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DigiHealth-Asia

D1.3: Learning material aimed at the skill requirements and training needs of ICT and health care practitioners

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1. Executive Summary

In this deliverable, we define the requirements for three types of courses in Pakistan, Mongolia and Thailand. We link the training needs that were identified through the pilot cases with specific course content for each country. For each country and each university, we detail the contents of the three courses that were identified (IoT for healthcare, AI and ML for healthcare, and embedded systems for healthcare). We provide a timeline for the establishment of specialization streams, specialized courses and vocational courses.

2. Introduction

This deliverable defines the teaching materials that will be developed in Pakistan (National University of Science and Technology (NUST) and Capital University of Science and Technology (CUST)), Thailand (Chiang Mai University (CMU) and Mae Fah Luang University (MFU)) and Mongolia (Mongolian National University of Medical Sciences (MNUMS) and National University of Mongolia (NUM)). Using the literature review created in Deliverable 1.1, we identify the training needs in each country. Then, we detail the timeline and content for three types of courses (specialized streams, specialized courses and vocational courses) and link this content with the pilot cases specific to each country. Finally, we study how the courses will meet the skill requirements and training needs.

3. Current status on the use of digital health technologies

3.1. Literature review in EU and Asia

A full deliverable (D1.1) is devoted to the literature review of digital Healthcare solutions in Asia and Europe. This section only contains a short abstract of that review, and compiles some of its conclusions.

Modern technologies and IoT and AI are cornerstones of digital health solutions. In the European countries participating in this project, numerous technologies are available to private and public institutions. This is not the case for the Asian partners.

In Pakistan, tele-consultations services are available, but no wearable or IoT systems are commercially available to the patients at this point. There is a need for digital systems that use wearable and non-wearable sensors and for more people to be able to use this data in Pakistan.

In Thailand, the state-of-the-art systems that monitor the factor of falls for older people are too costly to be present in every hospital and thus those are only present in some medical schools or universities. To provide healthcare for all the population, there is a need for local implementation of such technologies.

In Mongolia, although a few start-ups offer emerging online medical service, they lack traction in the domain of remote consultation. The pilot case and the dissemination created by this project through the formations will help building capacity around those areas.

3.2. Identification of skills and training requirement in Pakistan (CUST/NUST)

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 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, 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. 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. 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. There is a need 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. In addition to this the integration between health-care education and ICT is also required. There is a hesitation about ICT in health care providers as they are not introduced to trainings related to digital health similarly, ICT providers also lack the knowledge related to basics of medical science. Collaborative and integrative training efforts engaging both healthcare providers and ICT professionals is required.

Health care workers, lab technologists and biologists are familiar with the use of computers and do have limited programming skills required to install and run a machine or diagnostic equipment, similarly skills required for retrieval and interpretation of data are developed through trainings. Yet there is dependency on ICT professionals when it comes to integration of data from various sources. There is requirement among healthcare professionals to have knowledge and skills related to Artificial Intelligence and Machine Learning, Data receiving and sharing through internet, understanding of computing devices embedded in equipment. On the other hand, ICT professionals require trainings in AI/ML, Embedded systems and IoT focused on health care related cases. ICT professional require skills related to understanding of data type, integration and interpretation of clinical data.

3.3. Identification of skills and training requirement in Thailand (CMU/MFU)

Identification of Thailand's skill and training needs Thailand's government policy aims to move the country from Thailand 4.0 to Health 4.0. To be successful in the long run, the eHealth Strategy must

be integrated into a framework for moving in the same direction. Since October 2019, the government has been developing its telemedicine program at 32 hospitals in rural areas across eight provinces, encouraging the adoption of new technologies and remote medical care. This program is a collaborative effort between the Public Health Ministry and the National Broadcasting and Telecommunications Commission (NBTC) to address concerns about rising medical costs and inadequate healthcare access in rural areas. According to the eHealth Strategy (2017–2026). Healthcare IT is ranked second in terms of needing innovation and new technologies to modernize the overall system.

After four years of full implementation, telemedicine is expected to save patients and state-run hospitals a total of 38 billion baht in annual costs. This project will concentrate on four types of illnesses: high blood pressure, diabetes, eye disease, and skin disease. These account for more than 70% of hospitalizations. However, because it is more expensive to invest in the equipment and there aren't enough physiotherapists to support the population, this telemedicine project hasn't focused on mobility-related ailments. As a result, there is a gap in the development plan that leads to an unfulfilled vision of modernizing healthcare systems in rural Thailand. The Ministry of Health conducted a survey of health IT (hardware, software, network, and manpower) from 12,380 hospitals and health stations to assess readiness for deployment and implementation of modern ICT-based systems.

To identify the skills gap and training requirements for ICT and healthcare practitioners, the Thai partners (MFU and CMU), in collaboration with the Pilot Case # 2 leader (University of Northumbria at Newcastle), agreed to organize two workshops to gather adequate requirements from various groups of healthcare practitioners. They have varying degrees of expertise and experience, and they are working on two distinct projects (Chiang Rai and Chiang Mai provinces). According to the results of the 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 sub-stages. 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.

For the current state of the health workforce in Thailand, it is a critical issue in the healthcare system, particularly given the shortage of medical personnel. Therefore, the handicapped, rather than just doctors or nurses, will play an important role in caring for people with disabilities. Caregivers of people with disabilities must have fundamental knowledge and skills in order to care for people with disabilities. Reduce the incidence of disability complications to be able to care for people with disabilities correctly and appropriately. Therefore, it is a need for knowledge and skill training for these caregivers who can become assisting practitioners within the local area. Hence, to implement the future proposed ICT-based monitoring system, healthcare practitioners should be trained and updated on their ICT skills in these three domains.

- Digital literacy
- Data analytic
- Basic computer hardware

With this set of knowledge and skills, the proposed DigiHealth system could be used by healthcare practitioners and their assisting caregivers for the rest of their lives to prevent a serious falling accident in the target group.

3.4. Identification of skills and training requirement in Mongolia (NUM/MNUMS)

Mongolia is a large country by area with a population of 3,357,542 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. Thus, digitalization and strengthening human resources through AI is one of the main strategies of the local government to improve the health care system, quality, and access to early prevention, diagnosis, and treatment. Somehow, despite state policy advancement and infrastructure enhancement in ICT and AI, visible penetration and effective practical actions are at the initial stage, especially in the area of medicine and health sectors. Strengthening human resources at the higher educational institutional level through the present DigiHealth project will improve the Mongolian Health care professionals' competencies in ICT and AI as well as the quality of health care of citizens. Meanwhile, opportunities for training will be given for current engaged graduate students and practicing health professionals through new specialized courses to be created within the project duration.

In recent years, there has been a push from the Mongolian government and other organizations such as the Asian Development Bank to support projects which use new tools ICT technologies for remote examination, diagnosis, and facilitation of remote consultation with experts to respond to the need. ADB-supported projects are aimed at improving 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 professionals to equip them with the latest ICT tools and technologies is important for modernizing healthcare services, there is still an absence of research-based study to evaluate the skill set and current gaps in the proficiency of healthcare professionals in ICT technologies.

As part of the DigiHealth project, MNUMS and NUM jointly conducted workshops aiming to bring together cooperating parties by presenting the current situation and discussing how to meet health needs with smart digital solutions. In addition, a survey was collected from stakeholders to identify the existing skills and training requirements of ICT and healthcare professionals in Mongolia. Eighty-one percent of the workshop participants expressed that it was beneficial, whereas 78 % responded positively towards the introduction of training opportunities in the latest ICT technologies in AI/ML, IoT, and embedded systems.

The additional survey's results, collected separately apart from the workshop in June 2021, showed limited basic experience and skill, practice, and knowledge of the AI-related topics in students, healthcare professionals, managers, administrators, and faculties from the MNUMS: out of 325 respondents only 8.3% knew well and heard before about ML, IoT, Embedded system and AI in healthcare and 21.5% not heard at all. From all participants, 297 responded that will be interested in online training on the above-mentioned topic if it will be organized. For the question: "Which healthcare area will be the most benefit from Implementation of the teaching curriculum in ML, IoT, ES/AI?" participants answered the followings: preventive public health (1), public health education (2), patient health monitoring (3) and monitoring treatment outcome (4). In addition, for the question: "What is your main obstacle in using remote health care?", 60% responded lack of applications in

native language, 48% English language barrier, 34.8% lack of IT knowledge, but in reverse, 44.3% mentioned that need of smart healthcare solution in their private life is very important, and 32.3 % replied important, respectively. Specific subjects such as IoT and AI are needed to be included in the training curriculum due to the fast growth of technology and emerging innovations in the medical field. Formal higher educational institutions in Mongolia are left far behind of the IT industry whereas research in this area progresses. In addition, labor and societal demand needed to be supplied, accordingly.

3.5. Specialization stream

3.5.0. NUST

At NUST-SEECS, we are currently offering MS degree program in the areas of Information Technology (IT), Computer Science (CS), Artificial Intelligence (AI), Data Science (DS) and Electrical Engineering (EE). The specialized stream offered in these programs are launched after careful analysis of market demands and public interest. The themes of these specialization are quite generic to cover a broad range of elective courses. The specialization pertaining to narrow areas or specific interest are generally discouraged because it is hard to sustain them for longer run. In view of the above, currently, it is not possible to launch a new stream in any of the MS degree programs specifically related to healthcare. However, NUST-SEECS would make continuous efforts to offer the specialized stream related to healthcare at the institutional level subject to the approval of university authorities. For the time being, to support the deliverable/milestones of the Erasmus project, we will offer the elective courses which are already approved in our MS degrees programs and are relevant to digital health care. These include (i) Internet of Things (IoT), and (ii) Artificial Intelligence for Healthcare courses. In Internet of things course the pilot study of remote monitoring of cardiovascular patients will be included to satisfy the needs of the Erasmus project. These courses are regularly offered to MS programs and because of their popularity they are invariably taught every time, however, they cannot be made compulsory courses explicitly.

3.5.1. CUST

It is not possible in next 2 years to introduce a new stream, as the department has already planned for two new streams in coming years: (a) Data Science in 2022 and (b) Artificial Intelligence in 2023. The department has already started the approval process for these streams. If these two streams are started in near future, it will be very difficult to start yet another specialization stream on "ICT in Healthcare". The best we can do is to include one or two of our already defined courses, *e.g.*, IoT for healthcare and AI/ML for healthcare, as specialization (compulsory) courses in the AI stream (to be started in 2023).

3.5.2. CMU

College of Arts, Media and Technology at Chiang Mai University is proposing a major revision for the master degree in Digital Technology Management (DTM) curriculum. This process will take around 10 months which comprise of several tasks as shown below in timeline.

Timeline Year 2022	Task
Jan	- Faculty appoint external experts committee (3-5 persons) - Revise Curriculum by adding new three (3) courses and new specialized stream

Feb	Submit the revised curriculum to the external expert committee
Mid-March	Committee return the comments back to the faculty
March	Faculty reviews all comment and improve the curriculum
April	Faculty send the curriculum to the Chiang Mai University's Graduate school
May	Graduate school internally review the revised curriculum
June	The curriculum committee defends curriculum to graduate school's committee
July	Propose to the University Executive Committee
July	Propose to the Sub-Committee of the University Academic Council
August	Propose to the University Academic Council Committee
September	Presented to the University Council for acknowledgment
October	Get Approval by Ministry of Higher Education, Science and Innovation

The special track "Health Technology" (track named may be changed according to comment from the committee) will be implemented in the Master Degree of Digital Technology Management. The total of 36 credits included Core Courses (9 Credit), Required Courses (9 Credit), Elective Courses (6 Credit), Thesis (12 Credit). Three (3) required courses will be developed regarding to the DigiHealth Project.

3.5.3. MFU

MFU is working on the MSc. In IT curriculum revision. If the university council approves the new curriculum, we can promote this new curriculum included the DigiHealth specialization stream on the faculty's website in March 2022. Then, MFU will start to open the application for new academic year on August 2022.

Timeline	Task
November 2021	- Faculty appoint the experts to become an external committee (5 persons) - Revise Curriculum by adding new three (3) courses and new specialized stream
November 2021	Organize the meeting with external committees for their comments
December 2021	Faculty reviews all comment and improve the curriculum
December 2021	Faculty submit the curriculum to the Mae Fah Luang University's Academic Council
January 2022	The curriculum committee defends curriculum to MFU's Academic Council s committees
January 2022	Present the revised curriculum to the University Council for acknowledgment
March 2022	Submit the revised curriculum to the Ministry of Higher Education, Science and Innovation

The specialization stream that integrated into our new curriculum, will contain the proposed required courses from this Erasmus+ project with adjusted names as follows.

1) Intelligent Internet of Things (3 US credits)

2) Artificial Intelligence Applications (3 US credits)

3) Embedded System Platform (3 US credits)

4) Thesis (12 US credits) or Independent Study (6 US credits)

To promote the DigiHealth specialization stream, MFU will present to the applicants of the MSc program for acknowledging about the stream, the students who choose to do their thesis on the 'Healthcare Innovation' must enroll to study on all these 3 courses, 1) 2) and 3), on their program of study and have to complete on the total of 36 US credits as required by the university in order to pursue for the degree.

3.5.4. NUM and MNUMS joint program

NUM and MNUMS are jointly working with the Ministry of Education, Science and Technology of Mongolia since Dec 2020 to commence a new master degree program in 'Bio-medical engineering'. The program will belong to the School of Engineering and Applied Sciences, National University of Mongolia and will be run jointly by NUM and MNUMS. The process of getting approval from the ministry for the new program will take around 18 months which comprises of several tasks as shown below in timeline.

Timeline	Task
Dec 2020	Submitted the application for a new master degree program in 'Biomedical engineering' jointly with the MNUMS to the Ministry of Education, Science and Technology of Mongolia.
April 2022	The education classification index for the new program shall be assigned and approved by the Ministry of Education, Science and Technology.
Oct 2022	The new program request to the Ministry and its justification shall be discussed in and approved by three levels (department, school, university) of curriculum development committees.
Nov 2022	Get a preliminary approval from the Mongolian National Council for Education Accreditation.
April 2023	Get the education license for the new program from the Ministry of Education, Science and Technology.
May 2023	The curriculum of the new program will go through and shall be approved by the three levels (department, school, university) of curriculum development committees.
Sep 2023	Commencement of the new master degree program.

The new master degree program in 'Bio-medical engineering' will include the three courses proposed by the Erasmus+ Digihealth-Asia project in its compulsory subjects:

1) Internet of Things in Healthcare (3 US credits),

2) Artificial Intelligence in Healthcare (3 US credits) and

3) Embedded Systems in Healthcare.

Students also can choose their thesis work in digital healthcare for 6 US credits.

3.5.5. MNUMS existing program revised version

As an initial step, for the existing Biomedical graduate program (Master Course, PhD course) within the Specialized Compulsory syllabus the "AI in Healthcare" subject was included as 1 credit out of general 12 credits to be earned. The Revised Curriculum Approved by the Curriculum Committee of the MNUMS in January 2022. Supervisors within the 3 credits of electives will require students to select IoT and Embedded systems for healthcare if a graduate student's topic is related to ICT, AI in healthcare.

3.6. Specialized courses

3.6.1. Outline and link to the pilot cases

- IoT for healthcare

For this course, the main points are to introduce the Internet of Things (IoT) and in particular the Internet of Medical Things (IoMT); to present the devices and hardware that are commercially available and to explore the Human-Machine interaction and the data extraction aimed at human medical practitioners.

For pilot case 1, this means a particular focus on non-wearable sensors for cardiovascular monitoring.

For pilot case 2, this means a particular focus on connected environments to help people with mobility disorders

For pilot case 3, this means a particular focus on the use of sensors from smartphones or some easy-to-use technologies for telemedicine and remote consultation.

- AI/ML for healthcare

For this course, the main points are an introduction to the possibilities of AI in health care, a tutorial to use real data for inference and use some existing software solutions and an exposition to the limits of AI in healthcare, inter alia regarding explainability and ethics.

For pilot case 1, this means a particular focus on time series algorithms to automatically detect anomalies in heart rate or blood pression and on the profiling of "at-risk" patients.

For pilot case 2, this means a particular focus on image analysis to detect falls and on the profiling of "at-risk" patients.

For pilot case 3, this means a particular focus on autonomous response (chat-bot) for remote consultation and natural language processing. The data processing and techniques of AI training for historical data will also be an important part.

- Embedded systems for healthcare

For this course, the main points are an introduction to embedded systems and IoMT, an exposition of wearable devices for health and tutorials on uses and interoperability between components.

For pilot case 1, this means a particular focus on wearable sensors for cardiovascular monitoring.

For pilot case 2, this means a particular focus on wearable devices that can indicate a fall and connected environments for people with mobility disorders.

For pilot case 3, this means a particular focus on the use of sensors from embedded systems for telemedicine and remote consultation.

3.6.2. CUST

Artificial Intelligence in Health Care

This course will introduce to the students the application areas of healthcare in artificial intelligence (AI), the techniques and tools used in writing AI applications. In particular, the students will learn to structure a healthcare problem as an AI problem, apply the appropriate techniques and tools to solve the problem. The students will be taught Prolog language and its use in representing and solving a logical system in healthcare. Application of AI techniques such as state space search, heuristic search, optimization techniques, expert system development in healthcare using knowledgebase, natural language processing, and machine learning applications in healthcare will be covered in detail. The students will be taught the unique characteristics and challenges in medicine and healthcare and their solutions using AI techniques. It will also cover the risk stratification, patient outcome prediction and disease progression modeling using AI. The students will be given extensive programming exercises in python to provide them opportunity to practice their classroom skills.

Embedded systems for healthcare

This course introduces students with the design of embedded systems and its applications in healthcare. Students will learn about essential embedded technologies, embedded design components, and how to apply these technologies in healthcare devices and smart healthcare solutions. Students will also learn about embedded devices, sensors, actuators, Internet of Things (IoT) and IoT based solutions being used to transform the future of healthcare. Course is structured to provide students with a broad and in-depth knowledge of latest trends in embedded systems and smart healthcare.

Internet of things for healthcare

The Internet of Things (IoT) is transforming the way we live and work on an unprecedented scale. One of the key areas in which Internet of Things (IoT) plays a vital role is Healthcare systems. This course will describe the concepts around the Internet of Things (IoT), the technology used to build these kinds of devices, how they communicate, how they store data, and the kinds of IoT systems needed to support and improve the healthcare system. Modelling and integrating medical data with the IoT help in building effective prediction systems for automatic recommendations of diagnosis and treatment. There is a great demand for the design and development of methods dealing with capturing and automatically analyzing medical data from imaging systems and IoT sensors. This course discusses interactions, advantages, limitations, challenges and future perspectives of IoT based remote healthcare monitoring systems and also Includes data privacy and security analysis methods for the Internet of things in healthcare.

3.6.3. NUST

Internet of things

This course focuses on the fundamentals of Internet of things (IoT) and its technology stack. As of today, IoT is one of the fast-growing technologies worldwide and increasingly becoming pervasive in enhancing various verticals ranging from civilian to defense sectors. These domains include agriculture, environment, healthcare, education, manufacturing, livestock, water, etc., which are presently transforming their traditional infrastructure to support IoT. The unprecedented advancement in technology has made it possible to envisage persistent connectivity, storage, and

computation, which, in turn, gives rise to building different IoT solutions. Therefore, it is very important to learn the fundamentals of this emerging technology. The learning outcomes of this course include the understanding of the significance of the Internet of Things, its architecture, and communication protocols. In addition, the major focus of this course is to deliver the content related to IoT in healthcare to make the students understand how IoT can be useful in automating the healthcare units and remote monitoring of elderly, bed ridden patients and patient suffering from other health issue using wearable sensors. A key component of this course is the integration of pilot study to demonstrate the practical aspects of digi-health.

Artificial Intelligence for Health Care

The course is designed to develop student research skills in the broad area of computational pathology, medical image analysis and analyzing healthcare data. It will cover topics on the analysis of massive amounts of data generated in biomedical sciences, in particular DNA/RNA sequences and large multi-gigapixel pathology images. Students will be introduced to the foundations of two fundamental types of biomedical data including genomic sequences and tissue images and how these are acquired and processed. Machine learning plays a central role in processing these data, and to develop computational models that help us better understand the complex phenomena underpinning biological processes. The module will be taught following an “algorithmic approach”, demonstrating that computational biology is a wide-open arena that offers a very diverse range of problems and thus a diverse range of algorithms, making it an exciting and rapidly evolving field for computer scientists.

3.6.4. CMU

Our target audience for the CMU course will be those with a master's degree in Digital Technology Management from faculties of medicine or software and hardware engineers who do not have a strong background in healthcare technology. In the pilot case, the Chiang Mai University course will include fundamental knowledge of the following topics.

Internet of things for Health Care

The Internet of Things (IoT) is a technology that is based on the knowledge of embedded systems. This is a technology that is currently gaining a lot of attention. This improved technology will make it easier for electronic devices to interact and/or exchange data with one another. These are referred to as "Internet of Things" (IoT) devices.

CMU's IOT pilot course will be designed with a focus on students who will be able to understand how IOT technology can be used in public health systems, such as the use of health storage devices. We can collect and process health data using wearable technology by collecting bio signals such as vital signs, movement, and sleep. which is an example of Internet of Things technology

Artificial Intelligence/Machine Learning for Health Care

This course focuses on the knowledge required to understand the connections and applications of machine learning and artificial intelligence technology in a variety of fields, including medical diagnostic assistance, business and marketing, and others. In each course, students will be given an overview of how artificial intelligence technology is used. In each area, we would need to provide case study examples and teach the process of questioning, problem solving, analysis, and interpretation. Use information to aid and facilitate decision-making in medical work, which can then be applied to any application that students find interesting.

Digital Transformation for healthcare

As a result of the rapid advancement of technology and information, many different industries are preparing. In order to prepare for what lies ahead, CMU has devised a digital innovation management course in this pilot case of the project to improve the knowledge and capabilities of its personnel. Both groups in the medical field, including engineers and medical technicians, understand and can apply this transformation in healthcare.

In this course, we will concentrate on knowledge in areas such as digital fundamentals, digital transformation, tool design concepts, and analysis for medical digitalization.

3.6.5. MFU

Intelligent Internet of Things

This course will discuss on the principles and importance of Internet of Things (IOT), Internet of Things in daily life and business; hardware, software and computer network for IOT; IOT architecture and platform; application of IOT for transforming or improving works in various domains including education, agriculture and healthcare. The case study of the DigiHealth-Asia will be introduced and discussed to present the devices and hardware that are commercially available in order to explore the Human-Machine interaction and the data extraction aimed at human medical practitioners for creating a connected environments to help people with mobility disorders.

Artificial Intelligence Applications

In this course, it will be a discussion of the concepts and techniques for artificial intelligence; artificial intelligence tools; reasoning procedures under uncertainty; machine learning; expert systems; neural networks; nature inspired modeling; case-based reasoning; deep learning; case studies in artificial intelligence research and application, especially the DigiHealth-Asia case study will be introduced about the image analysis to detect falls and on the profiling of “at-risk” patients.

Embedded System Platform

In this course there will be the discussion of the principles of an embedded system; hardware and software for the embedded system; examples and usage of the microcontroller; interfacing microcontroller with equipment and sensors; a platform for the embedded system; and the existing research and innovation on embedded system platform including DigiHealth-Asia platform for indicating a fall will be introduced to the students.

3.6.6. NUM & MNUMS

Artificial intelligence in healthcare

As a result of the Fourth Industrial Revolution, there is a continuous flow of large amounts of data from patient surveillance and electronic histories in the health sector. It is important to collect this data, select the target data, and identify, assess, and predict the general characteristics of the population using artificial intelligence, machine training methods to prevent various diseases in the population. In addition, many advanced technologies based on artificial intelligence have been widely introduced in medical institutions, and in consequence, there is an urgent need for doctors and medical staff to work on them. The goal of this course is to introduce the basic concepts, methods, and the potential of intelligent systems in medical science. We will explore foundational methods in machine learning and knowledge representation and reasoning, and apply them to specific areas in medicine and healthcare including, but not limited to, clinical risk stratification, time series analysis of physiological data, disease progression modeling, and patient outcome prediction. As a research and project-based course, students will have opportunities to identify and specialize in particular machine learning methods, healthcare applications, and relevant tools.

Internet of things in healthcare

Internet of Things (IoT) has been popularly used in healthcare, and medical technologies are advancing drastically to diagnose, treat and monitor patients with help of IoT. In this course, students will acquire theoretical and practical knowledge of the IoT system foundation and will be able to understand how IOT technology can be used in medical practice, such as the use of medical data analytics and prediction, and health monitoring devices. As a research-oriented course, students will also have opportunities to specialize in particular medical data analysis and its healthcare applications.

Embedded system in healthcare

This course will provide students with the fundamental knowledge base that will enable them to solve complex problems encountered in embedded systems design. The course will provide an overview of associated hardware components and software methodologies as well as the tools used in the development of modern embedded systems in healthcare. Students will be exposed to the theoretical

foundations which will be enriched by laboratory exercises, thereby getting a sense of how the theoretical concepts connect with the real-world embedded systems applications, specifically in medical field.

3.7. Vocational courses

3.7.1. CUST

For vocational training, or specialized certifications courses could be offered and as per our calculation, these pieces of training and courses would be more effective and will attract more participants from both healthcare and ICT. Students and professionals are targeted both in medical sciences and health care providers (contents could be more focused on awareness) and ICT professionals and training could be focused on cardiovascular diseases and available solutions. At CUST we have also started research projects both at undergraduate Final Year project and at Graduate level as MS thesis

3.7.2. CMU

Vocational Courses

Target Audience

1. Digital-based Learner: (e.g., Software Developer, Health Technologist, Startup)
    1. Topics: Health Technology, Smart Medical Device
2. Health-based Learner: (e.g., Physical Therapist, Nurse, Caregiver)
    1. Topics: Artificial Intelligence, Machine Learning, Internet of Things,
3. General Learner: (e.g., Entrepreneur,) Health Technology Transformation (12 Hrs.)
    1. Topics: Health Technology Transformation, Digital Health, Wellness Technology

3.7.3. MFU

General outline

- Digital literacy
- Data analytic
- Basic computer hardware

Link with the pilot case

Workshop on how to setup and use the pilot case 2 prototyped system

Planning

On the 3rd year of this DigiHealth-Asia project

Impact on society

The proposed design system could be used by healthcare practitioners and their assisting caregivers for the rest of their lives to prevent a serious falling accident in the rural area.

3.7.4. NUM and MNUMS

Health professionals and health-related specialists, in Mongolia after completion of their undergraduate university Bachelor degree offered and encouraged to be engaged in continuing educational trainings and collect certain credits as a part of license extension to work in their professional health field. Thus, within the project, MNUMS and NUM joint postgraduate 1.5 months 6 credits certificate program is planning to be established.

1. Link with the pilot case

12/2021-01/2022	Curriculum Draft, Discussion meetings with NUM and MNUMS;	
02-04/2022	Process of Approval by the Postgraduate Training Institute, MNUMS;	
4-5/2022	Dissemination, Promotion	
9/2022-12/2022	Start of vocational postgraduate training	3 months
1/2023	Graduation&Certificate	

2. Impact on society: 1. A learning opportunity will be given to a broad specter of health and ICT professionals; even civil students open to join the short-term course.; 2. Basic knowledge and skills in ICT, AI, IoT, and Embedded system in healthcare will be obtained; 3. Access to professional healthcare service through the pilot case will be given for patients, remote consultation will be instrumental and early detection, prevention and treatment will be enhanced. 4. Research data will be collected for preliminary evidence-based data results.

4. Bridging the gap: how the courses will meet the skill requirements and training needs

How the training and the pilot cases will solve the problems in the respective partner countries.

4.1. Pilot case 1: cardiovascular monitoring in Pakistan (CUST/NUST)

In Pakistan, two study domains, medical sciences and ICT, are considered very separate paths and integration is very limited. Many medical professionals including practitioners, medical attendants and even Lab technologists are not very much aware of the upcoming ICT developments. They usually do not have any trainings, courses or even a course contents related to ICT. There is a lot of Gap in skill development related to ICT as well as its potential Applications in the domain. Similarly, ICT professionals may have basic knowledge of biology which restricts them to explore the potential in this domain. Introduction of potential applications of ICT in healthcare will open new avenues for them as well.

4.2. Pilot case 2: mobility disorder monitoring in Thailand (CMU/MFU)

The seminar and workshop will be organized in hybrid model (online and offline). The special topic on "Health Technology" will be arranged weekly or bi-weekly under the "Digital Talent Academy" (www.dta.in.th) Under the supervision of Digital Technology Management (DTM) degree program. Learners can collect the credit via Chiang Mai University Lifelong Education (CMU LE) [www.lifelong.cmu.ac.th].

The healthcare practitioners can enroll in the short course training (both online and onsite) for their reskill and upskill regarding our knowledge of the pilot case 2 e.g., IoT/AI/Embedded concepts for healthcare. They can also register for the credit banking for future study and pursuing the degree on our specialization stream at MFU.

4.3. Pilot case 3: remote patient consultation in Mongolia (NUM/MNUMS)

Three clinical cases were introduced at the workshop. Within the process out of efficacy and relevance NUM and MNUMS agreed to choose one pilot case: Oral health and caries remote monitoring. Based on literature review and existing need, a team of researchers, faculties, graduate students will oversee the implementation of remote consultation, monitoring using intraoral camera and cooperation of selected dental clinics will be involved. Subjects' data collection will be managed by dentists from the dental clinics, and analysis will be done by researchers. To improve skills in digital health of participants of the pilot case (member of research team, dentists) will be encouraged to join the 3 months certificate vocational postgraduate training as a part of the project.

5. Conclusion

In this deliverable, we linked the needs for training with three types of courses. We also showed that those courses can be put together with the pilot cases and the specific needs of each country and each university. We gave some characteristics for the timeline and content of specialization streams, specialized courses, and vocational training. More precisely, we are planning on starting six specialization streams between June 2022 and September 2023, and every partner university will start vocational training courses by June 2022. Finally, we showed how the courses will meet the skill requirement for health professionals, though workshops and seminars.