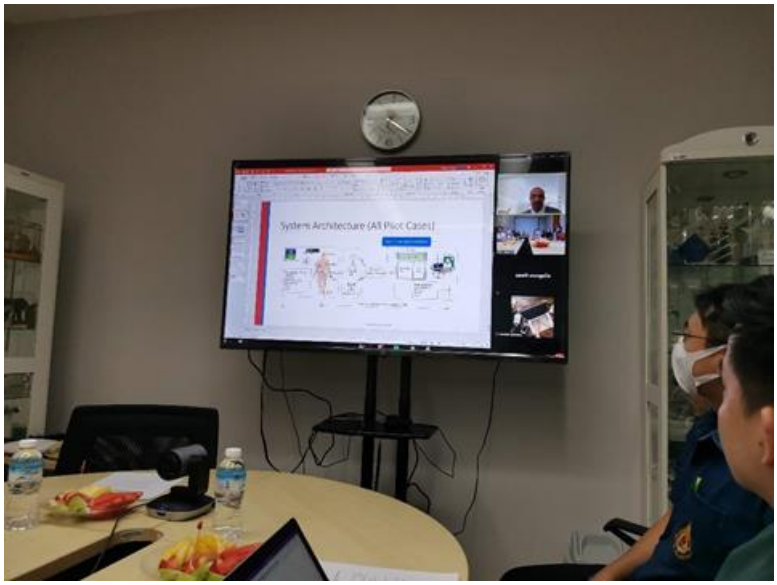


Figure 28: Main monitor display of the workshop.

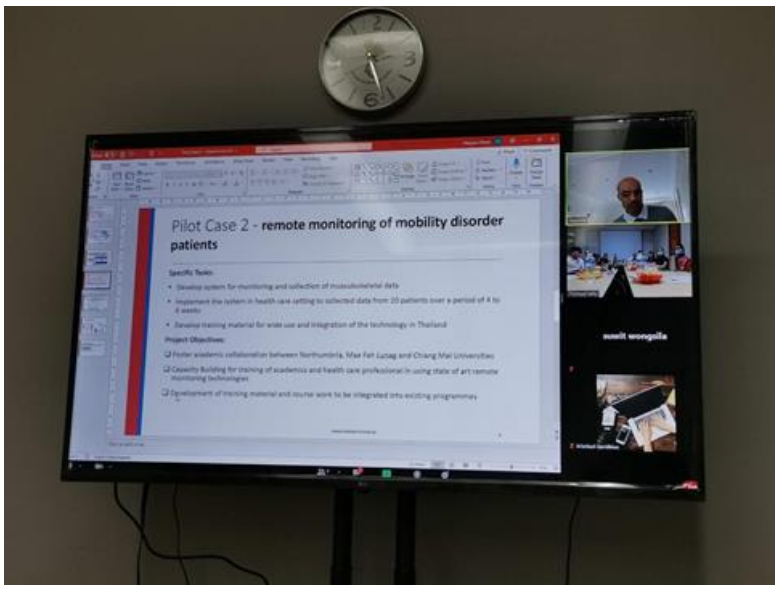


Figure 29: Introduction to the DigiHealth-Asia project given by Prof. Nauman Aslam (UNN).

In this 1st session of the workshop, MFU facilitated the brainstorming on “Priorities for Mobility Disorder Patients” which is focused on the following issues;

- What is the target group of mobility disorder patients for Pilot Case #2?

- What are the traditional tools/equipment to diagnose these patients who have mobility disorders?
- What is the existing ICT equipment used in medical operations?
- What is alternative IoT or Embedded System equipment could be used for measuring physical movement?
- What are the important skills required to handle this ICT equipment?

Figure 30: Brainstorming activity discussion on system requirement.

Figure 31: Brainstorming activity-analysis of the skills gap.

At the end of the 1st session, CMU joins MFU via online meeting to conclude the stakeholder needs of the training course for relevant target groups including physiotherapists, healthcare practitioners, and IT personnel. These initial findings were brought to analyze and prepare for the 2nd session of the workshop, which was held at Chiang Mai city, consequently.

Figure 32: Observation by CMU.

B) 2nd session of the workshop @CMU

Chiang Mai University organized the 2nd session of the workshop on March 18th, 2021, at Chiang Mai city. The welcome speech and introduction to Digihealth speech #Pilot use case 2 was given by Dr. Paradorn Sureepong.

Figure 33: Opening session by CMU.

In this 2nd session of the workshop, CMU introduced the details of the project as following main points.

Main Objective of Project

- To contribute to the modernization of healthcare systems in partner countries with the help of ICT-based patient monitoring and assistive technologies.
- To develop an education and training program for healthcare practitioners in partner countries for ICT-based patient monitoring and assistive technologies.
- To create a sustainable network of healthcare practitioners, researchers, academic teaching staff, researchers, and industry professionals, focusing on the development of new viable ICT-based technologies for remote monitoring and patients.

Work packages

Preparation

- Development of learning material and requirement analysis for the design of the proposed digital health monitoring and care systems
- T1.3 – Development of learning material, courses, and training program *(ULL, CMU)*

Quality Plan

- *Quality plan for training and certification of health care practitioners*
- T3.2 Qualification of participating health care practitioners *(ULL, CMU)*
- T3.4 Continuous quality assurance beyond the project *(UNN, CUST, CMU, MNUMS)*

Dissemination & Exploitation

- *Dissemination & Exploitation of DigiHealth-Asia project*
- T4.1 Dissemination and Publicity Team (DPT) and Dissemination Activities *(UGent, CMU)*
- T4.4 Workshops Organization in International Conferences *(UNN, ULL, CMU, MFU)*

Management

Management of DigiHealth-Asia Project

- T5.3 Quality Management *(ULL, CMU, UoH)*

Figure 34: System requirement discussion.

Figure 35: The skills gap and the needed knowledge for practitioners' brainstorming.

C) Requirement analysis for digital health care and monitoring system

According to the results of our 2 sessions workshop, the stakeholders agree to focus on the promotion and prevention stages of the falling accident in older people. These two stages are the earlier cycles of the healthcare model that consist of four stages as follows.

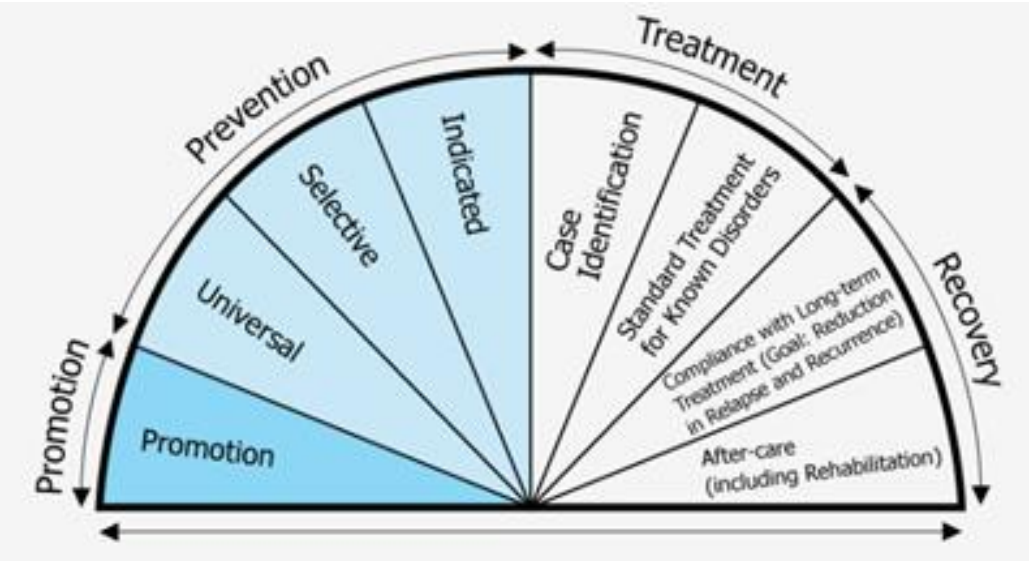


Figure 36: Behavioral Health Continuum of Care Model. [9]

1. Promotion – is the first stage of a healthcare method used to inform people about specific diseases and how to avoid them.
2. Prevention – is the second stage of the healthcare method in which a plan is developed to encourage the target population to improve their health status by attempting to eliminate the related symptom that links to the more serious factor of falling.
3. Treatment – is the third stage of the healthcare method that requires medical doctors diagnosing and treating the target patient.
4. Recovery – is the final stage of the healthcare method that focuses on the exercise task to recover the patient's symptom and the guideline for after-treatment care.

5. As a result, in order to avoid serious concerns and research ethics on inviting patients to participate in the project, healthcare practitioners advised focusing on the earlier stages of the healthcare model. The prevention mechanism to avoid falling is raised as the main issue to protect the elderly from physical problems associated with falling.

The physiotherapists proposed screening the target group with standard measurement tools used in hospitals and clinics to identify these problems. These tools are typically used to observe the patient on a non-technical level. As a result, this Erasmus+ project will use smart technology to improve the following three falling risk assessment tools in order to prevent patients from falling.

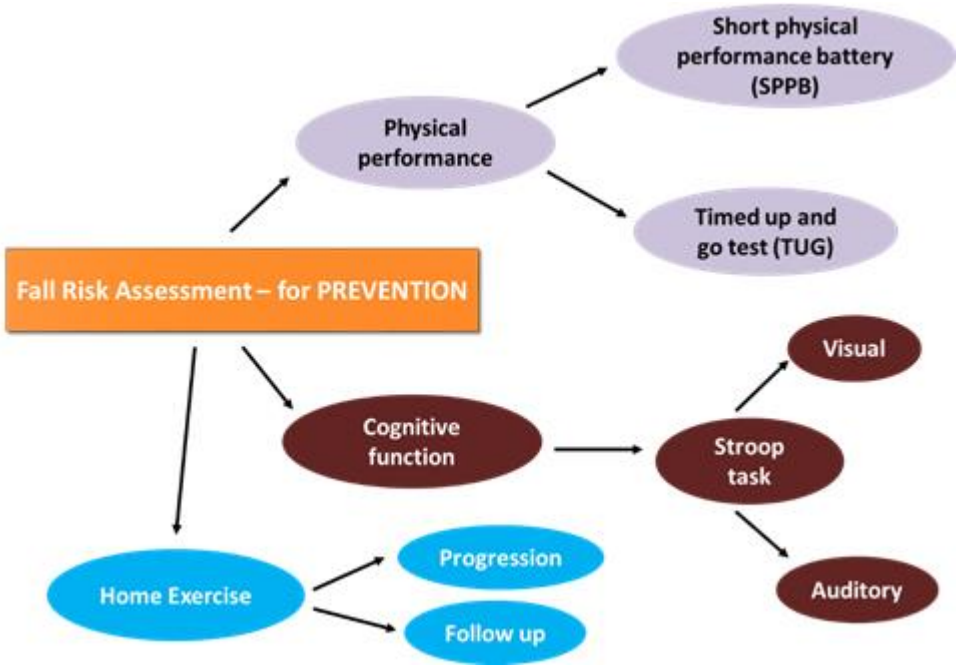


Figure 37: Falling risk assessment tools.

1. Physical performance – is the primary method for identifying the risk of falling in humans by leveraging the risk of falling using the short physical performance battery (SPPB) criteria. Furthermore, a clinical tool such as the Timed Up and Go test (TUG) is recommended to be used in conjunction with the SPPB to determine physical body balance. These two measurement tools can present the important factors associated with human falls.

2. Cognitive function performance – is a method for determining how well the human brain functions in controlling mobility activities. The Stroop task is proposed as the primary measurement tool for leveraging the falling risk in order to identify this function. The Stroop task can be used to assess the target group via a well-designed computer system by adapting the visual and audio equipment.

3. Home exercise – is a mechanism that encourages the target group to continue practicing on the assigned recovery program in order to keep the early-stage factors from falling. The strategy is to follow up with the participants using a mobile-based application to collect the progression of the participant's work out to meet the symptom rehabilitation.

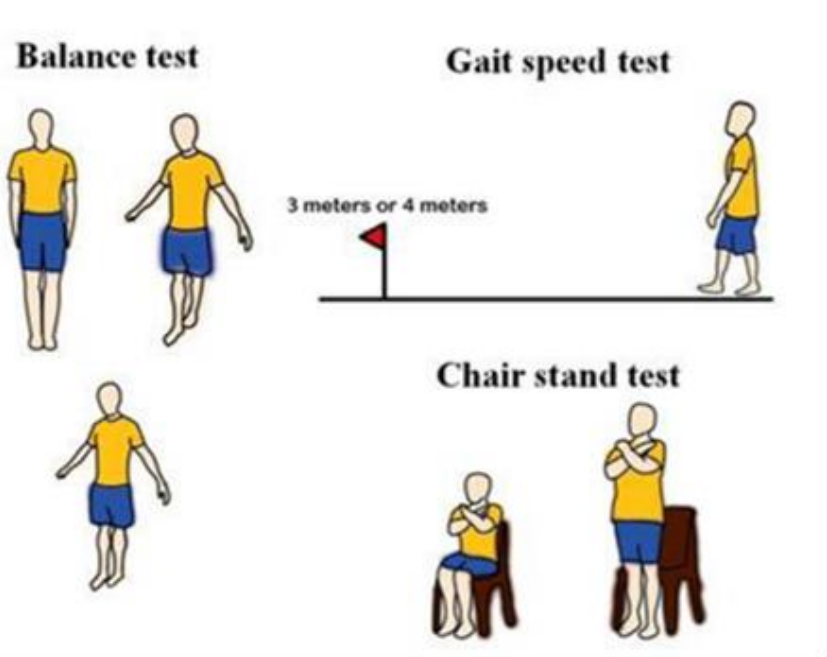


Figure 38: Short physical performance battery (SPPB). [10]

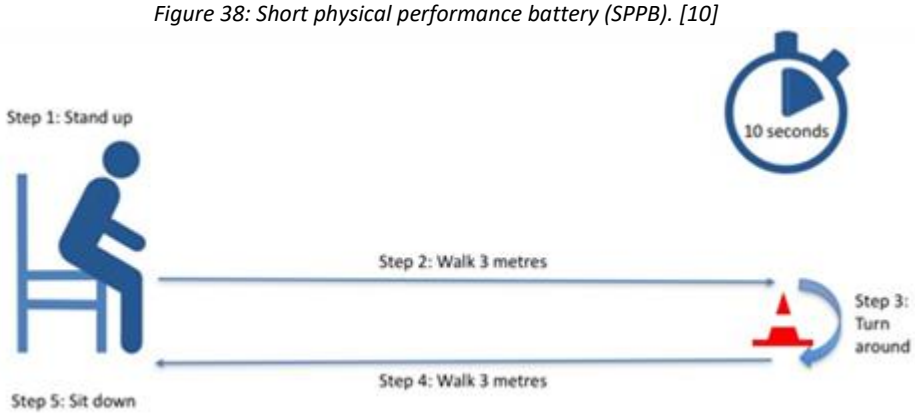


Figure 39: Timed up and go test (TUG). [11]

2.

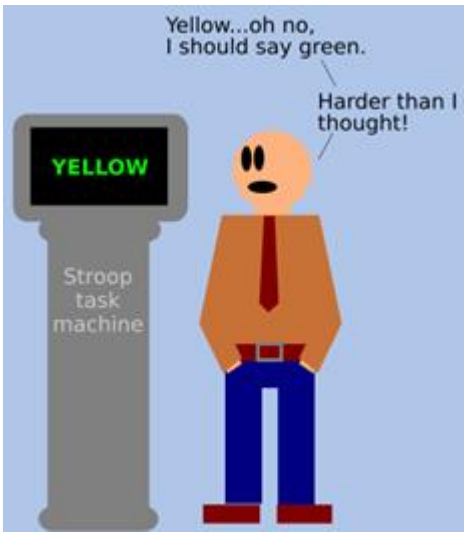


Figure 40: Example of Stroop task (Visual and Auditory). [12]

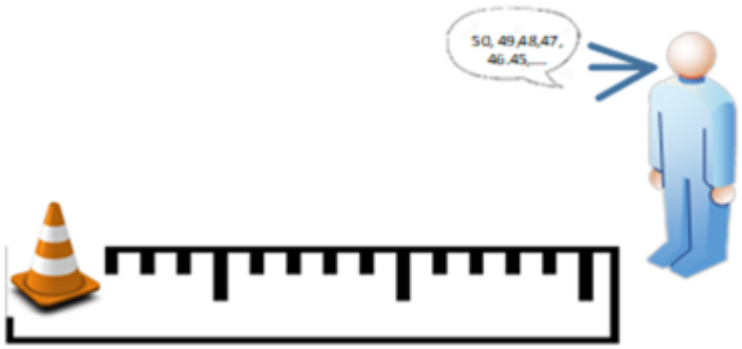


Figure 14: Dual-task biofeedback for cognitive test

Figure 41: Example of exercise tools. [13]

3.3. Results from the Survey Questionnaire

A survey questionnaire developed as part of project deliverable in WP3 (Task 3.2) was used to gather data related to participants' background, identification of skill set, relevance of the pilot study and potential of digital health care technologies.

A total of 134 participants completed the survey. The response and analysis of this survey for each question is summarized in the subsection below.

a) Question 1: Who are you?

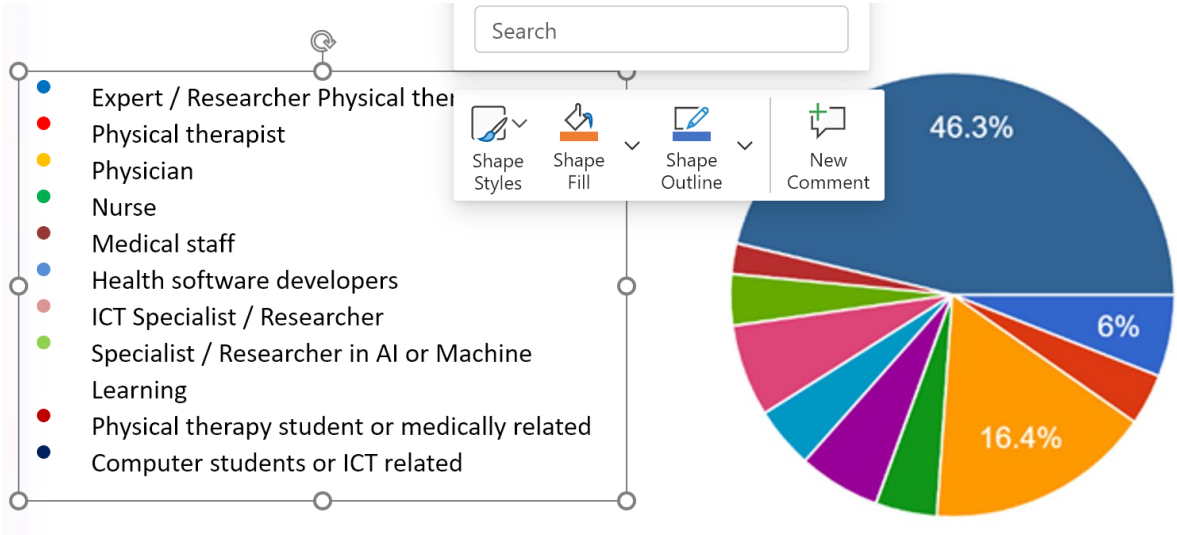


Figure 42. Percentage of responders belonging to different areas of specialization.

b) Question 2: Have you ever participated in a workshop in DigiHealth-Asia project before?

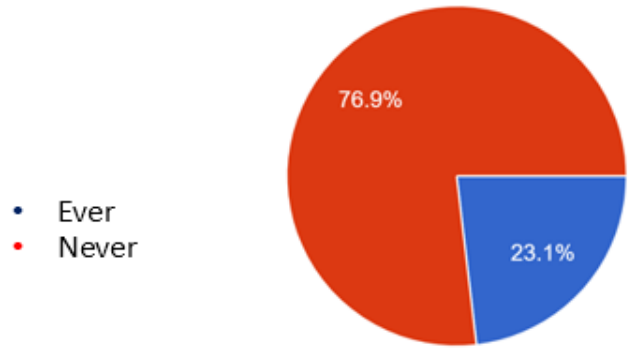


Figure 43. Relative proportion of responders with respect to their attendance in workshop in CUST.

c) Question 3: Was attending the workshop beneficial in introducing the aims and objectives of Capacity Building for Digital Health Monitoring and Care systems in Asia (DigiHealth-Asia)? Please answer in the scale from 1 (not beneficial) to 5 (very beneficial) ?

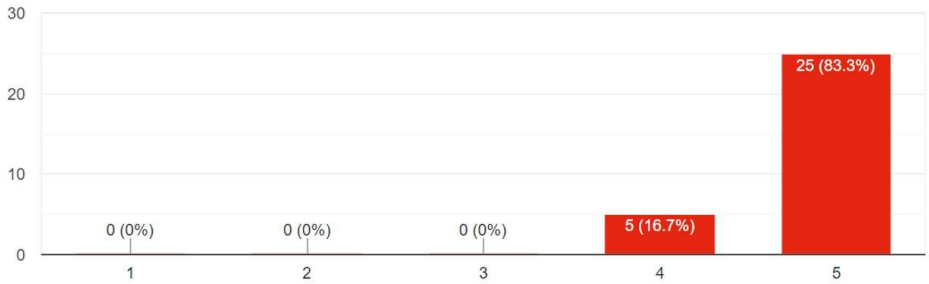
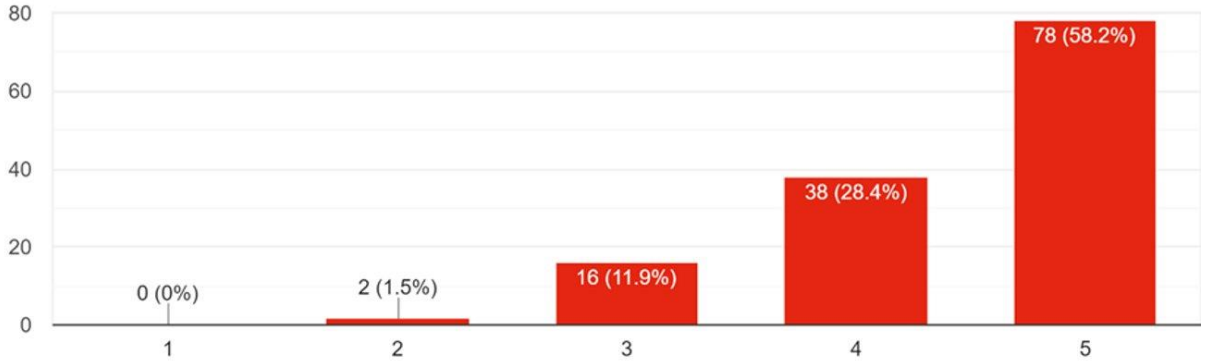


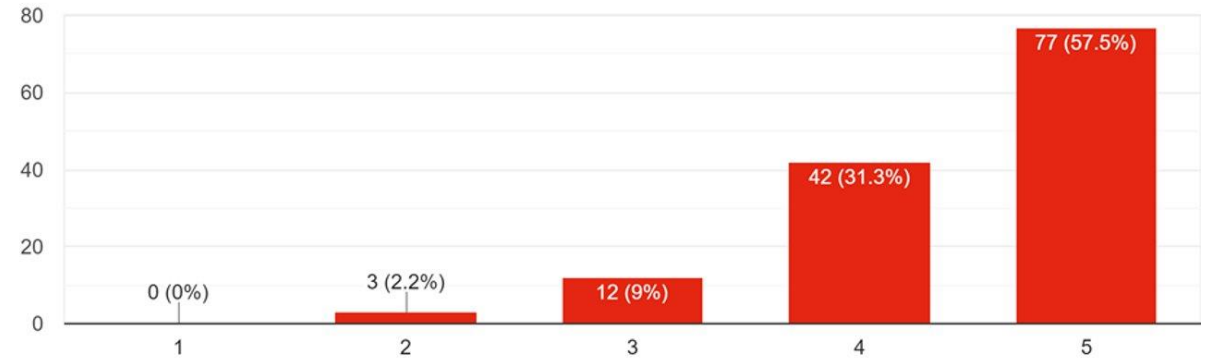
Figure 44. Percentage of responses on the significance of workshop in the scale 1(not beneficial) to 5(very beneficial).

d) Question 4: The idea of introducing new courses such as: IoT for healthcare, AI/ML for healthcare, and embedded systems for healthcare will be useful in the (Pakistan, Mongolia and Thailand)? Please give answer for each course.

Internet of Things (IoT) device skills for Healthcare



Applied AI / ML techniques for Health care



Embedded Systems Skills for Healthcare

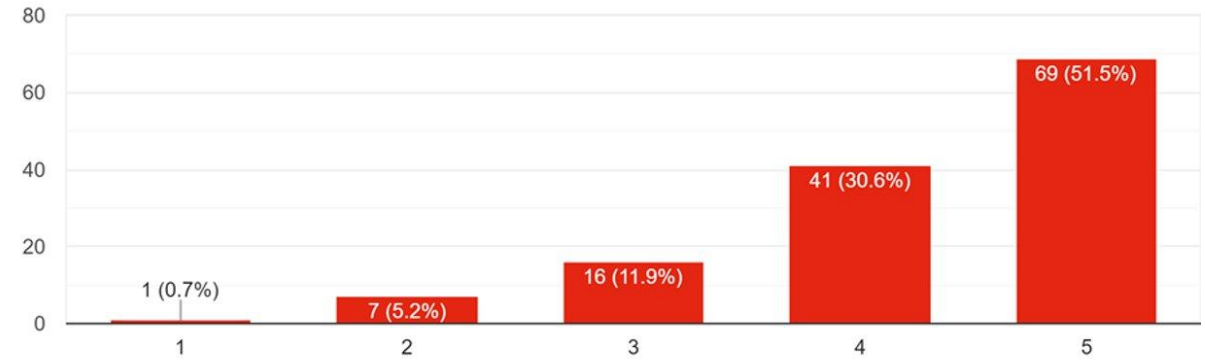


Figure 45. Percentage of positive and negative responses towards introduction of new courses like IoT and ML in healthcare in Thailand.

e) Question 5: What skills sets are deemed to be important for the next few years in digital health? Please rate their importance from low (1) to high (5).

Question	Very Low	Low	Moderate	More	Most
Question 7 Data analysis skills with Artificial Intelligence and Machine Learning.	0(0%)	3(2.2%)	13(9.7%)	44(32.8%)	74(55.2%)
Question 8 Skills for using or developing computer devices and sensors	1(0.7%)	2(1.5%)	11(8.2%)	42(31.3%)	78(58.2%)
Question 9 Mobile and website usage skills	0(0%)	1(0.7%)	11(8.2%)	34(25.4%)	88(65.7%)
Question 10 Skills in building and developing mobile applications and websites	1(0.7%)	4(3%)	13(9.7%)	37(27.6%)	79(59%)

Figure 46. Percentage of responses showing importance of given skill sets.

f) Question 6: Is the developed pilot study beneficial for the relevant country?

Question	Very useful	Not necessary
Question: You think that the development Will the health surveillance system for mobility problems in the DigiHealth-Asia project benefit the public health community in Thailand?	133(99.3%)	1(0.7%)
Question: Do you think the above ICT teaching and training course (IoT / AI / Embedded System) will be beneficial for development? Is the health surveillance system for mobility problems in the DigiHealth-Asia project?	133(99.3%)	1(0.7%)

Figure 47. Percentage of responses showing the utility of pilot case study for Thailand.

g) Question 7: How you foresee the scope of digital healthcare technologies in next 20 years? Rate the importance of the statements from low (1) to high (5).

1) Digital healthcare is a basic human need and deserves a high priority in educational programs.
2) Digital healthcare should be high on the agenda at the government level
3) There are other human needs that are more important than digital healthcare
4) Digital healthcare should go hand in hand with offering Internet access to all citizens
5) provide input here (textbox)

Question	Very Low	Low	Moderate	More	Most
Question: Digital healthcare will become a fundamental human and cognitive skill in the basic education system.	0(0%)	1(0.7%)	14(10.4%)	37(27.6%)	82(61.2%)
Question: Digital healthcare will become a governmental policy	2(1.5%)	5(3.7%)	14(10.4%)	35(26.1%)	78(58.2%)
Question: Is there other necessities that more important than digital healthcare.	7(5.2%)	15(11.2%)	31(23.1%)	28(20.9%)	53(39.6%)
Question: Digital healthcare systems can be sustainable by people must be encouraged to have comprehensive access to the basic Internet.	0(0%)	2(1.5%)	8(6%)	19(14.2%)	105(78.4%)

Figure 48. Percentage of responses against the scope of digital healthcare technologies.

h) Question 8: How you foresee the scope of digital healthcare technologies in next 20 years?

Summary of common responses:

- Modern Health care systems.
- Elderly people can understand the simplest and most beneficial use of technology to take care of themselves.
- Ideal of medical care systems.
- People have good health care skills. And can take care of themselves.
- These technologies cannot replace humans. Because at the end of the day, patients want to receive care or consultation from a human being. Human beings can understand each other's feelings.
- Not only technology developers and medical personnel need to understand the development. People's parties must develop their knowledge accordingly. For the correct use of technology.

3.4. Summary

The key highlights include two workshops that were organized at each partner institution in Thailand which were attended by the university academics, ICT professional as well as the health care experts from Chiang Mai and Chiang Rai regions. For the mobility disorders after a series of brain storming and discussions, a holistic approach consisting of multi-pronged strategy was presented. This approach includes prevention through fall risk assessment, measuring the cognitive functions, home exercise and monitoring using smart technology.

4. Identification of Skills and Training Requirements in Mongolia

Mongolia is a large country by area with a population of about three million making it the least densely populated country in the world. Medical services including hospitals are found in province (Aimag) towns, but medical specialists are available practically only in the capital Ulaanbaatar (UB). In recent years, there has been a push from the Mongolian government and other organization such as Asian Development Bank to support projects which use new tools ICT technologies for remote examination, diagnosis and facilitation of remote consultation with experts. ADB supported project aimed at improving everything from primary health care and health insurance to building health facilities, upgrading infrastructure, and providing modern equipment and training for medical staff. While the training of healthcare professional to equip them with the latest ICT tools and technologies is absolutely important for modernizing healthcare services, there is no research-based study to evaluate the skill set and current gaps in the proficiency of healthcare professional in ICT technologies.

4.1. Current View of ICT Skills (from Published knowledge sources)

4.2. Workshop on skill and training identification in Pakistan

The 1st workshop **AI in Healthcare in Mongolia** was organized by Mongolian National University of Medical Science on 12 March 2021.

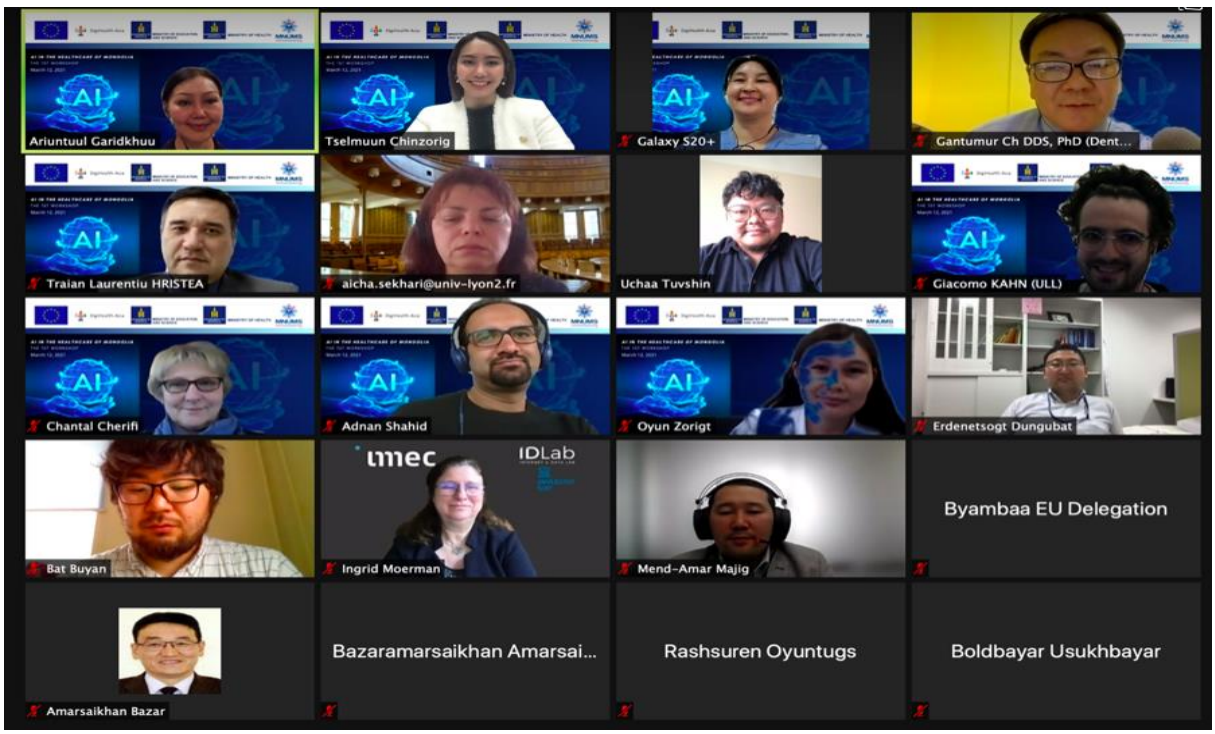


Figure 49. Meeting of DigiHealth Local Manager, Prof. Garidkhuu Ariuntuul with Minister of Education and Science of Mongolia, H.E. Enkh-Amgalan L.

Participants:

- EU Representative - Mr. Traian HRISTEA, Ambassador, Head of EU delegation in Mongolia;
- ULL - Dr. Chantal Cherifi, Dr. Giacomo Kahn, Dr. Aicha Sekhari;

- UGent - Dr. Adnan Shahid;
- MNUMS - Prof. Ariuntuul Garidkhuu, Prof. Amarsaikhan Bazar and Dr. Tselmuun Chinzorig;
- NUM - Dr. Mend-Amar Majig;
- Ministry of Health of Mongolia - Gantumur Ch;
- State Central Hospital #1, Department of ENT - Byambasuren L.;
- State Central Hospital # 2- Asralt N.;
- "Aid" ENT Hospital - Batbuyan G., Boldbaatar, Oyun N.;
- Mongolian E-medicine Center – Dr. Erdenetsogt Dungubat;

Besides these key participants, faculties of School of Dentistry, Mongolian National University of Medical Sciences (MNUMS) attended the workshop as well.

Goals of the workshop:

- To introduce the DigiHealth-Asia Project (Project goal / Expected outcome) to the main parties – Local kick-off meeting;
- To disseminate among policy and decision makers and to draw their attention: Ministries, EU representatives, among public and professionals;

Activities:

Due to limited experience, practice and knowledge of the AI related topics in the health sector of Mongolia within the workshop framework, we aimed to bring together cooperating parties by presenting current situations and discussing on how to meet health needs with smart digital solutions. Three clinical cases were introduced at the workshop. The experience will guide the implementation of remote healthcare systems in this project.

- ***Need for e-health: Children with hearing loss & early childhood caries*** - by Prof. Ariuntuul G & Prof. Amarsaikhan B,MNUMS,
- ***Cochlear Implantation for children with hearing loss in Mongolia*** - by Dr. Byambasuren L., Dr. Asralt N., ENT surgeons, State General Hospital #1 and # 2
- ***Audio Verbal Therapy for children with Cochlear Implantation*** – Video case by Dr. Oyun Z, "Aid" ENT clinic

For medical doctors, faculties and health workers, an overview on telemedicine and AI's status in Mongolia was presented by Dr. Erdenetsogt Dungubat, founder of Mongolian E-medicine Center "*Telemedicine and E-health*" and by Dr. Mend-Amar., National University of Mongolia *"Artificial Intelligence in Healthcare"*.

Discussion and brainstorming were facilitated by Dr. Tselmuun Chinzorig, the local coordinator of the DigiHealth team and moderator of the workshop.

Conclusions drawn from the discussion:

- Pilot case 3 will be used for fulfilling needs of involved parties: dental/medical professionals, speech therapists, professional interdisciplinary team members and patients with health issues. Participants shared their present situation and highlighted the importance of cooperation. At the

first stage, the team is going to develop an online platform to provide monitoring of early childhood caries and if possible - hearing aid.

- Skill gaps: Online training of moderators and related professionals will be developed within the process. Inclusion of parental education and monitoring is one of key activities to be considered in Pilot case 3. This will give a practical public health intervention for the purpose of preventing diseases and further expanding consultation in non-communicable diseases, which are prevalent but avoidable through early prevention and mass education through a smart digital solution.
- Pre- and Post- survey on AI needs, status and education of future medical professionals (medical students) and healthcare practitioners to be conducted based on the Mongolian National University of Medical Sciences (Amarsaikhan, Ariuntuul , Tselmuun);
- Pilot case needs for the market: Most suitable equipment is iPad, due to patients' rights and security of all equipment will be under supervision of the project team. Database will be collected to store their own data of patients.
- Scope of commercializing pilot case 3: The future system's smooth operation, management, sustainability and self-financing will be done through a startup team based on the DigiHealth project. Software always needs careful, regular, timely maintenance (update), so building a professional platform together with AI specialists is important.

Tasks to be completed by healthcare partitioners before the start of Pilot Case 3:

The following proposal was shared by Tselmuun Chinzorig for further development of the project and tasks for healthcare practitioners to complete before start of the Pilot case 3:

Discussions and comments:

It's crucial to have time to do a critical reflection on available information about the past efforts, gathering existing knowledge between health practitioners and IT experts. In this way we may fill the gap between the collaborating partners and develop the necessary skills.

Task 1: Fill out the following to evaluate the existing ecosystem (UNICEF guide):

Existing services - What systems we already have?	**Existing data infrastructure- where the data center is?**
Individual level?	
District level?	Patient registries within hospitals
National level?	"E- Health" National health data network
International level?	good practice model with sufficient data

Task 2: Map the ecosystem of your cases

Mapping the goal and the intervention may help to see clearly, where the digital fits and what it can accomplish. There are many tools for mapping the ecosystem.

The map must consider:

- supply chain management
- mobile financial transactions
- Whether it's app or a web, what coverages it will have, such as support for the patient's decision making, diagnostics, telemedicine, reminders and incentives?
- continuous coverage - will it gather persistent electronic health records
- Any client information content subscription?
- Accountability coverage - client registration, data collection and reporting?
- Screening tools?

Task 3: Define key user persona

1. Prioritize a user group - key user persona
2. Health practitioners must define the "Improved state" or changed state (what is current state and how the improved state must look like) by specifying the indicators of change. This may define our further work plan.
3. Exploring the user's environment - based on the user stories cluster common themes and choose the most important and diagnose the underlying causes;
4. Identify all possible users and describe them more in detail, including the service recipient and service provider.
5. Relationship Map - to help analyze and make sense of the user stories, map the relationships between the personas, their needs etc.
6. Conceptualize the digital solution and assess the solution.

Workshop Outcome:

- To conduct biweekly Meetings between MNUMS and NUM;
- For the situation analysis in Mongolia, start preparing a survey/tool for health professionals, using UNICEF's guide;
- To meet Education Minister of Mongolia and introduce the DigiHealth-Asia Project and ask for a support and cooperation;

4.3. Results from the Survey Questionnaire

A survey questionnaire developed as part of project deliverable in WP3 (Task 3.2) was used to gather data related to participants' background, identification of skill set, relevance of the pilot study and potential of digital health care technologies.

A total of 16 participants completed the survey. The response and analysis of this survey for each question is summarized in the subsection below.

i) Question 1: Who are you?

- IT, Web program developer 82/
- ICT specialist (2/0.6%)
- Student (219/67.4%)
- Medical doctor (54/16.6%)
- University faculty(36/11.1%)
- University management (3/0.9%)
- Other (20/6.2%)

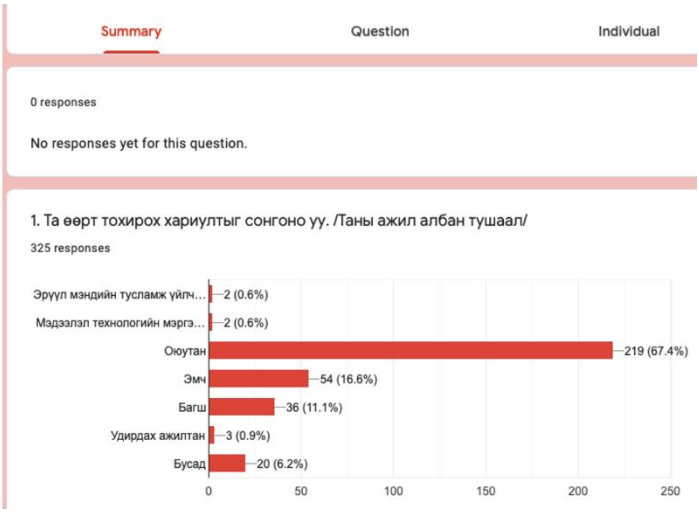


Figure 50. Percentage of responders belonging to different areas of specialization.

j) Question 2: Have you ever participated in a workshop in DigiHealth-Asia project before?

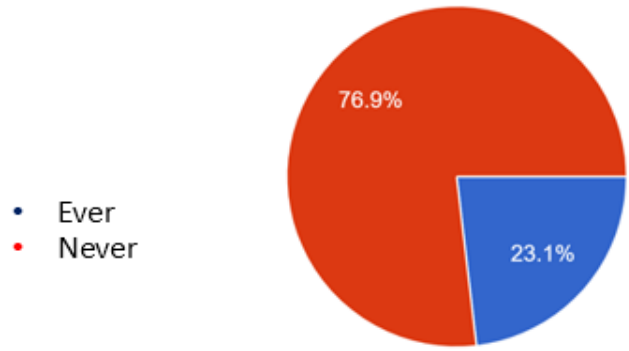


Figure 51. Relative proportion of responders with respect to their attendance in workshop in CUST.

k) Question 3: Was attending the workshop beneficial in introducing the aims and objectives of Capacity Building for Digital Health Monitoring and Care systems in Asia (DigiHealth-Asia)? Please answer in the scale from 1 (not beneficial) to 5 (very beneficial)?

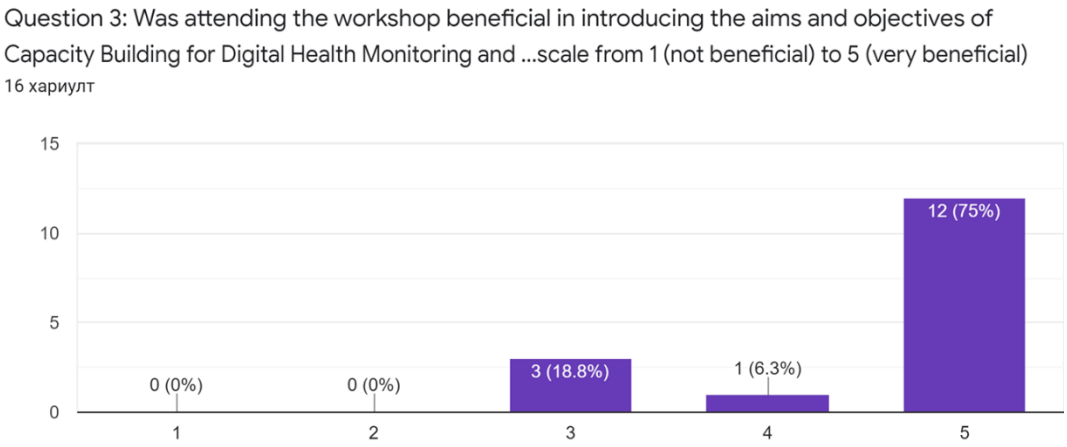


Figure 52. Percentage of responses on the significance of workshop in the scale 1(not beneficial) to 5(very beneficial).

l) Question 4: The idea of introducing new courses such as: IoT for healthcare, AI/ML for healthcare, and embedded systems for healthcare will be useful in the (Pakistan, Mongolia and Thailand)? Please give answer for each course.

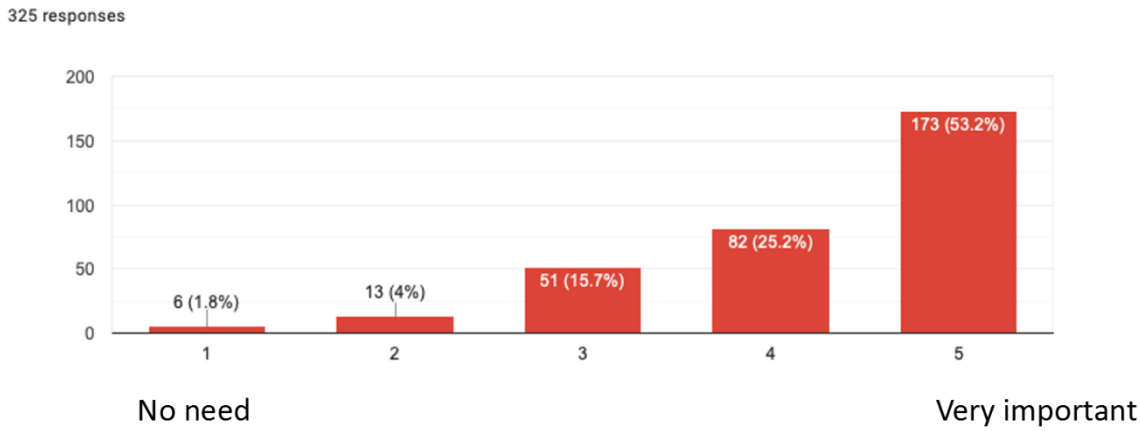


Figure 53. Percentage of positive and negative responses towards introduction of new courses like IoT and ML in healthcare.

m) Question 5: What skills sets are deemed to be important for the next few years in digital health? Please rate their importance from low (1) to high (5).

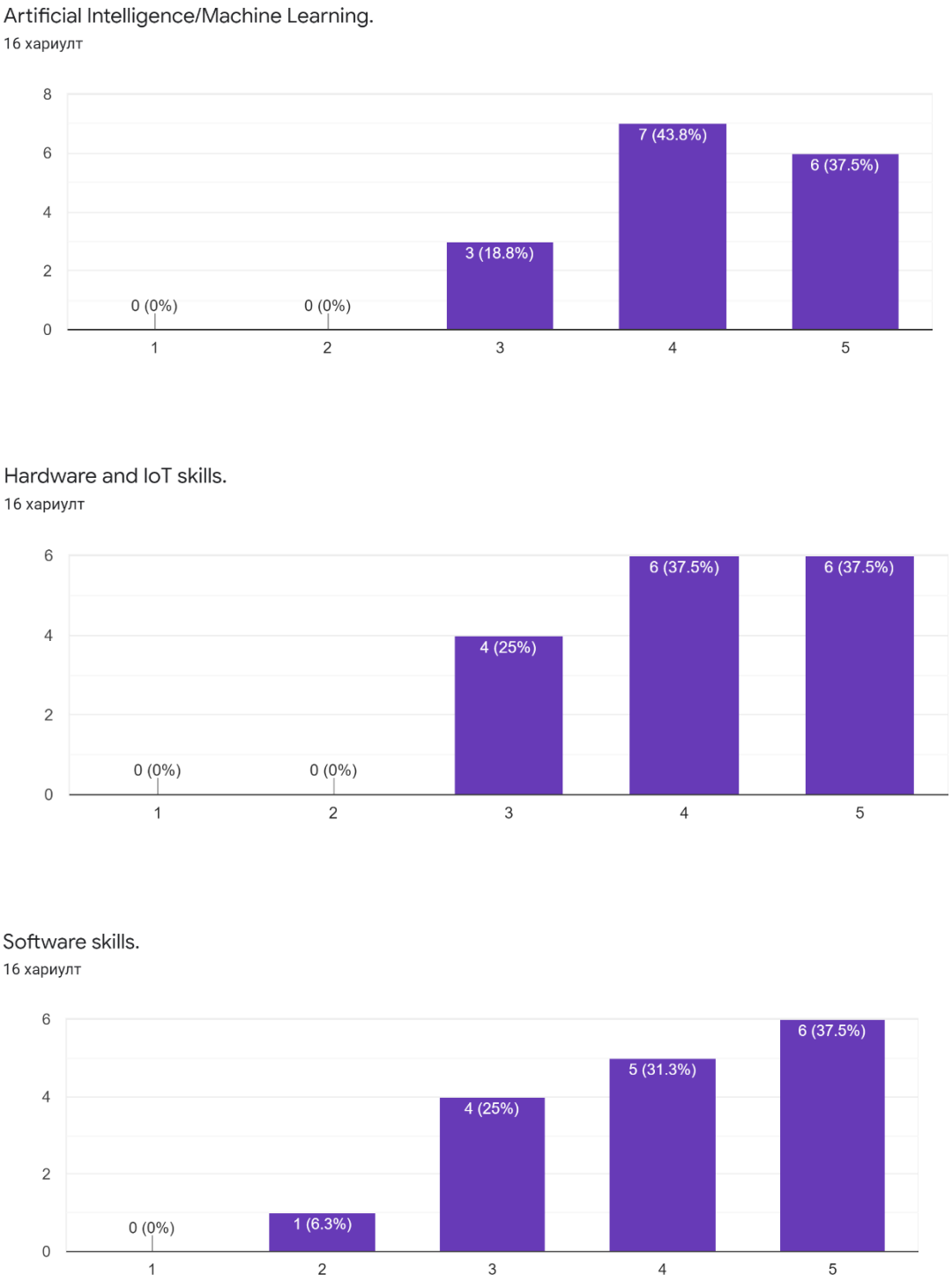


Figure 54. Percentage of responses showing importance of given skill sets in different areas.

n) Question 6: Is the developed pilot study beneficial for the relevant country?

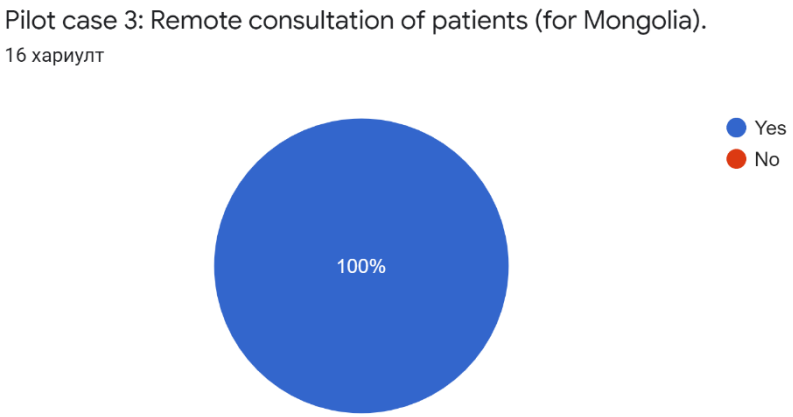


Figure 55. Percentage of responses showing the utility of pilot case study for Mongolia.

o) Question 7: How you foresee the scope of digital healthcare technologies in next 20 years? Rate the importance of the statements from low (1) to high (5).

1) Digital healthcare is a basic human need and deserves a high priority in educational programs.
2) Digital healthcare should be high on the agenda at the government level
3) There are other human needs that are more important than digital healthcare
4) Digital healthcare should go hand in hand with offering Internet access to all citizens
5) provide input here (textbox)

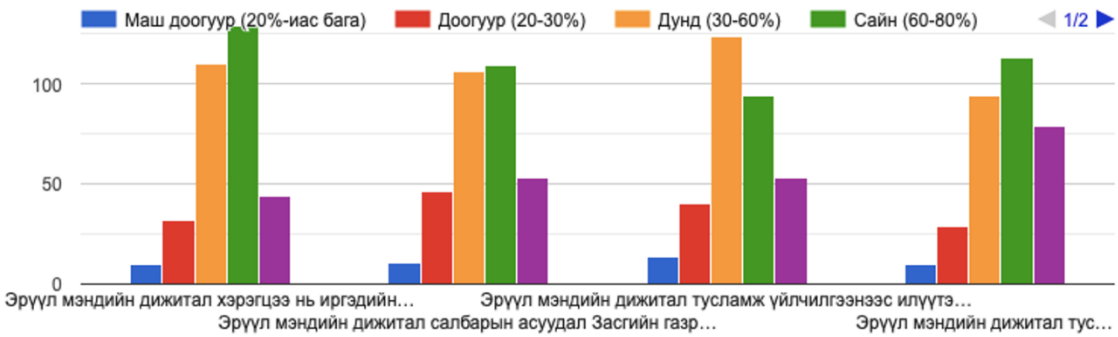


Figure 56. Percentage of responses against the scope of digital healthcare technologies.

p) Question 8: How you foresee the scope of digital healthcare technologies in next 20 years?

Summary of common responses:

4.4. Summary

This report attempted to evaluate the levels of skills in ICT among health care professionals in each Asian partner country and their training needs in order to bring them up to speed with latest technologies for remote health monitoring. The key findings of this deliverable can be summarized as follows,

1. Through the workshop conducted by each partner Asian country, the participating institutions focused on their respective pilot study. In the workshop organized by CUST (Pakistan), participants learned about essential technologies, sensors, monitoring systems for cardiac patients as well as the skills gap in healthcare professionals.
2. The workshop was found beneficial in each partner country (>91% in Pakistan, 100% in Thailand, 81% in Mongolia).
3. Majority of participants responded positively (90% in Pakistan, 78% in Mongolia, 80% in Thailand) towards introduction of training opportunities in latest ICT technologies in AI/ML, IoT and embedded systems.
4. The survey questionnaire provided somewhat mixed picture on the question of important skills in digital health in next five years. For example, in Pakistan and Mongolia, AI/ML was considered as the most important skills, while in Thailand use of mobile technology and websites was considered the most important skill. In all partner Asian countries, respondents overwhelmingly supported that the chosen pilot case study was beneficial for their country (Mongolia 100%, Thailand 99.3 % and Pakistan 89%).

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