

### **ASAIHL CONFERENCE 2022**

### University of Warsaw



# Bridges for Science and Education: Cooperation, Trust, Openness and Creativity in the Globalized World





asaihl@uw.edu.

www.uw.edu.pl



# **Organizational Committee**



Dr. habil. Agata Bareja-Starzyńska, Prof. UW

Dr. Jan Rogala

Tenzin Tsenyi M.A.

Beata Kryśkiewicz M.A.

Dr. Sylwia Surdykowska-Konieczny

Dr. Beata Wójtowicz

Dr. Jakub Wilanowski-Hilchen

Dr. Joanna Dolińska-Streltsov

Dr. Marta Widy-Behiesse

Dr. Magdalena Szpindler

Dr. Magdalena Kubarek

Faculty of Oriental Studies



#### September 25, 2022

17:00 ASAIHL Board Meeting (Senate Hall, Kazimierzowski Palace)

#### September 26, 2022

9:30-10:00 Registration and Coffee (Dobra 55, Aula 1007/08) 10:00 Opening Ceremony Address by Prof. Sambor Grucza, the Vice-Rector of the University of Warsaw

Address by Prof. Yoshihisa Baba, the President of ASAIHL

Address by Dr. Ninnat Olanvoravuth,

the Secretary General of ASAIHL

10:45-12:00 Main session: Bridges for Science and Education

10:45 Joanna Osiejewicz, (University of Warsaw, Poland) United We Stand: The University of Warsaw in European Collaboration Networks

11:15 Anna Wojtyś, (University of Warsaw, Poland) 4eu+ Alliance: Towards Flexible Education Pathways

12:00-13:30 Lunch

at 13:00 University of Warsaw Tour – optional for 25 people 13:30-15:30 Country reports

> 13:30 Tawiwan Kangsadan, Chayakorn Netramai, Boonchai Sangpetngam, Alexander Brezing and Nisai Fuengwarodsakul, (Thailand)

Extensive Joint Collaborations with International Universities for Development of Industrial-Oriented Engineering Education Model and Best Practice in Thailand



14:00 Fr. Marcelo V. Manimtim, (Adamson University, the Philippines) Country Report on the Philippines 14:30 Jamaluddin Jompa, Adi Maulana, Muhammad Yusri Zamhuri, (Hasanuddin University, Indonesia) Millennial Science Education for the Sustainable Development Goals 15:00-15:30 Coffee break 15:30-17:30 (1) Cooperation: inter-universities educational programs 15:30 Tofan Agung Eka Prasetya, (Universitas Airlangga, Indonesia) Inter-Universities Collaboration: Building, Strengthening, and Empowering Collaboration in Cultural Diversities 16:00 Grzegorz Kula, (University of Warsaw, Poland) How European University Alliances Address the Question of Well Being 16:30 Prasert Trivijitslip, Sranya Phaisawang, and Anan Srikiatkhachorn, M.D. (King Mongkut's Institute of Technology Ladkrabang, Thailand) Medical Treatment and Medical Device Innovation during the COVID-19 Pandemic: Contributions from King Mongkut's Institute of Technology Ladkrabang 17:00 Anna Sadecka, Karolina Trybowska-Greń, (University of Warsaw, Poland) Cooperation of the University of Warsaw with Countries of Southeast Asia 18:00-20:00 Concert and Reception (The Columned Hall, Main Campus)

#### September 27, 2022

9:30:00-13:00 Sessions (Dobra 55, Aula 1007/08) Country Report 9:30 Zygmunt Lalak, (Vice-Rector of the University of Warsaw) Science and Education in Poland (2) Openness: a cross-cultural workshop - how to understand each other? 10:00 Józef Pawłowski, (University of Warsaw, Poland) Studies on Asia at the University of Warsaw – On the Significance of Understanding Other Cultures 10:30 Jakub Zajączkowski, Łukasz Golota, (University of Warsaw, Poland) Panel discussion Cooperation in Higher Education and Diplomatic Relations between FU and ASFAN 11:00-11:30 Coffee break (3) Creativity: cross-disciplinary and/or interdisciplinary research? 11:30 Ni Nyoman Tri Puspaningsih, (Vice-Rector,

Universitas Airlangga, Indonesia)

Strengthening the Global Academic Community to Foster Inter – and Multidisciplinary Research Innovation and Community Development among High Educational Institutions

12:00 Allyson Kaye L. Plaza, (University of Manila, the Philippines) A Comprehensive Overview on 5g as The Newest Innovation in Cellular Network Technology

12:30 Hermanto Trijoewono, (Universitas Airlangga, Indonesia), Brain Friendly Medical Education? A Neglected Bridge not a Bridge Too Far

13:00-14:30 Lunch (Dobra 55, Aula 1007/08) at 14:00 University of Warsaw Tour - optional for 25 people 15:00-16:30 Sessions (4) Pandemic Situation and High Education 15:00 Kaushalya Yatigammana, Gamini Wijayarathna, (University of Kelaniya, Sri Lanka) Continuity of Education in the Post-Pandemic Era: Implementation of the Smart Postman Concept in the Sri Lankan Educational System (online) 15:30 Angela E. Lorenzana, (Bicol University, the Philippines) Semantic Explication of the Filipino Concept of Debt of Gratitude or 'Utang na Loob' (online) 16:00-16:30 Coffee break (Dobra 55, Aula 1007/08) 17:30-18:00 Closing Plenary Session (including presentation of the next ASAIHL conference) (The Columned Hall, Main Campus) 18:00 Reception (The Columned Hall, Main Campus)

#### September 28, 2022

Networking: faculty meetings, study visits







# ABOUT THE UNIVERSITY OF WARSAW





The University of Warsaw was founded in 1816. It is the largest university in Poland and the best research centre in the country.





The University of Warsaw graduates have won 6 Nobel Prize awards:

- Nobel Prize in Literature: Henryk Sienkiewicz, Czesław Miłosz, Olga Tokarczuk
- Nobel Peace Prize: Menachem Begin, Joseph Rotblat
- Nobel Prize in Economic Sciences: Leonid Hurwicz

# UNIVERSITY COMMUNITY

- 7 498 employees
  3 834 academic teachers
- 2 451 doctoral candidates
- 40 493 students
- 4 802 international students and doctoral candidates
- 2 086 postgraduate students
- 9 000 graduates per year



# **Travel Information**

#### Venue

Our conference venue is at Dobra 55, the building near to the University of Warsaw Library (Biblioteka Uniwersytetu Warszawskiego, BUW), address: Dobra 56/66, Warsaw. The nearest metro station is Centrum Nauki Kopernik, some 8 minutes walk away. Buses number 115, 108 and 127 stop right outside the building.

http://en.uw.edu.pl/practical-information-for-visitors/campuses-and-facilities/campuses/

http://en.uw.edu.pl/

http://en.uw.edu.pl/visit-campus/must-see-at-the-university/#lightbox[galleryid-14306-1]/8/

#### Мар

Location on Google Maps: https://goo.gl/maps/ KWQop6igWdFUXj22A

#### Visas

Poland is one of the Schengen countries. If you do not have a valid Schengen visa, you will need to apply for one in due time. Please consult visa information on the website of the Embassy of the Republic of Poland in your country.

Please consult this website to find the addresses and contact details of Polish embassies worldwide:

https://www.msz.gov.pl/en/travel\_to\_ poland/polands\_missions\_abroad/

#### Health insurance

EU-residents: European Health Insurance Card (EHIC) – access to public healthcare provided in Poland at a reduced cost, or sometimes for free. For more see: http://www.poland. travel/en/useful-information/in-an--emergency

Non-EU residents are advised to arrange appropriate health insurance ahead of travel.

Please note that in some countries not all insurance companies are approved for issuing insurance for travel to Schengen states. Please consult the website of the Polish mission to your country to check which companies can be used.

#### Money and tickets

In case you have no Polish currency (i.e. Polish złoty/zł/PLN), you will find ATM machines at the airport and at the railway station. You can also use money exchange offices, called 'Kantor' in Polish. Using ATMs and paying by card may be a better option financially, as exchange offices at airports and in tourist areas tend to offer not the best exchange rates.

For public transport, you should buy tickets before boarding. Tickets can be bought from ticket machines, kiosks (news vendors) and in some shops.

# Getting to the venue

Please remember to validate/activate your ticket once you begin your journey. In many (but NOT ALL) buses and trams, tickets can also be bought inside from coin- or card-operated ticket machines (Note: tickets bought inside a bus from a card-operated machine are already validated and for immediate use only). Bus drivers do not sell tickets.

For rides exceeding 20 minutes you will need a 4,40 PLN ticket (valid for 75 minutes and you can change buses/ trams/ local trains), for those up to 20 minutes it is 3,40 PLN. There are also 24-hour tickets (15,00 PLN) valid for as many rides as you wish from the time of their validation. For more details on public transport in Warsaw (timetable, fares etc.):

http://www.ztm.waw.pl/?l=2

#### By plane

Below you can find the most important information about the access to and from the airport. For more details please see:

http://www.lotnisko-chopina.pl/en/access.html and http://www.ztm.waw. pl/index.php?c=571&l=2

#### From Warsaw Chopin Airport

1. There are no direct buses that will get you to the venue, and we recommend you take one of the registered taxis or an Uber (see point 3 below).

2. Bus no. 175 that operates just outside the terminal and will get you to central Warsaw and the University area (get off at the stop "Uniwersytet 02" just next to the University main gate). The bus ride takes approx. 40 minutes depending on the 36traffic. Please note that the venue is some 15 minutes of walk away from the main campus, and it might not be convenient to use this route with luggage.

3. Taxi: Ele Taxi, Super Taxi and Sawa Taxi licensed corporations operate from the airport and can be found just outside the terminal. The taxi fare to the city centre is approx. 40-50 PLN. In many taxis, you cannot pay with card, only cash (złoty) is accepted. Please AVOID taxi drivers soliciting customers inside the terminal and DO NOT take just any taxi, because in most cases you would have to pay much more than you need (this also applies to travels within the city). An Uber ride from the airport, depending on the time, should be between 25 and 40 PI N

You can also consult the Airport's website: http://www.lotnisko-chopina. pl/en/access.html

#### From Warsaw Modlin Airport

Please consult:

http://en.modlinairport.pl/ http://www.ztm.waw.pl/?c=572&l=2 The easiest way is to take a bus (regular ticket 33 PLN). For more details please see:

https://www.modlinbus.pl/en An Uber ride from Modlin Airport to the venue should cost between 110-150 PLN, depending on the timing.

#### By train

If you arrive at the 'Dworzec Centralny' (Central Railway Station), walk in the underground passage towards Marriott Hotel. Right below Marriott, you will find the bus stop "Dw. Centralny 01". Take the bus no. 127, and get off some 15-20 minutes later at "Biblioteka Uniwersytecka 02", right next to the venue.

You can also take a taxi from a licensed taxi stand, which you can find on both sides of the station: Ele Taxi operates from the stand facing Hotel Marriott and Sawa Taxi from the stand facing Złote Tarasy shopping mall. The taxi fare to the University Library is approx. 30-35 PLN. Please AVOID taxi drivers soliciting customers and DO NOT take just any taxi.

An Uber should cost between 20 and 30 PLN.

#### Car

The whole city centre of Warsaw is a paying parking zone (from Monday to Friday, from 8 am to 6 pm). It can be

difficult to find parking space in the venue's vicinity.

#### Safety

Warsaw is generally a safe city and most likely you will not face any problem. Petty crime, however, does happen and travellers should be on guard against pickpockets working on bus routes by the airport and the railway station.

Please remember to use clearly marked taxis of licensed corporations (a few names have been given above); you will find their list and numbers here:

https://warsawtour.pl/en/getting-around-warsaw/?doing\_wp\_cron=166323 7830.0759179592132568359375

Usually in Warsaw people call cabs by phone in advance instead of hailing them in the street. The operators speak English and waiting time is normally around 10 minutes. Uber is readily available, and cheaper than -regular taxis.





ASAIHL CONFERENCE 2022, WARSAW, POLAND ABSTRACTS

#### Millennial Science Education for the Sustainable Development Goals

Jamaluddin Jompa<sup>1</sup>, Adi Maulana<sup>2</sup>, Muhammad Yusri Zamhuri<sup>3</sup>

<sup>1</sup>Department of Marine Science, Faculty of Marine Science, Hasanuddin University, 90245, Indonesia

<sup>2</sup>Department of Geology, Faculty of Engineering, Hasanuddin University, 90245, Indonesia

<sup>3</sup>Department of Development Study, Faculty of Economy and Business, Hasanuddin University, 90245, Indonesia

#### Abstract

Science can be found everywhere in our daily lives. Science study is critical to developing and protecting the life of creatures and even our social-economic issues. Science is believed to be able to illustrate the complexity of functions in our daily life ranging from the anatomy of a creature to the cutting edge of technology or, in short, sustainable development. Consequently, teaching science in our education system is essential. Moreover, the National Science Teaching Association explains that to cope with the fast global changes, 21st-century skills are required to consistently work with the science education system.

On the other hand, teaching science in our education system can also be challenging. Centre for Education in Science and Technology (2022) argues that students enjoy learning science because it allows students to think creatively. Science develops students' critical thinking according to their existing knowledge and plan.

Nevertheless, Éric Anderman suggests that science teachers in secondary to high schools need to understand their students' cognitive development. Moreover, students often shift their careers in the future due to bad experiences during their studies. In addition, science education often neglects social issues such as the under representativeness of gender and minority groups. Having said that, the importance of science in education, there has to be a change in how we teach and promote science in our education because science has an essential role in achieving our sustainable development goals.

#### Extensive Joint Collaborations with International Universities for Development of Industrial-Oriented Engineering Education Model and Best Practice in Thailand

Tawiwan Kangsadan<sup>1</sup>\*, Chayakorn Netramai<sup>2</sup>, Boonchai Sangpetngam<sup>3</sup>, Alexander Brezing<sup>4</sup>, and Nisai Fuengwarodsakul<sup>5</sup>

<sup>1</sup>Chemical and Process Engineering Program, The Sirindhorn International Thai-German Graduate School of Engineering, King Mongkut's University of Technology North Bangkok, 10800, Thailand

<sup>2</sup>Software Systems Engineering Program and Railway Vehicles and Infrastructure Engineering Joint Program, The Sirindhorn International Thai-German Graduate School of Engineering, King Mongkut's University of Technology North Bangkok, 10800, Thailand <sup>3</sup>Department of Civil Engineering and Railway Vehicles and Infrastructure Engineering Joint Program, Faculty of Engineering, Chulalongkorn University, 10330, Thailand <sup>4</sup>Mechanical Engineering Simulation and Design Program, The Sirindhorn International Thai-German Graduate School of Engineering, King Mongkut's University of Technology North Bangkok, 10800, Thailand and RWTH Aachen University, 52062, Germany <sup>5</sup>Electrical Power and Energy Engineering Program, The Sirindhorn International Thai-German Graduate School of Engineering, King Mongkut's University of Technology North Bangkok, 10800, Thailand and RWTH Aachen University, 52062, Germany <sup>5</sup>Electrical Power and Energy Engineering, King Mongkut's University of Technology North Bangkok, 10800, Thailand

\*Corresponding author E-mail: tawiwan.k@tggs.kmutnb.ac.th

#### Abstract

International collaboration is the key mechanism to reform education and to boost the reputation and recognition of Thai universities in the global community. Numerous international collaborations with renowned universities around the world are developed and strengthened in Thailand. To achieve Thailand 4.0 goals and Hi-value and Sustainable Thailand together with Digital Economy, the suitable engineering education and practice model must be evaluated for the development in the capacity building of engineering professions. In this preliminary report, the international collaborations in both undergraduate and graduate engineering study programs between Thai and foreign universities are summarized. With the effort to determine the suitable engineering education model and the best practice, the correlation between the engineering education, the university rankings and the country's economy are briefly studied.

Keywords: Thailand, engineering education, international collaboration

#### Semantic Explication of the Filipino Concept of Debt of Gratitude or 'Utang na Loob'

Angela E. Lorenzana Language Arts and Literature/Humanities and Social Sciences Department Bicol University, 4500, Philippines aelorenzana@bicol-u.edu.ph

#### Abstract

Cultural concepts help us understand differences in how people think, behave and express themselves. It also leads to the awareness of the precepts constituting acceptable behavior. Without cross-cultural awareness, we tend to accept similarities as stereotypes and differences as strange, if not ridiculous, phenomena. People might never suspect the different perceptions cultures attach to equivalent words, thereby failing to grasp and appreciate each cultural group's unique way of looking at things.

The study is a semantic analysis, which falls under descriptive or qualitative research, thereby primarily employing linguistic data using the term ,utang na loob.' A culture's fundamental concepts are highly influenced by the existing cognitive structures constituting a given culture's values and attitudes. Hence, studying a language, especially its vocabulary, can reveal essential features in a speech community's culture and offer important clues for its distinction from others. Authors such as Nurazijah (2018), Naito and Washizu (2015), Rungduin and co-authors (2015) showed different perspectives on the concept among Asians.

It employs the Natural Semantic Metalanguage (NSM)) which is one of the most well-developed, productive, and comprehensive semantic analysis tools (Wierzbicka: 2015). Anna Wierzbicka casts linguistic meaning in terms of cultural scripts, which she constructs from a short list of 65 semantic primes, each with a grammar deemed essential to human language, in the sense that these occur in all languages.

The study consists of the literal definitions, popular meanings given by native speakers, a discussion on reciprocity as groundwork for explaining the concept, and samples from literary selections using the term. The actual explication of 'utang na loob' is as follows:

X has 'utang na loob'

- X thinks something like this
- (a) Y did something very good for me
- (b) Because of this, I think about Y
- (c) I want to do very good things for Y
- (d) I cannot not do this
- (e) If I do not do this, people may know and think something bad about me
- (f) I do not want this

The concept can be abused despite being hailed as a desirable, if not a mandatory, aspect of Filipino custom. Analyzing the cognitive element of this concept can help in using it as a tool for establishing goodwill and safeguarding against false gratitude.

**Keywords:** Natural semantic metalanguage, key cultural concepts, semantic explication

#### United We Stand: The University of Warsaw in European Collaboration Networks

Joanna Osiejewicz University of Warsaw

#### Abstract

The University of Warsaw (UW) cooperates with over 1000 foreign entities, is involved in the work of Polish and international scientific networks and associations, and belongs to numerous international consortia. Being a leading research center both in Poland and throughout Eastern Europe, as well as the largest Polish university and one of the largest European universities in terms of the number of students, the UW aims to strengthen its position also on the international arena, including the increasing cooperation with strategic foreign partners. The UW sees the greatest potential for wide-ranging cooperation in university networks. Apart of enjoying the membership in the Association of Southeast Asian Institutions of Higher Learning (ASAIHL), the UW is a member of the 4EU + Alliance, the CENTRAL Network, the European Network of Higher Education Institutions (ENIHEI) and the Eastern Partnership University Cluster (EPUC). While all these networks link European universities and focus on the éducational and research tasks they carry out, they have different natures and objectives. The aim of the speech is to characterize these consortia and present their origins and missions.

### A Comprehensive Overview On 5G As the Newest Innovation in Cellular Network Technology

Allyson Kaye L. Plaza Faculty, College of Education, The University of Manila, 1008, Philippines allyplaza97@gmail.com

#### Abstract

In 2019, 5G or fifth generation technology began its first commercial release in South Korea, promising a great boost in internet speed, capacity, low latency, and quality. Since then, multiple countries have followed suit and distributed their own 5G connectivity. However, despite its continuous growth in popularity, much of it is still relatively unknown to the public. This paper features a comprehensive overview on 5G; its history, notable features, possible technological advancements, and the common misconception on its "health risks". This paper analyzed over 100 varied sources and references to depict the most accurate and timely information regarding the newest innovation in cellular network technology.

**Keywords:** 5G, fifth generation technology, history, notable features, health risks

#### Inter-Universities Collaboration: Building, Strengthening, and Empowering Collaboration in Cultural Diversities

Tofan Agung Eka Prasetya <sup>a,b</sup>\* <sup>a</sup> Airlangga Global Engagement, Universitas Airlangga, Indonesia <sup>b</sup> Health Department, Faculty of Vocational Studies, Universitas Airlangga, Indonesia

#### Abstract

Collaboration is essential for development and growth, as it demonstrates the organization's capacities and resources to create a better educational system. The purpose of this paper is to provide an overview of the role of international collaboration in advancing higher education in universities in the midst of cultural diversity. Building collaboration is the beginning, which is the most challenging step because we must infiltrate the barrier of cultural diversity. Strengthening the collaboration network that we already have is the primary channel to improve the quality of higher education at universities. Empowering our network will be a strategic step where there can be a process of giving and receiving for the continuity of education, research, and community development. Cultural diversity is a definite challenge as well as an opportunity for scholars to develop themselves and improve the quality of education, since in building a culture of Inter--Universities Collaboration, it is necessary to exceed the cultural boundaries and close the gap between them without eliminating the nuances of diversity.

Keywords: Collaboration, higher education, inter-universities

#### Strengthening the Global Academic Community to Foster Inter- and Multidisciplinary Research Innovation And Community Development Among HEIs

Ni Nyoman Tri Puspaningsih Vice Rector for Research, Innovation, and Community Development Universitas Airlangga

#### Abstract

It has been more than two years since COVID-19 has affected and continued to disrupt the world of work. The wellbeing of the global citizens remains to be threatened, especially with regards to health impacts of the pandemic leading to massive damage to our lives. In the beginning, the pandemic might have been seen only as a health problem. However, we eventually arrive to a place where - unfortunately - the consequences of the pandemic tend to be inequitably distributed across all sectors of life, including social, economic, and political areas. Not finished with Covid19 pandemic, we were surprised by the re-emerging of mouth and hoof disease in cows which also caused by a virus. Despite this unprecedented situation, it has been wonderful to observe that many of us, including academia, researchers, and expert practitioners, are joining hands; fostering collaboration through inter- and multidisciplinary research and community services to eventually find applicable solutions for local, national, and international issues arising from the pandemic. I believe our collaborations would ease us in identifying and addressing issues accurately that are essential in designing inclusive recovery strategies to support the needs of the society. And furthermore, this would result in the blossoming of societal cohesion and resilience – what we would like to achieve as a society. Through this ASAIHL conference, academics from higher education institutions will have the opportunity to transfer knowledge and skills to solve global community problems. This is in accordance with the principles of Universitas Airlangga as a SMART University, especially the "meaningful research and community service/development" aspect, where our current research and activity could be implemented for the development of the community.

**Keywords:** Global academic community, SMART University, HEIs, Covid 19 pandemic

# Cooperation of the University of Warsaw with the Countries of Southeast Asia

Anna Sadecka Karolina Trybowska-Greń International Relations Office University of Warsaw, Poland

#### Abstract

The purpose of this presentation is to discuss the main aspects of academic cooperation between the University of Warsaw and higher education institutions in Southeast Asia, including the most recent developments.

First, the presenters will provide an overview of the University of Warsaw activities on the international scene, participation in networks, excellence initiatives, academic mobility, while indicating the role of academic ties with institutions in the Southeast Asian region. Then, the focus will be on the academic cooperation with Southeast Asia, which embraces, among others, bilateral agreements, Erasmus+ programme, previously: Erasmus Mundus programme, governmental initiatives, networks. Recent initiatives include participation in the Indonesian International Student Mobility Awards Programme, financed by the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia and mobility scheme within Erasmus+ KA171 Programme (international credit mobility).

Finally, during the summary and conclusions part, the participants will be able to ask questions, share their comments and suggestions regarding possible future initiatives, as well as discuss main issues concerning international academic cooperation in the region.

#### Brain Friendly Medical Education? A Neglected Bridge Not a Bridge Too Far

Hermanto Trijoewono Medical Education, Research and Staff Development Unit, Faculty of Medicine Universitas Airlangga Surabaya, Indonesia

#### Abstract

Findings in neurobiology of learning open new opportunity to have more effective learning and teaching in medical education – the one who famed for its rigid curriculum. This brain friendly learning findings include but are not limited to a. Caine & Caine: every brain is unique caused by its genetic and environment/ experience b. active participation in every aspects of learning and teaching results in better achievement c. Gardner finding on Multiple intelligences d. Goleman emotional intelligences d. visualization in sports medicine e. protégé effect d. Feynman technique in learning by teaching e. the effect of smile, positive feedback and reflective observation f. Marion Diamond – Enriching environment.

Application of these findings are a. participants centred approach: learning method that nurturing active participation, consider participants as subject of the learning and teaching process and the ones who construct the KAP b. One method does not fit for all – one curriculum, one credit, one duration and one method should be changed to more adaptive personalized curriculum c. various learning strategies / methods should be apllied and replace the lecture based curriculum d. learning climate should be fun less stressful in order to prevent fight or flight reaction and also foster the development of reflective competency e. in developing procedural / psychomotor skills, deconstruct every procedure into safest and efficient small steps and ask the participants to remember and visualize every step f. give positive specific and timely feedback g. learning by teaching – include by Feynman technique h. smile in every situation.

This brain friendly learning is not a bridge too far but more as a neglected bridge in medical education that should be started as soon as possible. This proposed learning method obviously fits for all higher education setting. If not us, who, if not now, when.

**Keywords:** Medical education, brain friendly learning, neglected, opportunity application in learning and teaching

#### Medical Treatment and Medical Device Innovation during the COVID-19 Pandemic: Contributions from King Mongkut's Institute of Technology Ladkrabang

Prof. Prasert Trivijitslip, M.D.<sup>1</sup>\*, Sranya Phaisawang, Ph.D.<sup>2</sup> and Prof. Anan Srikiatkhachorn, M.D.<sup>2</sup>

<sup>1</sup> King Mongkut's Chaokhunthahan Hospital, King Mongkut's Institute of Technology Ladkrabang, 10520, Thailand

<sup>2</sup> Faculty of Medicine, King Mongkut's Institute of Technology Ladkrabang, 10520, Thailand

\*Corresponding author. E-mail: prasert.tr@kmitl.ac.th

#### Abstract

With recurring disease and infections, the COVID-19 pandemic has caused significant health care and economic burden worldwide. Lack of vaccinations and unequal distribution of medical devices has created a gap in health infrastructure and health equity, especially in developing nations including Thailand. In Thailand alone, nearly 80% of medical devices (over USD2.8 billion annually) are imported from foreign countries including US, UK, Germany and China. This dependence on imported medical goods has led to the shortage of medical equipment and emergency devices, especially during the pandemic. In addition to best efforts from the Thai government, many other public entities have initiated contributions in medical knowledge to develop medical devices and offer vaccination assistance to the society. Through visionary leadership, Thailand's leading higher education institution, King Mongkut's Institute of Technology Ladkrabang (KMITL), has stepped to the forefront of health care solution providers during the pandemic with its many proactive initiatives to promote the development of locally-innovated and locally produced medical devices. In addition, the establishment of Thailand's most innovative research hospital specializing in domestic medical device development and elderly care innovations, King Mongkut's Chaokhunthahan Hospital (KMCH) under royal patronage of the Supreme Patriarch, will play an integral role in Thailand and the region's constantly evolving medical and health care ecosystem.

**Keywords:** Thailand, medical devices, health care innovation, COVID-19 management, tomorrow's hospital, medical device hub

#### 4eu+ Alliance: Towards Flexible Education Pathways

Anna Wojtyś, University of Warsaw 4eu+ Alliance, Flagship 2 Leader

#### Abstract

The role of universities in Europe is that of lighthouses of the European way of life. This assumes the promotion of fundamental European values such as diversity and democracy, which are at the root of modern culture. The European community needs to be aware of and appreciate the plurality of its roots and cooperate on the basis of the principles of tolerance, respect and equality. Thus, it is universities' responsibility to offer educational programmes based on in-depth and innovative research, which will equip future citizens with necessary skills and competences that will allow them to face and answer future challenges and thrive on the job market. In order to be successful, such programmes have to be prepared by experts in the respective fields and offer transversal skills (e.g. innovative mind-set, critical thinking, civic engagement, data literacy). But above all, students need to be trusted with the choice of the courses they consider most beneficial. All this prompted the decision to structure flexible learning pathways within Flagship 2. Composed of modules, which incorporate courses offered at all six universities grouped in 4eu+ Alliance, the educational pathways devoted to Multilingualism and European Citizenship are an ideal example of synergy through cooperation.

#### Continuity of Education in the Post-Pandemic Era: Implementation of the Smart Postman Concept in the Sri Lankan Educational System

Kaushalya Yatigammana<sup>1\*</sup>, Gamini Wijayarathna<sup>2</sup> <sup>1</sup> Department of Commerce & Financial Management, Faculty of Commerce & Management Studies, University of Kelaniya, Sri Lanka. <sup>2</sup>Department of Software Engineering, Faculty of Computing and Technology, University of Kelaniya, Sri Lanka.

\*Corresponding author: kaushalya@kln.ac.lk

#### Abstract

The Covid-19 pandemic challenged this traditional, wellestablished face-to-face teaching. As a result of the instructions by higher authorities to use an online mode of delivery in education, educators switched to face-to-screen mode using the curriculum and course materials designed for face-to-face teaching. Smartphones with pre-paid Internet connections have been the main method of connecting to the internet. Weak signal strengths and coverage holes are the main problems faced by this learning community. There are households with no smartphone, and children have to use their parents' smartphones, and/or siblings have to share a single device for education. Health issues have been reported due to the small screens of mobile devices. This widens the gap of the digital divide in Sri Lanka. However, University of Kelaniya, Sri Lanka has been aware of this situation and produced an easy-to-use content authoring and playing tool: NeLCon Studio, to support non-technical teachers to develop their content. University has also worked in Microlearning content and being worked continuously to support the students. As a result. University of Kelaniya has proposed a new hybrid delivery mechanism of pre-recorded microlessons: the Smart Postman project. In this method, teachers' microlessons will be sent to the students using Internet connections where it is available and using Bluetooth transfer of lessons by the postmen using smartphones in the absence of the internet. It has been tested and found to be a success. A quality assurance quideline also developed to assure the quality of the digital contents.

Keywords: Blended learning, microlearning, postman, education



# ASAIHL CONFERENCE 2022,

# WARSAW, POLAND

PAPERS

#### Extensive Joint Collaborations with International Universities for Development of Industrial-Oriented Engineering Education Model and Best Practice in Thailand

Tawiwan Kangsadan<sup>1</sup>\*, Chayakorn Netramai<sup>2</sup>, Boonchai Sangpetngam<sup>3</sup>, Alexander Brezing<sup>4</sup>, and Nisai Fuengwarodsakul<sup>5</sup>

<sup>1</sup>Chemical and Process Engineering Program, The Sirindhorn International Thai-German Graduate School of Engineering, King Mongkut's University of Technology North Bangkok, 10800, Thailand <sup>2</sup>Software Systems Engineering Program and Railway Vehicles and Infrastructure Engineering Joint Program, The Sirindhorn International Thai-German Graduate School of Engineering, King Mongkut's University of Technology North Bangkok, 10800, Thailand

<sup>3</sup>Department of Civil Engineering and Railway Vehicles and Infrastructure Engineering Joint Program, Faculty of Engineering, Chulalongkorn University, 10330, Thailand

<sup>4</sup>Mechanical Engineering Simulation and Design Program, The Sirindhorn International Thai-German Graduate School of Engineering, King Mongkut's University of Technology North Bangkok ,10800, Thailand and RWTH Aachen University, 52062, Germany

<sup>5</sup>Electrical Power and Energy Engineering Program, The Sirindhorn International Thai-German Graduate School of Engineering, King Mongkut's University of Technology North Bangkok, 10800, Thailand \*Corresponding author E-mail: tawiwan.k@tggs.kmutnb.ac.th

#### Introduction

Thailand is in the transition from the 12th National Economic and Social Development (NESD) Plan (2017-2021) to the 13th NESD Plan (2023-2027). With the 12th NESD Plan, Thailand launched the concept of "Thailand 4.0" to extensively transformed the country with the main emphasizes on the economic, social, and environmental development issues, especially on the Science, Technology and Innovation to overcome the "middle income trap" in conjunction with the "New Economies" which is consistent with the 20-Year National Strategy (2016-2036) (ONESDBOPM, 2017). Thailand 4.0 has focused on technological development and innovation within 10 key industrial sectors and aims to expand the business and markets to other ASEAN countries. Due to the COVID-19 pandemic, targets were missed and not applicable for the emerging situation. As announced in the 13th NESD Plan, the country will extend the focus to the "Hi-value and Sustainable Thailand" and "Digital Economy" and prepare the country for any global concerns and issues. With the increasing demand and rapid changes in the new digital world, the production of its goods must be restructure and done within the country. Therefore, the research and development will be emphasized along with the development of human resources. Issues on engineer readiness to work within and outside Thailand are also concerned (Kraisuth and Panjakajornsa, 2018). The funding and recruitment of 12,290 postdoctoral researchers (domestic and foreign) are in need including a critical shortage of "skilled knowledge workers" and "engineering experts." To facilitate this development, Thailand reorganized the higher education universities, national research institutes and national funding agencies to the Ministry of Higher Education, Science, Research and Innovation (MHESI) in 2019 with missions to reform the higher education and build the human resource for the 21st century in order to lead the country with the knowledge and innovation for the sustainable development. The improvement of the quality of Thai institutions and internationalization of Thailand's research-intensive universities can be accomplished by increasing number of academic partnerships i.e., joint degrees (one degree jointly issued by two institutes), double/dual dearees (offered two degrees from both institutes) and Master and PhD arrangements as well as international collaborations in the engineering postgraduate study program with top universities in foreign countries. These could boost to institutional rankings through joint publications and researcher mobility as well as the research collaboration in areas including energy, environment, agricultural biotechnology, medicine, materials science, applied mathematics, nanotechnology and especially information and communications technology (ICT), besides in the area of business, services, and tourism. Consequently, students enrolled in the engineering program would be increased along with the increasing in student and researcher mobility and opportunities for internships.

With this report, international collaborations in the engineering education are the main focus and collected based on the best practice engineering education models, especially from Germany. Since 1959 "German Engineering Education Model" has been implemented at King Mongkut's University of Technology North Bangkok (KMUTNB) with the support from German Government, also at Thai-German Technical Institute Khon Kaen (TGTI) during 1970-1975. However, KMUTNB has a long history for the continuation of the implementation in vocational, dual, undergraduate, and graduate academic programs, particularly The Sirindhorn International Thai-German Graduate School of Engineering (TGGS).

#### Methodology

To determine the suitable engineering education model and the best practice in Thailand, the correlation between the engineering education, the world university ranking, and the country's world economy are briefly evaluated along with the mobility of postgraduates in engineering. Then, the international collaborations in both undergraduate and graduate engineering study programs between Thai and foreign universities are explored and summarized. Since the world economy and the education have been affected by the COVID-19 pandemic, the statistics in this report were analyzed up to 2019.

#### Results

#### Engineering Education and Economic Development

The correlation between a country's engineering capacity as observed in Engineering Index (EI) (Cebr, 2016), Economy Complexity Index (ECI)

(Hausmann et al., 2019), Knowledge Economy Index (KEI) (EBRD, 2019), Global Competitiveness Index (GCI) (Schwab, 2019), and Global Innovation Index (GII) (Dutta et al., 2019) and its economic development (Gross Domestic Product (GDP) per capita) are shown in Fig. 1. Remarkably, top 20 countries in world and regional economy ranking of GDP Nominal (2019) are ranked high in these 5 indexes and also comprise of high--ranking universities in engineering and technology. Top 5 countries in the world economy are USA, China, Japan, Germany, and India (Statistics Times, 2019) where USA ranked 1st in the world and in the region with GDP Nominal of \$21,439.45 billion (24.8% share) and the growth rate of 2.35. In Europe, Germany is ranked 1st with GDP Nominal of 4.46% share and the low growth rate of 0.54. China is ranked 1st in Asia with GDP Nominal of 16.3% share and the high growth rate of 6.14, followed by Japan with 5.95% share and the low growth rate of 0.89. While Thailand is ranked 23rd in the world and 8th in Asia with GDP Nominal of \$586.1 billion (0.677% share) and the growth rate of 2.04. This confirms that the engineering is driven the country economy and development. Interestingly, certain countries are not in the world economy ranking, however, they are listed in the top ranking of GII as well as KEI. Furthermore, those countries are emphasized on the importance of education and human resource development by allocating approximately 10-20% of the total expenditure on the education and 20-35% of that on the higher education (THE, 2019).



Figure 1. KEI, EI, GII, GCI and ECI of countries in the world and regional economy.

Germany, Switzerland, and Sweden have all 5 indexes ranked in the top 10, however, Germany and Sweden are not ranked in the top 10 universities according to THE (2022), unlike universities in USA, UK, and Switzerland. Sweden, Denmark, and the Netherlands as the top 3 countries in El have high employment in engineering, the highest average engineering wages, and high-quality infrastructure. Top 100 universities are also in Singapore, China, Netherlands, Germany, Canada, Hong Kong, South Korea, Japan, Australia, Belgium, Taiwan, Sweden, Denmark, France, and Italy (THE, 2022) in which these countries have strong engineering education model and practice as shown in the score of industry income and the employment. Majority of top ranked universities in these countries have the industry income score in the range of 80-100 and with top ranked of the employability. Hence, the engineering strength in the country could be achieved through boosting the number of engineering graduates, raising employment in engineering fields, and improving the guality of infrastructure.

The outbreak of the COVID-19 pandemic has leaded us to the alobal health crisis and the world economy recession. On the road of recovery and the transformation towards new economic systems, Scandinavia countries are the readiest to transform according to the economic transformation readiness performance score as shown in Table 1 (Schwab and Zahidi, 2020). However, talent shortages have become more pronounced due to the outdated education systems and there are limits to international mobility. During 2016-2020, the downward trends in adequacy of skill sets of university graduates have been seen in India, South Africa, UK, Germany, Brazil and USA, while others such as Saudi Arabia, China, Korea, Turkey, Australia and Argentina have been improved. The difficulties in searching for engineers with needed skills to fill vacancies in enterprises are remained, especially with the digital skills and other skills of the new economy as technology disrupts labor markets. The World Economic Forum's Future of Jobs Report 2020 has projected that technological change is set to displace a range of skills in the labor market while driving greater demand for a new set of core skills (emerging skills) such as analytical thinking and innovation; active learning and learning strategies; complex problem solving; critical thinking and analysis; creativity, originality and initiative; leadership and social influence; technology use, monitoring and control; technology design and programming; resilience, stress tolerance and flexibility; reasoning, problem-solving and ideation; emotional intelligence; troubleshooting and user experience; service orientation; systems analysis and evaluation; and persuasion and negotiation.

Table 1. Country economic transformation readiness performance score in specific categories related to the education and engineering.

Category	Top 3 countries
1. Upgrade infrastructure to accelerate the energy transition to the green economy, upgrade transport networks, expand digital networks, and broaden access to electricity and ICT.	1. Estonia 2. Denmark 3. Netherlands
2. Update reskilling, upskilling and education curricula and expand invest- ment in the skills (such as digital skills and critical thinking skills, ongoing learning and skilling) needed for jobs in markets of tomorrow.	1. Finland 2. Netherlands 3. Denmark
3. Expand eldercare, childcare and healthcare infrastructure and innova- tion for the benefit of people and the economy.	1. Sweden 2. Denmark 3. Canada

4. Rethink competition and anti-trust frameworks needed in the Fourth	1. US
Industrial Revolution, ensuring market access, both locally and internatio-	2. Canada
nally.	3. China
5. Facilitate the creation of "markets of tomorrow", especially in areas that require public-private collaboration (demand and investments in R&D towards the production of more sustainable and inclusive goods, services and technologies).	1. Finland 2. US 3. Japan

Source: Schwab, Klaus; Zahidi, Saadia. (2020) *The Global Competitiveness Report Special Edition 2020—How Countries are Performing on the Road to Recovery.* Cologne/Geneva: World Economic Forum.

With the impact of COVID-19 on companies' strategy in Thailand has accelerated the digitalization of work process, the automation of tasks, the implementation of upskilling/reskilling programs and the digitalization of upskilling/reskilling by 84.4%, 50%, 40.6% and 34.4%, respectively (World Economic Forum, 2020). Similar figures have been observed in Germany, while approximately 8-10% more in those strategies observing in USA, UK, Australia, Japan, and China. In the ASEAN countries, all companies in Singapore and Malaysia have accelerated the digitalization of work process, while 91.7% of companies in Indonesia provide more opportunities to work remotely. Companies with the implementation of upskilling/reskilling in Singapore, Malaysia and Indonesia are 68.2%, 33.3% and 41.7%, respectively, while the digitalization of upskilling/ reskilling are 59.1%, 58.3%, and 75%, respectively. However, workers have been temporarily reassigned to different tasks as much as 33.3% in Malavsia and 50% in Singapore. Temporarily reduction of workforce has been adopted in Indonesia for 41.7%. Upskilling/reskilling of workforce is necessary and typically done with the internal learning and development. The private training providers share approximately 15-20% with the increasing of external online training of 20-25%. Still, the public educational institutions hold less than 10% for the upskilling/reskilling.

#### Postgraduate studies in Engineering Education

Postgraduate studies are the heart of the innovation and invention and the key to economic growth corresponding to the number of Ph.D. graduates in natural sciences and engineering programs, however, it should be considered in conjunction with the quality of education. USA has 71,000 Ph.D. graduates in 2017 in all degrees, followed by China (56,500), India (28,800), Germany (28,400), UK (28,100), Russia (27,300), Brazil (21,600) and Spain (20,000) (OECD, 2019). These countries have the enrollment rate in higher education of more than 60%, except India with 30%. With high enrollment rate in higher education, there is a potential that students would pursue postgraduate degrees. Among those Ph.D. graduates, more than 30% are graduated in natural sciences and engineering, especially in countries with El higher than 70% such as Switzerland, Netherlands, Germany, Japan, Australia, Sweden, and Denmark. In 2020, 1.45 million Thai students were enrolled at the bachelor's level, while only 6.73% and 1.83% pursued in the master and the doctoral studies, respectively (DGA, 2020). Thus, the country with high educated workforce would have high number of natural science and engineering graduates.

Since the graduate studies are important, most bachelor graduates from 23 countries, especially from China, India, Indonesia, Iran, Malaysia, Pakistan, Vietnam, and Thailand, pursued graduate studies in USA, UK, Germany, Australia, Japan, and Canada. Notice that these target countries have EI above 50% with high score in research, engineering employment and wages and salaries as illustrated in Fig. 2. These countries are top target-countries for postgraduate students' mobility in 2012 with forecasted highest growth in 2024 based on the tertiary-aged population growth (25-34 years old) (British Council Report, 2014). However, the recent demographic trends on tertiary-aged populations will drive the higher education market by directly affecting recruitment, enrollments and mobility as China and India, two biggest international education markets (OECD, 2015).





Engineering Index Indicators:

- (1) Research
- (2) Gender Balance
- (3) Engineering Employment
- (4) Wages and Salaries
- (5) Engineering Business
- (6) Human Capital
- (7) Infrastructure Quality
- (8) Digital Connectivity
- (9) Engineering Exports

Source: 1. THE World University Rankings for Best Universities for Engineering Degrees in 2022.

2. Engineering and economic growth: a global view—A report by Cebr for the Royal Academy of Engineering. September 2016.

Figure 2. Engineering Index for top 6 countries for postgraduate student's mobility compared to ASEAN + 6 Countries with the overall score and individual indicators.

Among the top universities (Fig. 3), RWTH Aachen University (RWTH) in Aachen, Germany has scored with 100 in the industry income category and more than 90 in the research category since 2016 (THE, 2022). RWTH is the largest university of technology in Germany and one of the most renowned in Europe with extremely strong ties with industry in which attracts exceptional levels of external funding to its researchers. Aachen is the dominant city for university spin-off companies and offices of engineering firms. The world's first wind tunnel and particle accelerator were both developed at RWTH. Major innovations created onsite include a pioneering aircraft made entirely of metal and a diesel soot filter. RWTH focuses on the interdisciplinary research, along with diversity, internationalization, and natural sciences as the university's strategy plan for 2020 and being carried out at the university research park. As of 2021, RWTH has 260 institutes in 9 faculties, 22 Collaborative Research Centers and Transregios, and 39 Research Training Programs including 15 DFG Research Training Groups. With strong staff consisting of 553 Professors, 6,240 Other academic staff, 2,961 Non-faculty staff, and 496 Trainees. RWTH has 3 Clusters of Excellence as part of "Excellence Strategy» Competition of the German Federal and State Governments: (1) The Fuel Science Center – FSC; (2) Internet of Production – IoP; (3) Matter and Light for Quantum Computing – ML4Q. ML4Q is a joint project between the University of Cologne (coordinating university), RWTH, the University of Bonn, and Forschungszentrum Jülich. In addition, RWTH has one Excellence University RWTH on «The Integrated Interdisciplinary University of Science and Technology - Knowledge, Impact, Networks.» In the academic year of 2021, RWTH offers 170 high quality courses in engineering, natural sciences, humanities, society and economics, and medicine including 16 private courses of study. Total enrolled students have been increased by 4% from 2019, prior the COVID-19 pandemic, to 47,269 of which 56% are in the engineering discipline and 28% are international students. In the engineering discipline, the distributions of students in the bachelor, master and doctoral studies are 15,706 (33%), 8,605 (18%), and 1,636 (3.5%), respectively. As a result of RWTH strategy plan for 2020, number of international students have been increased by 18% from 2019 and they are from 138 countries. Remarkably, 9,003 international students are studied in the engineering discipline. Though, number of graduates remains relatively the same with 7,344 (16%) in 2021. RWTH earns €1,108 million in total annual budget, including €422 million from external funding which is approximately 38%.





Overall and scores in 5 categories: (1) Citations, (2) Industry Income, (3) International Outlook, (4) Research, and (5) Teaching.

Figure 3. THE World Ranking in Engineering Degree for the top universities in UK, USA, Germany, China, South Korea, and Japan (THE, 2022).



Overall and scores in 5 categories: (1) Citations, (2) Industry Income, (3) International Outlook, (4) Research, and (5) Teaching.

As the leader in Asia economy, China has universities in the top 100 universities in engineering which Zhejiang University earns score of 100 for the industry income (THE, 2022). Korea Advanced Institute of Science and Technology (KAIST) and National Cheng Kung University in Taiwan also earn score of 100 for the industry income (THE, 2022). China, Korea and Taiwan perform relatively well in all categories, except in the international outlook. Singapore with only two universities in engineering and technology, National University of Singapore ranked 10th and Nanyang Technological University ranked 15th in 2022, have the scores ranging from 85 to 95 in most categories (THE, 2022) due to a strong STEM. Ranking of universities in Malaysia and Thailand could be improved in all categories. Malaysian universities are strong in the international outlook followed by the number of citations and the industry income. This is the outcome from the education reform in 2007 and significant boost in funding from the government. While universities in Indonesia and Thailand are only strong in the industry income category. Surprisingly, two universities in Vietnam, Duy Tan University and Ton Duc Thang University are ranked higher than universities in Thailand and some universities in Malaysia with score of 100 for number of citations (THE, 2022) and high-level in the international outlook. Duy Tan University focuses on "the education and research of various sciences and technologies" and expands the partnerships with well-known international universities such as Purdue University in the USA in the past three years and another in the last year with Coventry University in the UK. Ton Duc Thang University is also focused on high quality research, training, and internationalization, as well as many interdisciplinary research opportunities.

#### **Engineering Education Model and Best Practice in Thailand**

Numerous collaborations have been established in Thai universities for academic and research with opportunities for students to conduct the internship and/or research at the partner university, but the degree is still awarded by Thai university. With the understanding and acknowledgement in the course structure, teaching strategy and standards in both universities as well as regulations in both countries, the collaboration would lead to the joint and double/dual degrees. This report presents the well-developed undergraduate and graduate study programs in engineering leading to double/dual and joint degrees and the establishment of departments, faculties, and even universities.

A cooperation agreement among Japan Federation of Economic Organizations (Nippon Keidanren), the Federation of Thai Industries (FTI), and Thammasat University (TU) was reached in 1992 and established The **Sirindhorn International Institute of Technology (SIIT)** in 1994. SIIT (2022) offers undergraduate and graduate programs (master and doctoral levels) from five schools: Bio-Chemical Engineering and Technology; Civil Engineering and Technology; Information, Computer, and Communication Technology; Management Technology; and Manufacturing Systems and Mechanical Engineering. The program structure in all three levels is similar to other existing engineering programs. Foreign exchange and extended training are options for the last semester. SIIT is also collaborated with Japan Advanced Institute of Science and Technology (JAIST) together with National Electronics and Computer Technology Center (NECTEC) and Asian Institute of Technology (AIT) as co-founders in offering the doctoral dual degree program in area of Service Science and launched in August 2019.

Tokyo Institute of Technology (Tokyo Tech) has been active in academic collaboration with Asian countries, and opened overseas offices in Bangkok, Manila, and Beijing, since 2002, 2005, and 2006, respectively. With the experience in the international distance education, a new graduate program allied with National Science and Technology Development Agency (NSTDA) and Thai universities called Thailand Advance Institute of Science and Technology (TAIST) - Tokyo Tech was established in 2007 and serves as a virtual institution and focal point (TAIST-Tokyo Tech, 2022). NSTDA provides researchers to act as adjunct professors, research projects and scholarships for graduate students as well as conducting research and education. Thai universities (namely King Mongkut's Institute of Technology Ladkrabang; KMITL, King Mongkut's University of Technology Thonburi; KMUTT, Kasetsart University; KU, and SIIT) provide an academic framework, academic staff to oversee and guide students and degrees for the successful candidates. Currently three master programs are running: Automotive Engineering, Information and Communication Technology for Embedded Systems, and Sustainable Energy and Resources Engineering. Also, Rail Transportation Certificate which is the joint program with Mahidol University (MU). Major courses are entirely taught from Tokyo Tech, and some others combine distance education. Research at TAIST-Tokyo Tech will base upon collaboration among Tokyo Tech, Thai universities and NSTDA and possible cooperation with various industries, mainly Japanese (Nishihara, 2010). Successful students will be awarded master's degrees from Thai university with the certificate signed jointly by representatives of Tokyo Tech and NSTDA.

According to Country Report: Thailand by QAA, UK-Thailand collaborative degree programs have been developed, mostly for the bachelor's degree (QAA, 2019). For example, the dual degree by KMITL and Glasgow University (Glas) in UK for B.Eng. in Biomedical Engineering in 2017 (BME-KMITL, 2019) and B.Eng. in Software Engineering (SE@ KMITL, 2022). Students will study the first 2 years at KMITL and the final 2 years at Glas. University of Warwick (Warw) in UK and Chulalongkorn University (CU) are collaborated in the part-time dual master's degree in engineering management for nearly 20 years (CUSE, 2022). The study duration is within 18-36 months with the modular approach. All modules offer practical teaching and learning by case studies, simulations, and even games. Tutors are industrial experts or senior managers from Warw. Prominent guest speakers share localized experiences with students. Whereas MU offers M.Sc. Double Degree in Computer Science with University College London (UCL) in UK (ICT-MU, 2019) comprising of two
models: the foundation of Computer Science module offered by MU's Faculty of Information and Communication Technology and a specialist in Computer Science module offered by UCL's Faculty of Engineering Science. A student of this program will study at both MU and UCL.

The collaborations between the universities and industries must be strengthen for the sustainable development in the country. With a strong demand for gualified manpower to work in the fast-growing petrochemical and related industries, CU established The Petroleum and Petrochemical College (PPC) in 1988 to produce graduates of high international standards in the fields of petroleum and petrochemical technology and polymer science (PPC, 2022). Later in 1992, academic partnerships with three internationally recognized universities: Case Western Reserve University (CASE), the University of Michigan (MU), and the University of Oklahoma (OU) in USA were established and currently offers International Master and Doctor of Philosophy Degree Programs in two majors: Petrochemical Technology and Polymer Science. More than 1,800 masters and 200 PhD alumni graduated from PPC. Since the success of the first two programs, PPC launched a new international master's degree program in Petroleum Technology, in conjunction with the Institut Français du Pétrole (IFP) in France, MÚ and OU in USA in 2002. However, the degree is still awarded by CU.

Later in 1997, The Chemical Engineering Practice School (ChEPS) Program at KMUTT as the first and only Practice School in Chemical Engineering in Thailand was established the international master's degree in chemical engineering program in collaboration with the Massachusetts Institute of Technology (MIT), which has successfully operated the practice school concept in the USA since 1916 (ChEPS. 2022). ChEPS program emphasizes close ties and partnerships with industries, with funding and resources from Thai Oil Public Co., Ltd., PTT Global Chemical Public Co., Ltd., SCG Chemicals Co., Ltd., SCG Corporation, etc. This program aims to produce high quality professional chemical engineers with a strong command of English to serve the local chemical industry as well as any joint ventures. This leads to a unique curriculum consisting of two academic years and one summer. The program starts with the training in English and simulation in the summer, followed by one year of coursework on campus, one semester of individual research projects also on campus, and one semester in the second year on-site working in teams on technical projects. Problembased learning (PBL) in the form of industrial design problems is implemented in each course. Students work in teams using simulation tools to solve real-life engineering problems to prepare them for the real work at the industry in the second year. Students will experience to new ideas and broaden their horizons in regular seminars and plant trips. Currently, ChEPS has collaborations with several overseas universities such as University of Waterloo (UW) in Canada, National University of Singapore (NUS) in Singapore, and James Cook University (JCU) in Australia, in giving gualified students to conduct the research aboard.

In a recent development, foreign higher education institutions are allowed to open branch campuses in Thailand since 2017 with the intension to modernize the education system and reduce skills gaps in Thailand. To avoid direct competition with Thai universities suffering from declining enrollments, foreign institutions will only be able to operate in the country's "special economic zones" such as Eastern Economic Corridor (EEC) and are not allowed to offer programs that are currently taught at Thai universities. As a result, CMKL (Carnegie Mellon - KMITL) University was established in 2017 as a collaboration between Carnegie Mellon University (CMU) and KMITL (CMKL, 2022). CMKL provides cutting-edge engineering research and education in the areas of computer engineering and digital technologies in Southeast Asia. CMKL offers three graduate academic programs: M.S./Ph.D. in Artificial Intelligence and Computer Engineering, M.S./Ph.D. in Electrical and Computer Engineering, and M.S. in Technology and Creative Innovation. All courses are conducted in English by a combination of CMU and CMKL faculties. Students will start the coursework at CMU in USA and return to continue research work in Thailand. These programs also offer students a unique opportunity to collaborate on research and education activities with major industry partners with local Thai companies with international business in Thailand and Southeast Asia. Graduates of the program will earn dual degrees from CMU, as well as CMKL.

In 2019, **KOSEN-KMITL** was established as KMITL is the first KOSEN (National Institute of Technology, Japan) in Thailand under the collaboration between both governments to produce KOSEN engineers for Japanese industries at EEC (KOSEN-KMITL, 2022). Two engineering study programs (5-year program) are Mechatronics Engineering to earn Associate Degree in Engineering. Associate Degrees in Computer Engineering and Electrical and Electronic Engineering are in the future (in 2023). The bachelor's degree in production engineering is planned to launch in 2024. Languages are Thai, English and Japanese. Core courses are taught by Professors KOSEN. Students will have the opportunity to study at KOSEN, Japan in some semesters. **International Collaboration with Germany and "German Engineering Education"** 

Especially in the context of joint educational activities between German and Asian Universities it becomes clear that the "German Model" of Engineering education is different from the American model, which basically is the model that is followed in Asia. Engineering Education in Germany seems to have a good reputation as have Engineers who have been educated in Germany, although the international university rankings do not seem to reflect that German Universities that focus on Engineering seem as highly regarded or even better than the best universities in the USA and the UK as well as many other countries that closely follow the American model of university education.

The low positions of even the best German Engineering institutions are easily explained with the fact that the ranking systems are aligned with the American system. But a reason lies also in the nature of the engineering domain itself: Engineering primarily is "applied sciences" and not science. A good engineering education therefore qualifies to apply knowledge of science in industry (business) to realize technical systems, not to do research and share the results with a scientific community. The German system has been perfected to suit industry demands and therefore performs weaker in the scientific KPI (mostly publications) which decide academic rankings. For example, the practice of requiring a paper publication for graduating from a Master of Engineering program is practically unheard of in German Engineering programs.

Possibly there are three key factors that contribute to the difference of German model of engineering education. One key factor is the substantial part of technical education that is separate of the German University system, which is vocational education. The "Berufsausbildung" (Wikipedia, 2018) is regulated by law which is enforced by the "Chamber of Industry and Commerce" and the "Chamber of Handcrafts" which look back on a history of hundreds of years. This training, which typically combines education in a company and in specific vocational schools allows the large share of 56%, for example in 2004 (BWP, 2012), of young people that does not feel comfortable with academic education to reach a professional certificate of apprenticeship within typically three years. This significant share of formally recognized professional education does not show in the statistics for university entry and graduation figures which are therefore lower in international comparison, although they have been increasing since the Bachelor/Master-system has been introduced. With regards to academic programs in engineering, the existence of this high-quality vocational education offer means that the university system does not need to compromise the educational standards. In other words, the gualification standards of graduates from German Engineering programs are high also because the qualification standard of the students entering such programs is high.

The second and probably most significant key factor for the specific character of German Engineering Education is the practice of appointing professors in engineering. Only candidates are eligible who have spent a substantial time in industry, typically in leading positions. A doctorate and habilitation or - in most cases - a publication track-record equivalent to a habilitation is also indispensable. Consequently, the salary of a professor must be high enough to compete with leading positions in industry, and professors are allowed to run a business on the side. The consequences for the standard and style in education are decisive: teaching and especially examination places highest importance on abilities to derive specific results from fundamental principles and pursue any project until the last step of realization. German engineers are therefore expected not only to show academic but also practical skills. These qualities of the educational culture do not show in the syllabi, and it is therefore difficult to prove that they exist (unless of course a systematic study would be undertaken to

compare examinations and graduate qualifications internationally).

The third factor which supports the specific character of German Engineering Education is the fact that it is practically free. Unlike most of the rest of the world, education is not considered to be profit-oriented business and therefore does not need to compromise content and quality to appear more attractive for students. Students in the German system also cannot expect as many services and convenience, and they cannot expect to graduate unless they develop a high degree of responsibility and independence to organize their lives and studies to succeed.

It is concluded that the German Engineering Education model is indeed different, and it is probably better suited to educate engineers to effectively serve industry. However, all key factors that result in these differences lie outside of the actual programs. It seems questionable if the "German Model" can be adapted to a system that follows the American educational concept or is otherwise constrained.

German Universities have been present in Asia through academic and research collaborations in the exchange program and the joint research. Greater cooperation in the engineering, science and technology is in the form of the establishment of another university campus such as Technical University of Munich Asia (TUM Asia) in Singapore in 2002 or the establishment of new university as demonstrated in German University of Technology in Oman (GUtech) in 2007 as the collaboration with RWTH Aachen University. While The Vietnamese-German University (VGU) in Vietnam was founded in 2008 under the form of a partnership between Vietnamese and German governments with the support of VGU-consortium (more than 30 universities in Germany including TU9—Association of the leading German Universities of Technology).

"King Mongkut's University of Technology North Bangkok" (KMUTNB) was established from the cooperation between Thai and German governments as the "North Bangkok Technical School" but generally called "Thai-German Technical School" in 1959 following the German Engineering Education model and later was upgraded and became an autonomous state university in 2007. KMUTNB extended its educational obligations to the rural areas in Prachinburi campus and Rayong campus located at the Eastern Seaboard Industrial Zone, Rayong. As "University of Creative Invention to Innovation" has 15 faculties. 2 graduate schools, 5 institutes and more than 10 research centers (KMUTNB Annual Report, 2021). With strong staff consisting of 1,149 academic staff (27 full professors, 173 associate professors and 523 assistant professors) and 947 other supporting academic staff, KMUTNB offers 3 vocational, 94 bachelors, 62 master and 35 doctoral academic programs in engineering, applied sciences, business, and architecture with 23 international programs to support the international exchange students from European countries such as Germany, France, Sweden, and Italy. Total enrolled students are 29,756 with 1,637 (5.5%) in master and 797 (2.7%) in doctoral programs in the academic year of 2021 and 6,223 graduates in the academic year of 2020. KMUTNB acquired 2,788.93 million THB in total annual budget in which 2,119.86 million THB from the government and 669.07 million THB (24%) with the external funding.

During 2018-2022, KMUTNB has been internationally recognized with many achievements. For example, IRAP ROBOT was the World Robocup Rescue 2018 Champion and received the best-in-class mobility and this was the 8th times world champions. TGGS Para Rubber Soil Cement Project has been implemented in Thailand with the support from the government. KNACKSAT was the first entirely Thai built satellite. Cube Sat with a dimension of 10x10x10 cm and successfully launched with Falcon 9 rocket into the orbit on December 3, 2018, by Spaceflight Industries. Three best academic programs awarded in research achievement by Thailand Research Fund in 2019. In 2022, KMUTNB is Top 10 best engineering universities in Thailand with the rank of 7th according to THE World University Rankings (2022). According to QS World University Rankings by Subject (2022), KMUTNB is ranked 3rd in Mechanical, Aeronautical and Manufacturing and 6th in Electrical and Electronic Engineering. KMUTNB has been ranked among the best global universities for engineering for the first time by U.S. News & World Report in 2022 with the 5th place in Thailand. This reflects the international recognition of the university's progress, advancement and quality in engineering education and research.

In January 2020, MHESI has launched the project to support Thailand's higher education institutions to be accredited by the Accreditation Board for Engineering and Technology (ABET) in which the Chemical Engineering Undergraduate Program, Faculty of Engineering, KMUTNB, was applied for the accreditation in August 2020 and unofficially accredited by ABET on October 5, 2021. (The chair of ABET's team and program evaluators unofficially informed and concluded that the Chemical Engineering Undergraduate Program, Faculty Engineering, KMUTNB, was accredited by the Engineering Accreditation Commission (EAC).) This is the first Chemical Engineering program in Thailand that has been accredited by ABET. The official accreditation will be bestowed in August 2022. The accreditation of this program will contribute to support the graduates in working with international companies or organizations around the world, as well as to increase the opportunity of the student in applying for the exchange or graduate programs abroad. Furthermore, the collaborations with the international universities in the academic (e.g., the joint and/or double/ dual degree) and in the joint research would be effortless and mutual.

Since the founding of KMUTNB, important collaborations with German government are TGGS and TGDE. Thai-German Dual Education and e-Learning Development Institute (TGDE) was established in 2012 to commemorate the 150th anniversary of Thai-German diplomacy and 53 years of academic collaboration between KMUTNB and Germany. TGDE offers the services in the implementation of information technology to the enhancement of e-learning, training activities and dissemination and transfer of appropriate technologies among students, technologists, higher education administration and personnel in Thailand and ASEAN countries.

Prior TGDE, The Sirindhorn International Thai-German Graduate School of Engineering (TGGS) was founded in 1996 by the bilateral collaboration between the Thai and the German governments, represented by KMUTNB and RWTH, respectively and became an autonomous faculty in 2005 (TGGS, 2022). The major goal of the establishment of TGGS is to develop an industry-oriented graduate educational institute in the South East Asia region based on the successful industry-oriented research and education according to German Engineering Education Model practicing at RWTH in Germany. In the first phase, both sides agreed to provide equal contributions. The Thai government invested in buildings and infrastructure, whereas the German government provided advanced laboratory hardware. DAAD: German Academic Exchange Service as the important partner in this project provides scholarships to qualify Thai and international students. Goethe Institut Thailand is also located at TGGS to provide the German language to TGGS and KMUTNB students and staffs as well as the nearby communities.

TGGS education philosophy is to educate professional engineers with orientation to industry's needs and environments, so that the graduates will be well trained and prepared for performing engineering tasks in advanced level, e.g., research and development, project management, planning of technical policy. The master's degree curriculum establishes firm links and relevance to industry by difference mechanism, such as project-based industry internship for at least 18 weeks at the industry, master thesis with relevance to industry research projects for 6 months, which provide opportunities for students to gain experiences in industry working environments within 2 years of the study program. In addition to the advanced engineering knowledges given by various taught courses, the curriculum also emphasizes the development of social skills for multicultural environment and professional abilities which are important requirements for the graduates' career in industry. While the doctoral study program curriculum is the research-based curriculum with 3-year study plan. To strengthen the collaboration and support the research and development with the industry, the external master and doctoral study programs with the research-based only are established in which the industry's engineers and researchers from the partner industry can enrolled and work on the most urgent and/or future industrial projects. TGGS offers international master and doctoral programs taught in English in different engineering disciplines: Chemical and Process Engineering (CPE), Materials and Production Engineering (MPE), Mechanical and Automotive Engineering (MAE) with the minors in Mechanical Engineering Simulation and Design (MESD) and Automotive Safety and Assessment Engineering (ASAE), Electrical and Computer Engineering (ECE) with the minors in Communication and Smart System Engineering (CSÉ), Electrical Power and Energy Engineering (EPE), Computer Engineering (COM), and Smart Grids Engineering (SGE).

As the important mechanism in the success of TGGS, TGGS Advisory Board serves as the channel for the stakeholders to supervise the operation of TGGS in accordance with its missions. The meeting is held annually in September with the agenda to report the performance and discuss on industry collaboration in teaching and research, visions, and administration policy. The board members are representatives from industries and governmental organizations: Siemens Limited Thailand, Covestro (Thailand) Co., Ltd., BASF (Thai) Co., Ltd., BMW Manufacturing (Thailand) Co., Ltd., B.Grimm Power Public Co., Ltd., Robert Bosch Limited, Thailand, TÜV Rheinland Thailand Ltd, Schaeffler Manufacturing (Thailand) Co., Ltd., PTT Public Co. Ltd., Bangchak Corporation Public Co., Ltd., SCG Chemical Co. Ltd., Energy Absolute Public Co., Ltd., Federation of Thai Industries and German-Thai Chamber of Commerce, German Embassy to Thailand, Ministry of Foreign Affairs, DAAD, Goethe Institute and 3 Electricity Authorities.

Today, TGGS has been widely recognized by the success of the industry-oriented education concept indicated by the high quality of the TGGS graduates and many achievements of TGGS in research performances. Dual Degree in Electrical and Computer Engineering (ECE) Master Program with Faculty 6 (Faculty of Electrical Engineering and Information Technology, FB6), RWTH Aachen University (RWTH) was first offered in 2018. Since the establishment of TGGS, RWTH has maintained the strong academic collaborations in the forms of exchange students, block lectures, co-supervisions of master and doctoral thesis and co-research projects until now. All mentioned exchange activities have been carried out in both directions. In each year, 5-10 Professors from RWTH travel to TGGS in Bangkok to give one-week block lectures for students. For special topics which are in the public interest, a oneday seminar will be organized to give the opportunity for the public to learn the updated advancement from the RWTH's professors. TGGS's lecturers could be also invited to teach a small course at RWTH of which content is not already offered. For student exchange, TGGS annually sends at least 13-15 exchange students to RWTH for conducting industrial internship and Master theses, which are cosupervised by both TGGS and RWTH's academic staff. This mechanism automatically leads to the co-research between both institutes.

Through these mentioned exchange mechanisms, the quality of teaching and research at TGGS has been developed to reach the equivalent level of RWTH's standard. As a milestone of TGGS's achievement, the Faculty of Electrical Engineering (Fachbereich Elektrotechnik FB6) of RWTH has officially recognized the quality of TGGS's study program by signing a Double Degree Agreement for Master Program in Electrical and Computer Engineering (ECE) (formerly Electrical and Software System Engineering; ESSE) with TGGS. By this double degree agreement, the students from both RWTH and TGGS have an opportunity to obtain two master's degrees by delivering more required academic performance at the partner institute, e.g., coursework, internship, or master thesis, in

addition to the regular requirements of the home institute. This double degree program has been approved and started in 2018. Currently, there are already students from both RWTH and TGGS enrolled in the double degree program. The first student in the Double Degree program already graduated in 2021. Moreover, TGGS-ECE program won nationwide 1st Place in Research Achievement assessed by Thai Research Fund Ranking in 2019.

Joint Master of Engineering Degree in Railway Vehicles and Infrastructure Engineering (RVIE) with CU and KMUTNB launched in January of 2020 with two minors in Railway Vehicles Engineering (RVE) and Railway Infrastructure Engineering (RIÉ). RVIE is a 3-year program, awarding a M.Eng. Degree jointly issued by KMUTNB and CU. Students will study the first year in Bangkok, at TGGS and CU, and the second year at Institute of Rail Vehicles and Transport Systems, RWTH. As for the third year, students have the possibility to do their industrial internship and the master thesis in either location. Importantly, RVIE was developed in the context of the German-Thai Railway Partnership (GTRP), a working aroup under the Thai Ministry of Transport and the German Embassy that realizes the motivation of the Joint Declaration of Intent (JDI) signed in November 2016 between the Ministry of Transport Thailand and the Federal Ministry of Transport and Digital Infrastructure Germany. The purpose of JDI is to develop and strengthen the cooperation in the field of railways in Thailand and its scopes include: (1) to cooperate and exchange for the development of the railway system in following areas: intensification of rail industry, operators and authorities by sharing best practice and experiences, exchange and training, organize seminars and workshops, and pay attention to projects in the area of rail transport, and (2) to support the railway industry of Thailand and Germany by joint consultations and deliberation, as well as supporting measures for the promotion of a fast and efficient modernization of the railway system in Thailand.

To accomplish its purpose efficiently, GTRP is grouped into three sub-working groups which are (1) Research and Development, (2) Railway Operation, and (3) Industry cooperation and Public Tenders. While the second and the third sub-working groups focus on strengthen the competencyoflocal operators and the establishment of local industries, the first sub-working group main focuses are knowledge transfer and human resource development. In this aspect, GTRP has already successfully organized 7 GTRP workshops over the past 4 years where experts from industries, government organization and universities in Thailand and Germany are invited to give talks. Since the first workshop in October 2018 until the latest one in March 2022, approximately 700 participants from the universities, government organization, companies and those who are interested in railway systems in Thailand joined the workshop.

In September 2021, GTRP has successfully set up The German-Thai Railway Association (GTRA) for more formal and cohesive cooperation in which KMUTNB was elected to be the chairman. The association is a solid platform for current and

new-coming GTRP members to share their common interest and activities which should benefit the Thai railway community greatly. For the establishment of GTRA, KMUTNB (namely TGGS) and CU are also taking part as the founding members among other 25 partners such as the German Embassy to Thailand, The German-Thai Chamber of Commerce (GTCC), DAAD, RWTH, NSTDA, The State Railway of Thailand (SRT), Bangkok Expressway and Metro Public Company Limited (BEM), Bangkok Mass Transit System (BTS), Siemens Mobility Thailand, just to name a few.

#### Conclusion

For the sustainable development of Thailand, economy and education reforms have been launched to overcome the "middle-income-trap" and lead the country to the knowledge society for the well-being of Thai people. Higher education institutes are key factor in this development, especially in the STEM and engineering education. Engineering academic program must be redesigned based on the outcome-based education and the industry needs as well as the research on the future trends in the technology and innovation. The industrial internship in graduate studies as presented in the "industrial education and research" based on the German Engineering Education Model is one of mechanism to enhance the student's learning and develop the skills and competences. Due to the shortage in engineers around the world, engineering mobility is growing with the expectation of ready-to-work. It is essential to expose Thai students with the international engineering education and environment. So that they can be "Future Engineers" equipped with the multidisciplinary knowledge and skills, international experience, and culture diversity.

#### Acknowledgement

Authors would like to thank King Mongkut's University of Technology North Bangkok, Faculty of Engineering at Chulalongkorn University and RWTH Aachen University for the support.

#### References

BME-KMITL (2019) KMITL-Glasgrow University Dual Degree Program. [Online] Viewed 15 November 2019, http://www.bmekmitl.org/2017/11/13/kmitl-gla-sgow-dual-degree/

British Council. (2014) *Postgraduate student mobility trends to 2024*. British Council Education Intelligence.

BWP. (2012) Qualifikationsentwicklung und -forschung für die berufliche Bildung – EQF als Transparenzinstrument und Erfahrungen komparativer statistischer Bildungsforschung. In: bwp@. Berufs- und Wirtschaftspädagogik – online. Nr. 11, November 2006, ISSN 1618-8543, Tabelle 1 (bwpat.de [abgerufen am 8. März 2012]).

Cebr. (2016) Engineering and economic growth: a global view—A report by Cebr for the Royal Academy of Engineering. London: Royal Academy of Engineering. ChEPS (2022) Chemical Engineering Practice School. [Online] Viewed 1 May 2022, https://www.cheps-kmutt.com/

CMKL (2022) CMKL (Carnegie Mellon – KMITL) University. [Online] Viewed 1 May 2022, https://www.cmkl.ac.th CUSE (2022) Part-time Dual Master's Degree in Engineering Management from CU & WMG [Online] Viewed 1 May 2022, http://cuse2.eng.chula.ac.th/ Digital Government Development Agency (DGA) (2020) Statistics of enrolled students in all levels of education in Thailand for the academic year of 2020 reported by Ministry of Higher Education, Science, Research and Innovation. [Online] 25 May 2022, https://data.go.th/en/dataset/univ\_std\_11\_01 (in Thai) Dutta, Soumitra; Lanvin, Bruno and Wunsch-Vincent, Sacha (2019) *Global Innovation Index 2019: Creating Healthy Lives—The Future of Medical Innovation.* 12th Edition. Ithaca, Fontainebleau, and Geneva: Cornell University, INSEAD, and the World Intellectual Property Organization.

EBRD. (2019) Introducing the EBRD Knowledge Economy Index. London: European Bank for Reconstruction and Development.

Hausmann, Ricardo; Hidalgo, César A.; Bustos, Sebastián; Coscia, Michele; Chung, Sarah; Jimenez, Juan; Simoes, Alexander; and Yıldırım, Muhammed A. (2011) *The Atlas of Economic Complexity—Mapping Paths to Prosperity.* New Hampshire: Puritan Press.

ICT-MU (2019) Faculty of Information and Communication Technology at Mahidol University. [Online] Viewed 15 November 2019, https://www.ict.mahidol. ac.th/en/?page\_id=1028

KOSEN-KMITL (2022) KOSEN-KMITL. [Online] Viewed 1 May 2022, http://www. kosen.kmitl.ac.th/

Kraisuth, Duangporn and Panjakajornsak, Vinai. (2018) Thai AEC Engineer Readiness: A Confirmatory Factor Analysis. SAGE Open. January – March 2018: 1-16

Nishihara, Akinori. (2010) Tokyo Tech Graduate Program Allied with Thailand: TAIST (Thailand Advance Institute of Science of Technology) – Tokyo Tech. *IEEE EDUCON Education Engineering 2010 – The Future of Global Learning Engineering Education.* April 14-16, 2010. Madrid Spain., 1031-1038.

OECD (2015) Education Indicators in Focus. April 2015. Paris: OECD Publishing. OECD. (2016) Education in Thailand An OECD-UNESCO Perspective. *Reviews of National Policies for Education.* Paris: OECD Publishing.

OECD. (2016) *Science, Technology and Innovation Outlook 2016.* Paris: OECD Publishing.

OECD. (2019) *Education at a Glance 2019: OECD Indicators*. Paris: OECD Publishing.

ONESDBOPM. (2017) *The 12th National Economic and Social Development Plan* (2017-2021). Office of the National Economic and Social Development Board Office of the Prime Minister Bangkok, Thailand.

ONESDBOPM. (2021) *The 13th National Economic and Social Development Plan (2023-2027)*. Office of the National Economic and Social Development Board Office of the Prime Minister Bangkok, Thailand.

PPC (2022) The Petroleum and Petrochemical College. [Online] Viewed 1 May 2022, http://www.ppc.chula.ac.th/

QAA (2019) Country Report: Thailand. The Quality Assurance Agency for Higher Education UK 2019.

QS World University Rankings. (2022) *QS World University Rankings by Subject* 2022: *Mechanical, Aeronautical & Manufacturing*. [Online]. Viewed 25 May 2022

https://www.topuniversities.com/university-rankings/university-subject-rankings/2022/electrical-electronic-engineering

QS World University Rankings. (2022) QS World University Rankings by Subject 2022: Electrical and Electronic Engineering. [Online]. Viewed 25 May 2022, ht-tps://www.topuniversities.com/university-rankings/university-subject-rankings/2022/electrical-electronic-engineering

ŘWTH (2021) RWTH Aachen University Žahlenspiegel 2021 [Online] Viewed 25 May 2022, https://www.rwth-aachen.de/cms/root/Die-RWTH/Profil/~enw/Daten-Fakten/lidx/1/ (in German)

Schwab, Klaus. (2019) *The Global Competitiveness Report 2019*. Cologne/Geneva: World Economic Forum.

Schwab, Klaus; Zahidi, Saadia. (2020) *The Global Competitiveness Report Special Edition 2020—How Countries are Performing on the Road to Recovery.* Cologne/Geneva: World Economic Forum.

SE@KMITL (2022) KMITL-Glasgow Double-Degree Program in Software Engineering [Online] Viewed 1 May 2022, https://se.kmitl.ac.th/program/KMITL-Glasgow

SIIT (2022) The Sirindhorn International Institute of Technology. [Online] Viewed 1 May 2022, from https://www.siit.tu.ac.th/

Statistics Times. (2019) Projected GDP Ranking (2019-2024). [Online] Viewed 13 November 2019, http://statisticstimes.com/economy/projected-world-g-dp-ranking.php. (Source Data: International Monetary Fund World Economic Outlook (October - 2019))

TAIST-Tokyo Tech. (2022) Thailand Advance Institute of Science and Technology (TAIST) - Tokyo Tech. [Online] Viewed 1 May 2022, https://www.nstda.or.th/taist\_tokyo\_tech/

TGGS (2022) The Sirindhorn International Thai-German Graduate School of Engineering. [Online] Viewed 25 May 2022, https://tggs.kmutnb.ac.th/ THE World University Rankings. (2022) *Best Universities for Engineering Degrees in 2022* [Online]. Viewed 25 May 2022, https://www.timeshighereducation.com/

world-university-rankings/2022/subject-ranking/engineering#!/page/0/length/25/sort\_by/rank/sort\_order/asc/cols/stats.

Wikipedia free encyclopedia. (2018) *Berufsausbildung* [Online] Viewed 15 November 2019, https://de.wikipedia.org/wiki/Berufsausbildung. (in German) World Economic Forum. (2017) These countries have the most doctoral graduates. [Online] Viewed 15 November 2019, https://www.weforum.org/agenda/2017/02/countries-with-most-doctoral-graduates/.

World Economic Forum. (2020) The Future of Jobs Report 2020. October 2020 [Online] Viewed 1 May 2022, https://www.weforum.org/reports/the-future-ofjobs-report-2020/

# Semantic Explication of the Filipino Cultural Concept Utang na Loob: the NSM Approach

Angela E. Lorenzana, PhD Bicol University, Legazpi City, 4500, Philippines aelorenzana@bicol-u.edu.ph

#### Introduction

The question whether language was a guide to culture had long been asked before the cognitive revolution took place. Owing to its plasticity and arbitrariness, language was not regarded as a reliable cultural indicator. Today, however, ordinary languages are recognized as a valuable tool in various cross-disciplinary studies.

Edward Sapir (1949), said that "language is a symbolic guide to culture" and "vocabulary is a sensitive index of the culture of the people". He and his student, Benjamin Lee Whorf, developed the idea called the Sapir-Whorf hypothesis which claimed that "when two languages differ radically in their vocabularies and grammars, their speakers live in wholly different thought worlds." Wierzbicka (1997) claimed that meanings of words... reflect and pass on ways of living and ways of thinking characteristic of a given society (or speech community) and that they provide clues to the understanding of cultures." Wierzbicka (1992) added that "Languages are the best mirror of human cultures, and it is through the vocabulary of human languages that we can discover and identify the culture-specific conceptual configurations characteristic of different peoples of the world."

This claim finds support in Sapir (1949), who said that "Languages differ widely in the nature of their vocabularies. Distinctions which seem inevitable to us may be utterly ignored in languages which reflect an entirely different type of culture, while these in turn insist on distinctions which are all but unintelligible to us. Such differences of vocabulary go far beyond the names of cultural objects such as arrow point, coat of armor, or gunboat. They apply just as well to the mental world."

Key cultural concepts (also called key words or cultural concepts) are defined by Wierzbicka (1997) as the "words which are particularly important and revealing in a given culture." Key concepts reflect the core values of the culture and can easily be identified by their commonality, that is, their frequent use in the speech and written work of the people, their frequent use in one particular semantic domain such as in the domain of emotion or judgments or their frequent use in literary forms. A key word can then function as a conceptual focal point for an entire complex of values, attitudes and expectations of one particular culture.

Numerous studies have been undertaken to determine the terminologies, motivations, and expressions of this concept. One of the earlier works was done by Hollnsteiner (1979) who said that *utang na loob* is "the third among the threefold classification of reciprocity," the first and second types of which are contractual reciprocity and quasi-contractual reciprocity. The paper on gratitude (Naito & Washizu: 2015) showed

different perspectives specially 'indebtedness' by East Asians based on different hypotheses. Rungduin and co-authors (2015) examined two values (*utang na loob* and gratitude) in terms of how they are understood by Filipinos and how they are manifested in the hope of delineating meanings and establishing links between the two constructs. Hays (2015) described utang na loob as a debt cycle where obligation and responsibility are often viewed in terms of reciprocity (*utang na loob*), with denotations of debt (utang), and inner-self-free will (na-loob). Hays called it a cycle or a process since this can be transgeneration beginning with a meaningful gift and the continuous exchange goes on to the next generation. On a similar vein, Matienzo (2017) shows utang na loob more than a "system of obligation" but a lifetime decision which is greater than its usual connotation. De Castro (1998), on the other hand, refused to call the concept by this name and instead used the term "debt of good will" saying that "debts of gratitude are those that are incurred by people who receive help or favors from others. In recognizing a debt of gratitude, one also recognizes the good will manifested by the benefactor in providing assistance or granting a favor." Similarly, Reves (2015) translated utang na loob as "debt of will" described as "the natural response to kagandahang-loob (beauty of will)" the character of a person "who has an affective concern for others and the willingness to help them in times of need."

A cultural concept, therefore, can be given varying interpretations. There is a need for a common language that will guarantee an accurate representation of the given vocabulary.

#### Methodology

By using a common measure or tertium comparationis such as the Natural Semantic Metalanguage (NSM), one can correctly and meaningfully compare concepts in different languages. This metalanguage contains terms for identifying and referring to the elements of the object-language (words, sounds or letters, etc.) and, in addition, a certain number of special technical terms which can be used to describe the relation between these elements, how they may be combined to form phrases and sentences, and so on. In NSM, the terms for describing the concepts in the object language is the set of semantic primes, a small core of basic, universal meanings which are believed to be shared by all the languages of the world. Although NSM is considered a technical artificial language, it is called natural because it has been taken or carved out of natural language, in this case from any object language. Accordingly, NSM has as many versions as there are natural languages (Marini, 2016).

The latest version of the proposed semantic primes (Goddard & Wierzbicka, 2014) of the lexicon of this metalanguage includes the following elements:

Substantives:	I, YOU, SOMEONE, PEOPLE, SOMETHING~THING, BODY
Relational substantives:	KIND, PART
Determiners:	THIS, THE SAME, OTHER~ELSE
Quantifiers:	ONE, TWO, SOME, ALL, MUCH~MANY, LITTLE~FEW
Evaluators:	GOOD, BAD
Descriptors:	BIG, SMALL
Mental predicates:	THINK, KNOW, WANT, FEEL, SEE, HEAR
Speech:	SAY, WORDS, TRUE
Actions, events, movement:	DO, HAPPEN, MOVE
Location, existence, specification:	BE (SOMEWHERE),THERE IS, BE (SOMEONE/SOMETHING)
Possession	(SOMETHING) IS (SOMEONE'S)
Life and death:	LIVE, DIE
Time:	WHEN~TIME, NOW, BEFORE, AFTER, A LONG TIME, A SHORT TIME, FOR SOME TIME, MOMENT
Space:	WHERE~PLACE, HERE, ABOVE, BELOW, FAR, NEAR, SIDE, INSIDE, TOUCH
Logical concepts:	NOT, MAYBE, CAN, BECAUSE, IF
Intensifier, augmentor:	VERY, MORE
Similarity:	LIKE~AS~WAY

The native meaning of the concepts discussed in the study are couched in an objective representation through the use of the Natural Semantic Metalanguage (NSM) which makes possible the bias-free, culture-independent and non-ethnocentric description of the meaning of a cultural concept and its comparison with other related concepts in other languages. Through the use of explications and cultural scripts based on the NSM approach, complex meanings can be described in terms of simpler ones. This reductive paraphrase prevents circular and obscure definitions and does not employ technical terms, neologisms, logical symbols, or abbreviations – only plain words from ordinary natural language. The patterns of combinability and the grammar of these basic sentences are discussed in Universal Grammar: The Syntax of Universal Semantic Primitives (Wierzbicka, 1996).

Using a collection of a variety of published materials in the Filipino language, this study includes proverbs, sayings or quotations, excerpts from literary materials such as short stories, essays, plays, and novels. These data simulate and reveal the thought processes of the speakers. The personal knowledge of the researcher, being a speaker of the Filipino language, was also used as a source of analytical data. Hurford and Heasley (1983) said, "Doing semantics is largely a matter of conceptual analysis, exploring the nature of meaning in a careful and thoughtful way, using a wide range of examples, many of which we draw from our own knowledge." In this respect, intuition, introspection and personal knowledge count as independent evidence. Wierzbicka (1980) said "Semantic intuition, even of ordinary language-users, is an empirical reality, and the semantic study of natural language, therefore, an empirical science."

In writing the explication or definition of a certain concept which is the hypothesis about the meaning of a word, first, the range of a word's use is examined. This was done through the collection and analysis of linguistic samples containing the concepts. To gather these linguistic samples, research in the Philippines was conducted in the following places: Philippine National Library, Ateneo de Manila Library, De La Salle University Library, Albay Provincial Library, Ateneo de Naga University Library, Bicol University General Library, Bicol University College of Arts and Sciences Library, Bicol University College of Education Libraries and other private and public school libraries in the province of Albay. Related studies and literature were taken from libraries in Poland such as the Biblioteka Narodowa (National Library), Biblioteka Uniwersytetu Warszawskiego (Warsaw University Library) and Warsaw University Institute of English Library. Other sources which were received or gathered through personal contribution were marked (PI) to stand for personal information. The researcher provided the sense translation of the samples into English. In the translated text, the concepts retain their original Filipino form.

Finally, only after the range of the word's use had been determined was the writing of the explications and the discussion surrounding the term begun. The use of the semantic primes allows the formulation of a detailed statement (otherwise known as explication) of the elements that compose the meaning or definition of a complex word. A definition or explication, according to Wierzbicka (1992), is a "hypothesis about the meaning of a word arrived at by examining the range of a word's use, and it is verified by checking whether it can account for that range." Where there appeared inconsistencies, these areas were verified repeating the same process of data analysis using linguistic evidence. Revisions were then employed until the explications, making use of the exact semantic primes, had already adequately captured the range of the concept's meaning. The description of the key cultural concept is presented in a script-like structure which provides us with simplified models of what the world is like and how one reacts to it. Schemas represent knowledge developed from prior experiences. Using cultural scripts then allows us to represent and compare culture-specific concepts in understandable terms which are also empirically verifiable.

#### Results

Utang na loob is an ancient Filipino operating principle. An illustration of utang na loob is shown by a chieftain who gave away the largest pearl in Mindanao to a foreigner for having cured his daughter.

(1) The world's biggest pearl nearly the size of a tennis ball, was given by a Moro diver to the Panglina Pisi, a Muslim settlement in southern Palawan. An American by the name of Dowell Cobb ingratiated himself with the Filipino Muslim chief by attending to his seriously ill daughter and giving some clothing, food, medicine and bullets. For this he was given the "Pearl of Allah" by the grateful chieftain. (Andres, 1988)

Badua (1989) attributes the source of *utang na loob* to the Filipino's natural penchant for kindness.

(2) Napakagandang ugali ang kumilala ng utang na loob sa kapwa. Ang ugat ng kaugaliang ito ay likas na kabaitan ng mga Pilipino. Mayroon tayong tinatanaw na utang na loob sa sinumang nakatulong sa atin gaano man kaliit ang tulong na iyon. (Badua, 1989)

'It is a very beautiful trait to acknowledge *utang na loob* to someone. The root of this custom is the natural kindness of Filipinos. We look back with *utang na loob* to anyone who has helped us no matter how small that help is.'

Looking into the thought processes of a person with *utang na loob*, this explication is presented as:

X has utang na loob to Y

X thinks something like this

(a) Y did something very good for me

(b) Because of this, I think about Y

(c) I want to do very good things for Y for a long time

(d) I cannot not do this

(e) If do not do this, people may know and think something bad about me

(f) I do not want this

# (a) Y did something very good for me

This explication means that Y did X a favor, or gave a gift or a service which for the recipient is something of great value. It includes assistance at a perilous moment when the recipient had no other recourse. It refers to the daily grind of parents in rearing children and to workers' dedication to duty.

(3) Ang medályang ito ay utang na loob ko kay Tata Ami ,y dahil sa siya ang naging tulay at gabay para marating ko ang aking tagumpay. (Cruz, 1970) 'This medal is my utang na loob to Tata Ami because he was the bridge and beacon for my success.' (4) Kung hindi ako nagkasakit hindi ko kayo makikilala. Hindi kami uuwi sa Pilipinas. Matagal na itong sakit ko. Hindi ko lang iniinda noon. At saka mabait ang Diyos, ibinigay Niya kayo sa akin. Utang na loob ko sa inyo ang aking kasiyahan. (Bonifacio, 1996)

'If I hadn't got sick, I wouldn't have met you. We would not have gone home to the Philippines. This sickness had been with me for quite some time. I just didn't pay attention to it. And God is good, He gave you to us. Having this joy is my *utang na loob* to you.'

The man's reason for his joy is that during the last moments of his life, when he could not be with his own family, he was surrounded by friends who supported and consoled him. Thus, Tata Ami who must be a distant relative (in Sample 3) and the friends (in Sample 4) gain the status of 'family' worthy of *utang na loob*.

(5) "Napakalaki ng utang na loob ko sa aking mga guro sapagkat sila ang nagturo sa akin na harapin ang lahat ng problemang darating ng buong tatag, buong tapang at ang pagkakaroon ng tiwala sa aking sarili,"sabi ni Liza. (Sujeco, 1999)

"I have a great *utang na loob* to my teachers because they taught me to face all the problems that will come with firmness, courage and of having confidence in oneself," said Liza.

When material things are given by a person at the time they are most needed, this person earns the recipient's feeling of *utang na loob*. *Utang na loob* stems from receiving both tangible (material things) and intangible (services, goodwill) favors. Nena, an employee of the speaker, returned an object which was lost. Her honesty earned her the gratitude of her employer.

(6) Aba 'ý napakalilimutin ko talaga kung saan-saan ko na hinanap ,yan. Maraming salamat sa iyo Nena utang na loob ko ito sa iyo. (Licuanan, 1999) 'I really am so forgetful, I have looked for it everywhere. Thank you very much Nena. It is my utang na loob to you.'

## (b) Because of this, I think about Y

In the context of the thought process, someone (X) thinks well of the benefactor (Y). A person who has *utang na loob* to someone, nurtures good thoughts about his benefactor and how can he repay the favor received.

(7) Hindi ko makakalimutan ang lahat ng kagandahang-loob na itinulong at ibinigay mo sa amin, Vick. Utang na loob ko sa yo ang lahat ng mga ito, Maraming maraming salamat. (Sujeco, 1999)

'I cannot forget the goodness that you shown us, Vick. All these are my utang na loob to you. Thank you very, very much.'

(8) "Nang malaman kong namatay si Enday," sabi ni Itay, "nagpunta ako sa bahay ng anak niya, lagi raw tayong nababanggit ni Enday na may *utang na loob* siya sa atin." (Parcero, 1995)

"When I learned that Enday had died," said Itay, "I went to the house of her child who recounted how Enday always mentioned that she had *utang na loob* to us."

Enday, an old woman who lived alone and was helped by the

speaker's father, spoke about her gratitude up to the moment of her death. Enday was asked her to go to his house every Sunday to receive some money as a form of help which obviously Enday was grateful for.

# (c) I want to do very good things for Y for a long time

A person who has *utang na loob* finds ways to show gratitude to the benefactor. It is not necessarily a repayment commensurate to the benefits received. Such benefits as being created by God, being borne by parents, being saved from certain death or an impending misfortune cannot be repaid. Thus, the recipient is in a perpetual state of indebtedness and the only way to repay this debt is by showing the benefactor the attitude of gratefulness and readiness to do a good turn when necessary. The children of a typical Filipino family readily share their material possessions with their parents to show their *utang na loob*.

(9) Mga kaibigan, tayo'y nilalang ng Maykapal upang kumilala, maglingkod, at magmahal sa kanila. Tayo na nagkapalad na maging tao, may angking lakas at katangian, ang kanilang gabay sa katandaan. Nalalaman nating dapat ipagpasalamat ang kanilang pagpapakasakit sa ginawa nilang pagpapakasakit sa ating mga magulang. Sa pamamagitan ng pusong nakadarama, lumilingap at tumitibok, sana y maipagkaloob ko sa kanila ang tampok na hiyas ng aking talino at kakayahan bilang pagtanaw ng utang na loob. (Lamberto, 1992)

'Friends, we are created by God to know, serve and love them. We, who by good fortune became persons, possessing strength and abilities, are their guide in old age. We know that we should thank them for their sacrifices. With a heart that feels, cares and beats, I hope I have given them the choicest gem of my talent and ability in order to show *utang na loob.*'

(10) Dahil sa matanda na ito ito'y kanilang inaalagaan at ang kanilang kalahating bahagi ng suweldo ay ibinibigay nila at nag-iisang magulang tanda ng utang na loob ito'y kanilang binubusog ng pagmamahal at pinansyal na pangangailangan, kaya naman laging ipinagmamalaki ni Gng. Santos ang kanyang mga anak sa lahat ng kanyang mga kakilala. (Alberto, 1997)

'Because she is already old, they take care of her and give her half of their salary as a sign of their *utang na loob*. They give their only living parent love and financial help that is why Mrs. Santos takes pride in her children.'

The following samples show sincere intent and resolution to repay one's indebtedness. Kuya Pepe saved his younger brother Rudy from certain death in a fire that had ravaged their house. Later, Rudy promises to be a good boy to his brother.

(10) <sup>"</sup>Ising, maraming salamat ha! Sana ay mabayaran ko ang napakalaking utang na loob ko sa iyo at kay Ka Berting."(Cruz, 1998)

"Ising, thanks a lot. I hope to pay my very great utang na loob to your and Ka Berting."

(11) Natuwa si Marilyn, sapagkat makakabayad siya nang kahit kaunti sa utang na loob sa pinanunuluyan niya. (Arceo, 1993)

'Marilyn was delighted because she could already repay even a little of

her utang na loob she incurred for staying (for free in her host's house).'

(12) <sup>"</sup>Kumusta, Kuya Pepe! Maraming salamat sa pagkakaligtas mó sa akin, tatanawin ko itong malaking utang na loob. Bayaan mo, kuya, mula ngayon ay di na kita aawayin at magiging mabuti na akong bata." (Abunan, 1983)

"How are you, Kuya Pepe? Thanks a lot for saving me, I will look at it as a great *utang na loob*. Don't worry, Kuya, from now on, I will not quarrel with you and I will be a good boy."

Roces (1985) took note that "during special occasions, *utang na loob* is in full play. It is an opportunity to acknowledge a debt through a token gift. Doctors especially are showered with gifts at Christmastime."

#### (d) I cannot not do this

The overt practice of *utang na loob*, a cultural value deeply entrenched among Filipinos cannot be simply disregarded. It is not only a social obligation but also a moral obligation as well. The following sample shows a girl who gives her assent, though reluctant, as a display of *utang na loob*.

(13) *"P-Pwede ... okey lang!" Hindi nakatanggi si Christy sa paghingi ni Gener ng address niya't numero ng kanilang telepono. Bale, pagtanaw ng utang na loob sa pagkabawi nito ng kwintas niya sa magnanakaw.* (Villagracia, 1998)

"I-It's possible ... it's okay!" Christy could not refuse Gener's request for her address and telephone number. It was an act of *utang ng loob* for the man who retrieved her necklace from the thief."

(14) Eh kasi, malaki ang utang na loob niya kay Mila kaya ganoon na lang ang kanyang pagpapakumbaba sa kanya. (Lico, 1993)

'She has a great *utang na loob* to Mila that is why she is so meek towards her.'

This *utang na loob* felt towards Mila emanates from Mila's care of her child when she worked abroad. Because of this *utang na loob*, there is meekness in her behavior towards Mila. Not to observe the practice of *utang na loob* is unthinkable among Filipinos. However, the desire to do very good things for Y because of *utang na loob* is exacted by either of these two motivations- by a real sense of gratitude or by the social pressure to repay. If utang na loob is prompted by a real sense of gratitude, the desire to do good things for Y is liberating. For instance, gift-giving is not interpreted as a repayment but as a reminder of this gratitude which deepens further the relationship between benefactor and recipient. If, on the other hand, it is motivated by the pressure to conform to the social expectation of repaying utang na loob, the result is a tension and uneasiness on the part of the debtor. This meekness of Mila, if prompted by social conformity, can be oppressive. Thus, some people refuse favors in order to avoid incurring utang na loob which can prove more burdensome than the worth of the favor received.

# (e) If do not do this, some people may know and think something bad about me

Accusation, rejection or ostracism can be thrown at a person

possessing no *utang na loob*. The following examples show a mild reproach and an outright censure even driving out someone from home for lack of *utang na loob*.

(15) *Wala kang utang na loob!* (Abueg, 1994) 'You have no *utang na loob!*'

(16) *"Layas! Lumayas ka! Wala kang utang na loob! Pagkatapos ng lahat, ito pa ang igaganti mo."* (Sangreo, 1995)

"Get out! Get out of here! You have no *utang na loob*! After everything, is this what you will do to us?"

# (f) I do not want this

A nonpayer of *utang na loob* in Southwestern Leyte is called *way ibalus* (one who has nothing to pay), a derogatory term placing him in a status below that of a beggar or a dog. A quotation says, "A beggar prays for the good health of whoever gives him alms; and a dog barks for his master, hut a *way ibalus* does not even have a prayer or a bark for his master." The primary result of unpaid *utang na loob* is the experience of *hiya*, the social price one has to pay. Thus, one wants to repay promptly lest a new form of *utang na loob* comes into existence.

(17) "Kakahiya na sa yo ... ", ang payuko niyang bulong, "ang dami-dami ko na ngang utang na loob sa'yo, "dadagdagan na naman."(Pl)

"It is embarrassing ..., " she whispered with her head bowed," I have so much utang na loob to you, and I must add to it again.""

Furthermore, non-repayment of *utang na loob* is regarded not only as a social but also a moral issue. As shown in the next example, the person asks for forgiveness for failing to show *utang na loob* promptly.

(18) "Matagal na kitang pinahihirapan. Hindi ko man lamang isinaalang--alang ang iyong damdamin. Patawarin mo ako, ako pala ang dapat na nasa katayuan mo at ikaw ang nandito. Malaki ang utang na loob ko sa iyo kaya hanggang langit ang paghingi ng tawad sa yo." (PI)

"I have made you suffer. I did not even consider your feelings. Please forgive me, I should have been the one in your place and you in mine. My *utang na loob* to you is great so my request for forgiveness has reached the heavens."

# Conclusion

Despite being hailed as a desirable, if not a mandatory aspect of Filipino social and moral customs, utang na loob can remain as a positive cultural value only if it is gratitude in pure form. Analyzing the cognitive element of this concept can help, therefore, in using utang na loob as a tool for establishing goodwill that can bind people together and guard against false, forced and feigned gratitude. Zaide (1994), a Filipino historian, spoke of the Filipino in this way: "Geographically, the Philippines is in Asia, but by race and culture, the Filipinos are a harmonious blend of the East and the West." Their being cosmopolitan in the world might be the cause or effect of this fragile Filipino identity but unless one knows where the influence of the East begins and the West ends, the question remains. Hence, the cognitive analysis of the Filipino mindset which is foreigninfluenced yet at the same time tenaciously loyal to cultural traditions shows us this unified convergence giving rise to a greater perception and appreciation of oneself, of the world and his behavior towards it.

## References

# Articles in edited volumes/books:

Abueg, E. (1994). Ang Kamatayan ni Tiyo Samuel. p. 287. In Yaman ng wika at panitikan. Eds. Lorenza Avena et al. Makati City: Diwa Scholastic Press, Inc. Abunan, I. Jr. (1983). Ang Mabait na Pato at ang Tupang Itim. p. 9. In *Bukang-liwayway, balarila at panitikan* I. Ed Inocencio C. Abunan Jr. Quezon City, Philippines: Xavier School.

Arceo, J. (1993). Buhay sa Mga Bula ng Alak. p. 227. In *Filipino IV*. Quezon. City, Philippines: FNB Educational. Inc.

Alberto, M. (1997). Butihing Ina. p.69. In *Wikang Pilipino*. Quezon City, Philippines: Phoenix Publishing House, Inc.

Badua, Z. (1989). Maraming Salamat. In *Hiyas ng lahi*. Ed. Zenaida Ruiz. Quezon City, Phi1ippines: Vibal Publishing House, Inc.

Bonifacio, A. (1996). Isang Mabuting Halimbawa. In *The Philippine Journal of Education*. Vo1. LXXV, No. 2, Quezon City.

Cruz, F. (1998). Dukha. p. 112. In *Maharlikang Pilipino III*. Quezon City, Philippines: Shalom House Publishing, Inc.

De Castro, L. D. (1998, January). Debts of good will and interpersonal justice. pp. 21-26 . In *The Paideia Archive: Twentieth World Congress of Philosophy* (Vol. 24).

Dela Cruz, L. (1984). Ang Hukom. p. 125. In *Panitikan*. Ed Virgilio B. Cruz. Metro Manila,. Philippines: GMC Trading Company, Inc.

Lamberto, M. G. (1992). Kabataan: Gabay ni Lolo at ni Lola. p. 67. In *Filipino IV*. Ed. Lydia C. Vicente. Philippines Campus Diliman, Quezon City.

Lico, V. (1993). *Banyaga Maharlika III*. Manila, Philippines: Phoenix Publishing Corp.

Licuanan, P. (1999). Kuwentong Pilipino. p. 164. In *The Philippine Journal of Education*. Vol LXXVIII, No. 4., Quezon City.

Parcero, P. (1994) Mama, 'Asan ang Gintong Itlog?. p. 213. In *Liwayway*. Vol.. XXVII, No. Quezon City, Philippines.

Reyes, J. (2015) "Loób and Kapwa: An Introduction to a Filipino Virtue Ethics," p. 148-171. In *Asian philosophy*, 25(2).

Rungduin, T., Rungduin, D. C., Aninacion, J. G., Catindig, R. B., & Gallogo, L. S. (2016). The Filipino character strength of utang na loob: Exploring contextual associations with gratitude. pp. 13-23. In *International journal of research studies in psychology*, 5(1).

Sangreo, E. (1995). Nang Sumikat ang Araw sa Karimlan. In *Filipino IV* (Diwang Makabansa). Quezon City, Philippines: Phoenix Publishing House,. Inc.

Sapir, E. (1949) Selected writings of Edward Sapir. In *Language, culture and personality*. Ed. David Mandelbaum. Berkeley: University of California Press. Sujeco, A. (1999). Guro, Doktor ... at Nayon. p. 69 in *Sining 3 Sining ng* 

*komunikasyon panghaiskul*. Eds. Julieta Pereyra et al. Manila, Philippines: JO-ES Publishing House.

Wierbicka, A. (1992). Defining Emotion Concepts. pp. 539-8. In *Cognitive Science* 16.

Washizu, N., & Naito, T. (2015). The emotions sumanai, gratitude, and indebtedness, and their relations to interpersonal orientation and psychological well-being among Japanese university students. International Perspectives. Pp. 209–222. In *Psychology: Research, Practice, Consultation*, 4(3).

## Books:

Andres, T. Q., 1988. *Negotiating by Filipino Values. Manila, Philippines: Divine Word Publications* 

Cruz, A. C.,1970. *Nasaan ang medalya?* Makati, Rimi, Philippines: Keystone Printing Press.

Goddard, C and Wierzbicka, A. , 2014. Words and Meanings: Lexical Semantics across Domains, Languages, and Cultures. Oxford: OUP

Goddard, C. (ed.)., 2006. *Ethnopragmatics: Understanding discourse in cultural context.* Berlin: Mouton de Gruyter.

Hollnsteiner, M. R., 1979. *Society, culture and the Filipino*. Ateneo de Manila University, Philippines.

Hurford, J. R. and Heasley, B., 1983. *Semantics: A coursebook.* Cambridge: Cambridge University Press.

Lico, V., 1993. *Banyaga Maharlika III*. Manila, Philippines: Phoenix Publishing Corp.

Roces, A. and Roces, G., 1985. *Culture shock: A guide to customs and etiquette.* Singapore: Times Editions Pte. Ltd.

Villagracia, B., 1998. *Sa pangarap na lang kita mamahalin*. Manila, Philippines: Bookman Inc.

Wierbicka, A., 1997. Understanding cultures through their key words: English, Russian, Polish, German, and Japanese. New York Oxford University Press.

Wierbicka, A., 1996. *Semantics: Primes and Universals*. New York: Oxford University Press.

Wierbicka, A., 1980. *Lingua mentalis - the semantics of natural language*. New York:Academic Press.

Zaide, S., 1994. The Philippines: *A unique nation*. Quezon City, Philippines: All-Nations Publishing Co., Inc.

## Website:

Hays, J. (2015). Social relations in the Philippines: Utang na loob, bayanihan and pakikisama. Viewed February 19, 2019 from http://factsanddetails.com/ southeast-asia/Philippines/sub5\_6c/entry-3868.html

Marini, M.G. (July 26, 2016). The natural semantic metalanguage: Interview to Anna Wierzbicka. Viewed February 27, 2019 http://www.medicinanarrativa.eu/ the-natural-semantic-metalanguage-interview-to-anna-wierzbicka Matienzo, R.A.(2017). Ang pagkilos ng pananampalataya at utang na loob: Si Hornedo sa etnograpiya ng popular na paniniwala. Viewed February 20, 2019 from https://www.kritike.org/journal/issue\_21/matienzo\_december2017.pdf Rungduin, T., Rungduin, D., Aninacion, J., Catinding, R. and Gallogo, L. (2015). The Filipino character strength of utang na loob. Retrieved February 19, 2019 from https://www.researchgate.net/publication/284433972\_The\_Filipino\_character\_strength\_of\_utang\_na\_loob\_Exploring\_contextual\_associations\_with\_ gratitude

# A Comprehensive Overview On 5G As the Newest Innovation in Cellular Network Technology

Allyson Kaye L. Plaza Faculty, College of Education, The University of Manila, 1008, Philippines allyplaza97@gmail.com

## Introduction

Since the advent of the 21st Century, mankind has brought forth multiple advancements in technology. One such advancement is the continuous development of cellular network technology. After years of constant research, cellular phone companies have finally released 5G or fifth generation technology; promising greater transmission speeds of 15 to 20 gigabytes per second with lower latency – the lowest possible being 1 millisecond (de Looper, 2020).

The principles of communication technology state that larger bandwidths are attributed to higher frequencies. 5G operates on high millimeter waves between 30GHz and 300GHz thus providing a great boost in speed, capacity, low latency, and quality. A gadget supporting 5G connectivity can now react 250 times faster than a human being; as people have an average reaction time of 250 milliseconds (Thales, 2021).

5G also boasts its connectivity. Utilizing 5G allows for multiple devices to be connected in a single network; approximately reaching a million within a square kilometer. Instant connections created in real time greatly favors the internet of things (IoT) as multitudes of data can easily be transferred to multiple devices in a short period of time (IoT Solutions, 2019).

South Korea was the first country to adapt to 5G; with telecommunication companies such as KT, LG UPlus, and SK Telecom offering 5G service to the public (Galazzo, 2020). Samsung also was the first company to release a gadget using 5G technology; citing the Samsung Galaxy S20 as the "first-ever all-5G smartphone". Since then, many companies followed suit in releasing phones supporting 5G connectivity such as Apple and Nokia (Collins, 2020). 100Mbps (Globe, 2019).

Despite numerous countries slowly adapting and switching to 5G, a great part of it is still relatively unknown to the public.

Thus, this paper was created to provide a comprehensive overview on 5G; its history, notable features, possible technological advancements, and the common misconception on the health risks that it may pose. This paper analyzed over 100 varied sources and references to depict the most accurate and timely information regarding the newest innovation in cellular network technology.

## Methodology

To produce a comprehensive review on 5G as the newest innovation in cellular network technology, over 100 relevant articles and studies were analyzed. Reputable open access and commercial article and journal databases such as Google Scholar and Research Gate were consulted to search for the literature used for the review. Limitations to the year of publication of reviewed papers were set from 2016 to 2021 to ensure that information presented is timely and accurate.

Thematic analysis coding was utilized in order to easily arrange information into specific topics that this paper aimed to discuss regarding fifth generation technology. The data gathered were organized into four main themes as stated below:

**A.** Concept and History of Cellular Network Technology

- **B.** Notable Features of 5G
- **C.** Possible 5G Technological Advancements
- **D.** Misconceived Health Risks About 5G

Thus, search terms to find the 100 5G-relevant articles and studies are anchored to the themes above such as, "cellular network technology", "concept", "background", "history", "timeline", "frequency", "speed", "future 5G technology", "health risks", and other related keywords.

Figures shown in this paper are also retrieved from said articles and journals reviewed for this study.

#### Results

This part of the paper covers all of the organized data from the related literature and studies that answer the themes/topics highlighted in the Methodology portion of the study.

# A. Concept and History of Cellular Network Technology

Cellular network technology is communication made through the utilization of mobile phones.

Cellular network technology enables mobile communication through the use of a two-way radio system between the mobile unit and the wireless network. It uses radio frequencies (radio channels) over and over again throughout a market with minimal interference, to serve a large number of simultaneous conversations. Larger bandwidths are attributed to higher frequencies (the shorter the frequency, the larger the bandwidth). However, the higher the frequency, the shorter distance it reaches (Guowang et al, 2016).

EMF Explained (2020) specified that there are two main components in cellular network technology, the Radio Access Network (RAN) and the Core Network. The organization explained that,

"The Radio Access Network consists of various types of facilities including small cells, towers, masts and dedicated in-building and home systems that connect mobile users and wireless devices to the main core network.

On the other hand, the Core Network is the mobile exchange and data network that manages all of the mobile voice, data and internet connections. For 5G, the 'core network' is being redesigned to better integrate with the internet and cloud based services and also includes distributed servers across the network improving response times (reducing latency)."

The standards by which a "generation" of cellular network technology is determined are set by the International Telecommunication Union (ITU) and the 3rd Generation Partnership Project (3GPP). Minimum standards are set by the ITU while generation-specific standards are set by the 3GPP (de Looper, 2020).

The first introduction of cellular network technology to the public was done in 1979 by Nippon Telegraph and Telephone and was labeled as 1G or "first generation. 1G was then presented to the North America through Ameritech in 1983. Being the first of its kind, 1G was considered to be "revolutionary technology". However, the quality of 1G calls made through 1G devices was poor; while download speeds through the 1G network only reached at about 2.4kbps (Horwitz, 2019; Galazzo, 2020).

A lot of improvements were made when 2G was launched in 1991 by the Global System for Mobile Communications (GSM) in Finland. Speeds averaging 0.2Mbps was reached, ringtones were created, and encrypted calls were made possible.

Due to this advancement, new forms of communication through cellphones were introduced: text messages (SMS) and multimedia messages (MMS). The demand for cellphones continued to rise and many have begun realized the potential and global influence that cellular network technology can bring to the table (Horwitz, 2019; Galazzo, 2020; Nordby, 2020).

International roaming services began with the arrival of 3G in 2001 through the NTT DoCoMo in Japan. Initial speeds reached up to 2Mbps; 4 times the speed of the 2G technology. Then, 3.5G "brought a truly mobile internet experience, unleashing the mobile apps ecosystem" as more and more people become dependent on their phones in surfing the internet. As constant developments followed, data rates increased up to 6Mbps and introduction to the concept of smartphones finally took place with the iPhone 3G or iPhone 2 in 2008 (Galazzo, 2020; Nordby, 2020; Thales, 2021).

4G, first introduced in Norway just before 2009 ended, is the standard cellular network service offered globally. With initial speeds reaching 12.5Mbps, it was first categorized as 4G LTE (long term evolution). Constant developments allowed for 4G speeds to reach up until 20Mbps in 2018. It was also the beginning of the tough competition between the companies Apple (iPhone series) and Samsung (Galaxy series); as the demand for high quality devices supporting 4G connectivity continued to rise (Nordrum & Clark, 2017; Galazzo, 2020).

After much innovation, the advent of 5G finally began in 2019. South Korea was the first country to adapt to fifth generation technology; with South Korean telecommunication companies such as KT, LG UPlus, and SK Telecom offering 5G service to the public. 5G was miles faster than 4G by approximately 205%; with initial speeds reaching up to 169.46 Mbps. 5G was, without a doubt, the most revolutionary discovery since the first creation of cellular network technology (Galazzo, 2020; Collins, 2020).

# **B.** Notable Features of 5G

The 3GPP developed the 5G New Radio (NR) as the 5G networks' air interface global standard. 5G NR utilizes two frequency ranges Frequency Range 1 (FR1) which includes sub-6 GHz frequency bands and Frequency Range 2 (FR2) which includes frequency bands in the mm-Wave range (24–100 GHz). It became accessible in 2017 (Teral, 2019). Thales (2020) provided a summary of specification requirements that are needed for a network to belong under the umbrella of 5G technology. The requirements were:

• up to 10Gbps data rate - > 10 to 100x speed improvement over 4G and 4.5G networks

- 1-millisecond latency
- 1000x bandwidth per unit area

• up to 100x number of connected devices per unit area (compared with 4G LTE)

- 99.999% availability
- 100% coverage
- 90% reduction in network energy usage
- 10-year battery life for low power IoT device."

IoT Solutions (2019) has highlighted several advantages of 5G technology to the community such as greater speed in transmissions, lower latency, greater number of connected devices, and network slicing.

According to standards, 5G speed range shall begin at ~50Mbps to over a gigabit/s. Although 5G technology's average speed ranges up to 100 to 400Mbps (mid-band 5G), it said that the highest possible it could reach would be within the 15-20Gbps range while the lowest reported latency of 5G is 10 milliseconds (compared to 4G's 50 milliseconds), but possible latency could reach as low as 1 millisecond. As of today, the highest recorded 5G speed is by Verizon at 10Gbps (Hoffman, 2019; Dolcourt, 2020; Thales, 2021).

Another key feature of 5G technology is its coverage. 5G networks are able to connect a million devices per square kilometer. Due to 5G's capability to access a wide range of frequencies, 5G can easily co-exist with 4G networks and also connect to 4G supported devices in areas where 5G technology is not yet fully developed (Singh, 2018; Segan, 2018; Forum, 2019).

With regard to some of the technology contributing to the incredible features of 5G technology, extremely high speeds are made possible by the use of the millimeter wave spectrum or the mmWave. According to Tracy (2016),

"Millimeter wave spectrum is the band of spectrum between 30 GHz and 300 GHz. Wedged between microwave and infrared waves, this spectrum can be used for high-speed wireless communications as seen with the latest 802.11ad standard (operating at 60 GHz)."

On the other hand, another contributory technology is 5G's

new network slicing technology, or the Orthogonal Frequency-Division Multiplexing (OMFD). According to Qualcomm (2020),

"5G is based on OFDM (Orthogonal Frequency-Division Multiplexing), a method of modulating a digital signal across several different channels to reduce interference. 5G uses 5G NR air interface alongside OFDM principles."

Some of the varied technologies utilized for 5G are as follows: new radio frequencies (frequency range 1 and 2), massive MIMO, edge computing, small cell, beamforming, convergence of Wi-Fi and cellular, NOMA (non-orthogonal multiple access), SDN/NFV, and channel coding (Maunder, 2016; Ordonez-Lucena, 2017; Fisher, 2019).

## Network Slicing

5G's key feature is "network slicing"; a technology enabling hardware to support different services and applications through slices or partitions. 5G is divided into "geographical cells" or service areas and works by sending encoded data through radio waves.

Simply put, Bump (2020) stated that "5G signals will come from one main 5G tower in a centralized location, such as the middle of a city. Then, that signal will be amplified by smaller cell towers around it -- often referred to as 'small cells.' This will cover a large distance of mobile devices with high-speed 5G networks.



Fig. 1. A visual representation of how 5G's network slicing works (Bump, 2020).

Currently, 5G operates in three different frequencies, low-band, mid-band, and high-band. Low-band 5G operates in frequencies below 2GHz and are almost similar to the current 4-G. Mid-band 5G operates in frequencies ranging from 2GHz to 10 GHz and is the most commonly used 5G today.

## *C.* Possible 5G Technological Advancements

Due to the many beneficial characteristics of fifth generation

technology, 5G can create potentials previously thought impossible to society.

As huge amounts of data can be transferred in the nick of time, 5G's speed and network capacity greatly favors the internet of things. Multiple devices to be connected without any form of human intervention at greater speeds allows for the possibilities stated below:

# Fully Automated Vehicles

With data speeds reaching up to 20Gbps with 1 millisecond latency, cars will be able to react faster than their rider; enabling the existence of driverless vehicles with low probabilities in getting into accidents.

## Highly Reliable Drones/Robotics

5G allows for drones to operate more accurately and reliably without the need for human intervention. For example, multiple delivery drones may operate at the same time as 5G allows multiple devices to be connected without any connection drop.

## Advanced Healthcare Monitoring Systems

As data regarding a person's health can immediately be delivered through 5G, multiple possible solutions can also be presented at the same time if an accident were to happen.

# Improved Virtual Reality

5G revolutionizes the field of virtual reality through its data transferring capacities. 5G allows for less lag and quick time reactions; allowing for a more realistic gameplay.

# Smart Homes, Smart Farms, and Smart Cities

With all of the possibilities stated above, 5G can allow one person to operate multiple devices with just a click of a finger; even going as far as operating without any need for human intervention. Thus, smart homes which adjust to the needs of the homeowners, smart farms which monitor the condition of the animals and farm production, and smart cities which adapt to its citizens are possible with fifth generation technology.



Fig. 2. Possible technological advancements that 5G can bring the community (EMF Explained, 2020).

# D. Misconceived Health Risks About 5G

Broad (2019) from the New York Times reported that RT America, a U.S.-based news channel under RT Network controlled by the Russian Government, had spread misinformation on 5G technology causing health concerns such as "brain cancer, infertility, autism, heart tumors, and Alzheimer's disease" which "lack scientific support". This in turn became the catalyst to the misinformation spread by blogs and websites who witnessed the program.

As of today, many scientists have confirmed the safety of 5G technology. Multiple radiation tests have proven it to be safe and harmless (Novella, 2019; Cellan-Jones, 2020; Bowler, 2020). A review on 300 biomedical studies about low-level RF electromagnetic fields from 6 GHz to 300 GHz, stated that all of the well-designed experiments found no evidence of DNA damage in skin cells, it also "showed little evidence of health effects including cancer at different sites, effects on reproduction and other diseases", and "provided no confirmed evidence that low-level MMWs are associated with biological effects relevant to human health" (Karipdis et al, 2021).

A 2017 and a 2021 study showed evidence that 1.8 to 2.2 GHz of radio frequencies lead to tissue heating, a condition which takes place when the skin takes in electromagnetic energy, which leads to a slight temperature rise in the body. However, tissue heating doesn't last long. Also, tissue heating might not even take place as the community is only exposed to really low EMF frequencies (Sacco et al, 2021; Knott, 2021).

A study conducted by Curcio (2018) reviewed 43 studies examining if EMFs negatively affect cognitive function. Results have shown that "there is no evidence of a causal relationship" and thus, cognitive concerns on 5G are unfounded.

In addition, the International Commission on Non-Ionizing Radiation Protection (ICNIRP) called for stricter radiation rules on 5G technology, thus ensuring that no harm shall be inflicted on its users. As per the ICNIRP Chairman, Dr. Eric van Rongen (Hern, 2020),

"The guidelines have been developed after a thorough review of all relevant scientific literature, scientific workshops, and an extensive public consultation process. They provide protection against all scientifically substantiated adverse health effects due to [electromagnetic field] exposure in the 100 kHz to 300 GHz range."

Another conspiracy theory surfaced online reporting that the CO-VID-19 spread is partly caused by the 5G towers being built which led some arson cases on said towers. In retaliation, the World Health Organization published an "infographic" debunking the myth that 5G is the cause of the spread (Cerulus, 2020; Fildes et al, 2020).

#### Conclusion

This paper was created to provide readers a comprehensive overview on 5G or fifth generation technology; its background, notable features, possible technological advancements, and even misconceived notions about its potential health risks. With various relative information collated into one paper, individuals curious about the concept of 5G may consult this study for an easy-access yet substantial reference material. This was done in order further shed light on data previously considered to be relatively unknown to a huge number of people and debunk misinformation carried out by irreputable sources.

5G, since its conceptualization up until its actual commercial distribution, has so far, been an unparalleled innovation in cellular network technology. Boasting extremely fast internet speeds, lower latencies, faster data transmission, multiple device-access, and other great qualities, fifth generation technology has already surpassed its predecessors by a huge margin. 5G allows never-before-seen technology to become imaginable because of its high-grade specifications; opening possibilities for fully automated vehicles, highly reliable drones/robotics, advanced healthcare monitoring systems, improved virtual reality, smart homes, smart farms, and smart cities to come into fruition.

5G continues to evolve at an unprecedented scale and thus, studies regarding this technology must continuously be conducted to ensure that any information regarding its development would remain accurate, updated, timely, and relevant.

#### References

"Globe 5G – The Latest Broadband Technology". globe.com.ph. June 2019 AccelerComm. (2020). The essential 5G NR glossary. AccelerComm, United Kingdom.

Bowler, J. (2020.) what's 5g, and why are people so scared of it? here's what you need to know. ScienceAlert.

Brackett, R. (2019). 5G Wireless Networks Could Interfere with Weather Forecasts, Meteorologists Warn. The Weather Channel.

Broad, W. (2019). Your 5G Phone Won't Hurt You. But Russia Wants You to Think Otherwise. The New York Times.

Bump, P. (2020). 5 Ways 5G Will Impact Marketers. HubSpot, Inc.

Cellan-Jones, R. (2020). 5G judged safe by scientists but faces tougher radiation rules. BBC News.

Cerulus, L. (2020). 5G arsonists turn up in continental Europe.

Collins, Katie (2020). The Nokia 8.3 is the 'first global 5G phone.' Here's what that means for you. CNET.

Corera, G. (2019). Huawei: MPs claim clear evidence of collusion' with Chinese Communist Party. BBC.

Curcio, G. (2018). Exposure to Mobile Phone-Emitted Electromagnetic Fields and Human Attention: No Evidence of a Causal Relationship. Frontiers in Public Health. Department of Biotechnological and Applied Clinical Sciences, University of L'Aquila, L'Aquila, Italy

Dahmen-Lhuissier, S. (2019). ETSI – Mobile. ETSI.

Davies, D. (2019). Small Cells – Big in 5G. Nokia.

de Looper, Christian (2020). "What is 5G? The next-generation network explained". Digital Trends.

Dolcourt, J. (2020). We tested 5G speeds across the globe. CNET.

Duckett, C. (2019). Europe warns 5G will increase attack paths for state

actors. ZDNet.

EMF Explained. (2020). 5G Explained: How 5G Works. International Telecommunications Union (ITU)

Fildes, N., Di Stefano, M., & Murphy, H. (2020). How a 5G coronavirus conspiracy spread across Europe. Financial Times.

Fisher, T. (2019). 5G vs 4G: Everything You Need to Know. Lifewire.

Flynn, K. Workshop on 3GPP submission towards IMT-2020. 3gpp.org.

Fóo, Y.C. (2018). EU countries, lawmakers strike deal to open up spectrum for 5G. Reuters.

Forum, C. L. X. (2019). 1 Million IoT Devices per Square Km – Are We Ready for the 5G Transformation?. Medium.

Freedman, A. (2019). Global 5G deal poses significant threat to weather forecast accuracy, experts warn. The Washington Post.

Galazzo, R. (2020). Timeline from 1g to 5g: A Brief History on Cell Phones. Canada's Centre of Excellence in Next Generation Networks.

Guowang, M., Zander, J., Sung, K.W., & Slimane, S.B. (2016). Fundamentals of Mobile Data Networks. Cambridge University Press. ISBN 978-1107143210.

Hern, A. (2020). 5G confirmed safe by radiation watchdog. The Guardian. Hoffman, C. (2019). What is 5G, and how fast will it be?. How-To Geek website. How-To Geek LLC.

Horwitz, J. (2019). The definitive guide to 5G low, mid, and high band speeds. VentureBeat online magazine.

IoT Solutions. (2019). Advantages Of 5g And How It Will Benefit The IOT. IOT Solutions, Fira de Barcelona.

Karipdis, K. Mate, R., Urban, D., Tinker, R., & Wood, A. (2021). 5G mobile networks and health—a state-of-the-science review of the research into low-level RF fields above 6 GHz. Journal of Exposure Science & Environmental Epidemiology. 31, pages 585–605 (2021). https://www.nature.com/articles/s41370-021-00297-6 Kastrenakes, J. (2018). Is Verizon's 5G home internet real 5G?. The Verge.

Knott, M. (2021). Is 5G Harmful to People?. Healthline.

Lubar, D. (2019). A Myriad of Proposed Radio Spectrum Changes – Collectively Can They Impact Operational Meteorology?. 15th Annual Symposium on New Generation Operational Environmental Satellite Systems. Phoenix, AZ: American Meteorological Society.

Maddison, J. (2019). Addressing New Security Challenges with 5G. CSO Online. Maunder, R. (2016). A Vision for 5G Channel Coding (PDF).

Mello, G. (2019). Ericsson to invest over \$230 million in Brazil to build new 5G assembly line. Reuters.

Misra, S. (2019). The Wizard Behind the Curtain? – The Important, Diverse, and Often Hidden Role of Spectrum Allocation for Current and Future Environmental Satellites and Water, Weather, and Climate. 15th Annual Symposium on New Generation Operational Environmental Satellite Systems. Phoenix, AZ: American Meteorological Society.

Nordby, G. (2020). The Road to 5G. Start it Up. Medium.

Nordrum, A. & Clark, K. (2017). Everything you need to know about 5G. IEEE Spectrum magazine. Institute of Electrical and Electronic Engineers. Novella, S. (2019). 5G Is Coming". Science-Based Medicine.

Ordonez-Lucena, J., Ameigeiras, P., Lopez, D., Ramos-Munoz, J., Lorca, J., & Folgueira, J. (2017). Network Slicing for 5G with SDN/NFV: Concepts, Architectures, and Challenges. IEEE Communications Magazine. 55 (5): 80–87. arXiv:1703.04676.

Paul, D. (2019). Some worry 5G may pose huge problems for weather forecasting. The Buffalo Post.

Pressman, A. (2020). Why only one-quarter of the world will get true 5G wireless, McKinsey says. Fortune Magazine, February 2020 Issue.

Proctor, J. (2019). Why Canada's decisions on who builds 5G technology are so important. CBC News. Canadian Broadcasting Corporation.

Qualcomm. (2020). Everything you need to know about 5G. Qualcomm Technologies, Inc.

Sacco, G., Pisa, S., & Zhadobov, M. (2021). Age-dependence of electromagnetic power and heat deposition in near-surface tissues in emerging 5G bands. Scientific Reports volume 11, Article number: 3983

Samenow, J. (2019). Critical weather data threatened by FCC ,spectrum' proposal, Commerce Dept. and NASA say. The Washington Post.

Samenow, J. (2019). FCC to auction off wireless spectrum that could interfere with vital weather data, rejecting requests from U.S. House and science agencies. The Washington Post.

Segan, S. (2018). What is 5G?. PC Magazine online. Ziff-Davis.

Shim, W.H. (2021). Seoul has fastest 5G network speeds: report. The Korea Herald: Business.

Singh, S. (March 16, 2018). Eight Reasons Why 5G Is Better Than 4G. Altran. Teral, S. (2019). "5G best choice architecture" (PDF). ZTE.

Thales. (2021). 5G technology and networks (speed, use cases, rollout). Thales Group.

Tracy, P. (2016). What is mm wave and how does it fit into 5G?. RCR Wireless News.

Violette, E.J., Espeland, R.H., DeBolt, R.O., & Schwering, F.K. (2018). Millimeter--wave propagation at street level in an urban environment. IEEE Xplore.

Warren, T. (2020). British 5G towers are being set on fire because of coronavirus conspiracy theories. The Verge.

Witze, A. (2019). Global 5G wireless networks threaten weather forecasts: Next-generation mobile technology could interfere with crucial satellite-based Earth observations. Nature News.

Yu, Heejung; Lee, Howon; Jeon, Hongbeom (October 2017). 39 "What is 5G? Emerging 5G Mobile Services and Network Requirements". Sustainability. 9 (10): 1848. doi:10.3390/su9101848.

#### Medical Treatment and Medical Device Innovation during the COVID-19 Pandemic: Contributions from King Mongkut's Institute of Technology Ladkrabang

Prof. Prasert Trivijitslip, M.D.<sup>1</sup>\*, Sranya Phaisawang, Ph.D.<sup>2</sup> and Prof. Anan Srikiatkhachorn, M.D.<sup>2</sup>

<sup>1</sup>King Mongkut's Chaokhunthahan Hospital, King Mongkut's Institute of Technology Ladkrabang, 10520, Thailand

<sup>2</sup>Faculty of Medicine, King Mongkut's Institute of Technology Ladkrabang, 10520, Thailand

\*Corresponding author. E-mail: prasert.tr@kmitl.ac.th

#### Introduction

According to the World Health Organization (WHO) in March 2022, there have been over 437,333,859 confirmed COVID-19 cases and at least 5,960,972 deaths globally. (WHO, 2022) The situational risk assessment remains very high due to different variants of the coronavirus itself. (WHO, 2020). With recurring disease and infections, this pandemic has caused much more than a health care burden, but that of an economic burden worldwide. Lack of vaccinations and unequal distribution of medical devices has created a gap in health infrastructure and health equity.

In developing nations, including Thailand, the struggle to manage the COVID-19 pandemic has been witnessed. With over four different waves of the outbreak since late March 2019, the effects of the virus have greatly impacted the livelihood of its citizens and governance, education, economic and health care infrastructure. According to the International Trade Administration, in 2020, the value of Thailand's medical device market was approximately USD 6 billion. In response to COVID-19 needs, local manufacturers increased their production of personal protective equipment (PPE). Although imports of medical devices used for COVID-19 patients, such as ventilators, increased, imports of medical devices, in general, decreased by approximately 20 percent due to public and private hospital shifting efforts towards COVID-19 treatments. (ITA, 2022)

In the following paper, an overview of the effects of the COVID-19 pandemic will be presented followed by the King Mongkut's Institute of Technology Ladkrabang (KMITL) response for a more proactive and sustainable health care approach to navigate future medical, disease and societal trends.

## Health Governance of the COVID-19 Pandemic

In terms of governance, the country's leaders were faced with adverse challenges to manage COVID-19 and ensure the safety of the country and its citizens since its first outbreak in late 2019. As a result of 4 waves of the virus, the country has seen strict enforcement of mandatory lockdowns and curfews to nation-wide rollout of vaccinations, easing of restrictions, self-isolation, social distancing, hand washing and face mask guidelines. Thailand has slowly but surely, upheld international standards of COVID-19 protocol from the WHO and attempted the

difficult task to import COVID-19 vaccines to immunize the entire Thai population. According to WHO Director General 2, Dr Tedros Adhanom Ghebrevesus, Thailand has responded to the first outbreak and mutations of the Coronavirus i.e., Omicron variant by changing its outlook to balance safety without sectioning out the country's need for growth. (WHO, 2020) Thailand has been an active member of the global health community and for 40 years, has been making improvements to the health care system with investments in a number of areas to enhance the medical capabilities of the nation. These government public health initiatives push for constant development which has allowed the country and its leaders to respond as adequately as possible to the COVID-19 crisis. Thailand has been recognized for its continued research capabilities and resourcefulness as it offers a powerful example of how investment in public health and all-of--society engagement can control outbreaks of deadly diseases, protect people's health and allow economies to continue functioning. (WHO, 2020) Educational Disruption During the COVID-19 Pandemic

Both public and private learning institutions across Thailand were disrupted in a way that would forever change the landscape of education. Overnight, all offsite classes were halted and online learning became a reality for 2 years. Infrastructure and resources created a big rift in the delivery and mode of e-learning as many students and educational institutions in the provinces were at a shortage of online technology including adequate mobile, tablet, computer devices as well as connection of internet and WIFI to online classroom applications and programs to help facilitate the online learning demand that resulted from the first nation-wide lockdown in late 2019.

It is estimated that over 15 million Thai students were out of school for a prolonged period of time due to the widening educational inequality, ineffective teaching practices, and poor teacher support. (Kenan Foundation Asia, 2022) Therefore, the approaches to online learning were developed. 21st century skills were highlighted and the importance of technical fluency became a learning priority outcome. However, as schools are now reopening, the hybrid educational environment is now becoming a sustainable solution. With both faceto-face and online learning instruction, the educational institutions are becoming more agile with how they will manage the uncertain future of the COVID-19 disruption. Trends of this "blended" approach is being applied to all sectors to help create bridges to working and health care gaps as well. Eventhough classes in the first semester of 2022 were onsite, flexible learning approaches were required as both face-to-face study and hybrid teaching programs must have been available for online students who were infected or considered high-risk due to direct contact with infected peers.

#### Economic Downturn During COVID-19

With the lockdown in place, there was a strain on the major industries that perpetuate the Thai economy, especially in tourism, hospitality and retail. The unemployment rate began to rise and as a result, low-middle income households experienced a decline in their income since March 2020, with around 80% of the households in rural areas, the southern region, and low-income groups experiencing drastic income declines. (World Bank, 2021). In addition, according to World Bank growth predictions, private consumption, and the likelihood that international tourist arrivals will remain very low through the end of 2021, dropping nearly 90% from over 40 million tourist arrivals in 2019 to just 0.6 million in 2022. (World Bank, 2021)

As a result of the devastating effects from the persisting CO-VID-19 pandemic, the Thai economy has been stretched to its limits and must find a way to recover as quickly as possible. This economic disruption has however, given rise to some new reform concepts to help make the rebound more efficient and effective. These will be of long-term focus to help lower trade costs and barriers to get Thailand back to take part in more productive global economic activity. (World Bank, 2021) However, in June 2022, the Thai government eased restrictions for tourists to visit the country which is expected to regenerate the economy and raise income levels for workers all industries. *Health Care State During COVID-19* 

It has exposed the vulnerability in the Thai health care system and created awareness of the many barriers that prevent adequate health care for the entire nation. Many hospitals were faced with a shortage of hospital beds, medical supplies and emergency equipment ranging from respirators, high-flow oxygen machines and COVID-19 vaccinations. The Thai healthcare system had never been stretched to its limits for over a century and it was on the verge of collapse under the weight of the exponential increase in cases. (Department of Disease Control Ministry of Public Health Thailand, 2021a and 2021b)

Although best efforts from the government were initiated, many public and private organizations began to contribute medical knowledge, know-how and resources, both financial and infrastructural, to help alleviate the surmounting pressure caused by the COVID-19 pandemic. King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand's premier higher learning university, rose to the occasion and quickly established itself as a leader in the fight against the pandemic and all of its challenges.

Through visionary leadership, KMITL rallied its academic faculties, world-renowned experts, and extensive network of like-minded institutions to develop sustainable, efficient and cost-effective solutions for the Thai population at large. From the development of locally innovated and locally produced medical-grade respirators and other breathing apparatus, to the founding of the King Mongkut Chaokhunthahan Hospital (KMC) under royal patronage of the supreme patriarch, KMITL was at the forefront of the pandemic health care initiatives.

#### KMITL Medical Device Development & Health Care Contributions

Currently, many developing nations rely heavily on the import of medical devices, thereby creating a shortage and unevenly distributed curve of accessible health care. In Thailand alone, nearly 80% of medical devices (over USD2.8 billion annually) are imported from foreign countries including US, UK, Germany and China. This expenditure often equips the private sector hospitals and few larger public tertiary care hospitals (BOI, 2022). Since most of the imported medical devices are limited to that of more powerful hospital conglomerates and larger public sector health care institutions, the spike in COVID-19 cases drastically exacerbated the shortages of smaller, community-based hospital availability, medical personnel and vaccines. It was this inability to offer adequate health care on a national scale that set the plan to develop locally made medical devices into motion. A call-to-action was initiated by KMITL to begin development of the most essential COVID-19 devices, surveillance and preventative measures for the entire nation.

COVID-19 Vaccination Hub for Eastern Bangkok

After the vaccine suppy shortage in 2020 during the COVID-19 pandemic, KMCH and its International Faculty of Medicine, MDKMITL, together with all faculties and colleges within KMITL took proactive measures in developing vaccination systems and established the KMITL Vaccine Center on May 2021 to facilitate the vaccination administration process to all students, essential and non-essential employees of the university and those from other governmental agencies in the vicinity.

At the high-capacity KMITL Vaccine Center, every faculty personnel and in every position from the President of the University, Vice and Assistant Presidents, its Faculty Deans, Associate and Assistant Deans to department heads, chiefs, academic and supporting staff, along with MDKMITL medical student volunteers were assigned to help facilitate and make this community initiative a proactive process to administer the vaccine.



Figure 1. KMITL Vaccine Center Precheck. Figure 2. Registration at KMITL Vaccine Center. Figure 3. KMITL COVID-19 Control Center.

Figures 1, 2, 3 show the capacity and service processes of the KMITL Vaccination Center during the COVID-19 pandemic in Thailand. The Vaccination Center utilized all levels of leadership, instructors and staff of KMITL.

Beginning with preregistration, health check, registration app to link with the Ministry of Public Health (MOPH), COVID-19 Control Center, health counseling, vaccine preparation and vaccination injection, post injection observation, recheck after injection prior to leaving and the assignment of the next dose date, all of the KMITL team were able to harness manpower to provide over 102,508
doses to the Thai population. (Figure 6) Together, KMITL stepped up to meet the demands of the COVID-19 pandemic and assisted in the vaccination of a majority of the population in the area and for the greater good of the public.





Figure 4. MDKMITL Student Volunteer for Pre-check Station. Figure 5. MDKMITL Student Volunteer for Vaccination Preparation Station. Figures 4, 5. KMITL international medical student volunteers were dispatched to assist with vaccination stations to promote real-life clinical skills in a community setting.



Figure 6. Total Vaccinations from May 2021-March 2022.

Local-Made COVID-19 Essential Medical Devices

KMITL efforts for the development of locally-produced essential medical devices to help relieve the financial and import burden during the COVID-19 pandemic included the ideation and production of local-made respirators, high-flow oxygen concentrator machines, HEPA filtration systems, self-contained breathing apparatus for first responders, cost effective PPE, suction purifier unit for the dentistry station, KMITL Mobile CO-VID-19 Swab & Testing Units (Figure 14), Swab Tests, Negative Pressure Tests, Positive Pressure Tests, medical supply delivery robots, UVC light sterilization robots, emergency transport ventilators, ozone generators for closed system sterilizers, temperature scanners with face scanning systems, artificial intelligence (Al) systems, advanced diagnostics to identify COVID-19 strains, along with many more pipeline innovations to help the society. During the 3-year pandemic period, an astonishing 1,076 KMITL-developed COVID-19 innovations were donated to 342 hospitals and other community health care organizations in 77 different provinces across Thailand.

These initial steps towards gaining independence from the

import of western medical devices had begun as a result of the quick action taken by KMITL. In less than 1 month after the first pandemic period in Thailand, the first generation ambubag ventilators were manufactured and donated to local hospitals that were faced with equipment shortages. Over the course of 9 months, these first-generation devices were enhanced more user-friendly and efficient features including the addition of device monitors and volume pressure for the 2nd and 3rd generation devices. applications to pair machines with tablets, which allowed health care personnel such as clinicians, nurses and emergency rescue units to treat COVID-19 positive patients from a safe distance. Figures 7, 8, and 9 show the three generations of KMITL ventilator development.



Figure 7. KMITL 1st Generation Ventilator. Figure 8. KMITL 2nd Generation Ventilator. Figure 9. KMITL 3rd Generation Ventilator.

Figures 7, 8, 9. Three generations of KMITL ventilators during the COVID-19 pandemic. 1st generation was designed as an ambubag compressor, 2nd generation enhanced the model with sensor and monitor, 3rd generation included a blower to make the machine more efficient.

Figures 10 and 11 depict clean air ozone generator and UV sterilization technology, respectively, which were used to enhance safety and hygene measures in the three events of the World Badminton Competition held in Thailand in January 2022. Due to the highly contagious nature of the coronavirus, the innovators at KMITL developed a spectrum of devices to compliment the primary line of emergency care devices. The ozone generator and UV sterilization machines were dispatched in both patient care wards and general areas throughout hospitals and other vaccination clinics. The demand for high-flow nasal cannula devices in limited medical resource settings in Thailand were met as first-generation devices were donated and distributed to provincial hospitals.





Figure 10. KMITL Ozone Generator. Figure 11. KMITL UV Robot. Figures10 and 11 are examples of disinfection and sterilization devices developed by KMITL during the COVID-19 pandemic.





Figure 12. 1st Generation High-Flow Nasal Cannula Device. Figure 13. 2nd Generation High-Flow Nasal Cannula Device.

Figure 12, 13. Figures 12 and 13 show the first and second generations of high-flow oxygen concentrators developed by KMITL. The 2nd generation devices enhanced its functionality with addition of a monitor and tablet device control application to promote health care personnel safety.

Figure 12 shows the 1st generation high-flow nasal cannula devices in a clinical setting with an LED monitor showing the respiration rate, heart rate, oxygen blood concentration, percentage of air-humadity, alarm and link with paired machine tablet to control air flow rate were added to allow for treatment of high-risk patients from a safe distance. Health care personnel such as clinicians, nurses and emergency rescue units were able to treat COVID-19 positive patients from a safe distance with these innovations. While Figure 13 shows the 2nd generation high-flow nasal cannula devices which were enhanced for more user-friendly and efficient features after first-hand feedback from health care personnel.



Figure 14. The first KMITL Mobile Swabbing Station. Figure 15. The 2nd Mobile Swabbing Station with 3 stations in one car when in service. Figure 16. The 2nd Mobile Swabbing Station with 3 stations in one car enroute.

Figure 14 depicts the KMITL mobile swabbing station and Figures15-16 the 2nd Mobile Swabbing Station with 3 stations in one car in service and enroute. During the COVID-19 pandemic, over 40 mobile stations were dispatched to both urban and underserved populations across Thailand.

As a result of ingenuity and determination, KMITL medical innovations were able to be designed and manufactured at 3-4 times less than imported instruments, saving the nation over THB 100 million. (RYT9, 2021) These cost-effective and cost-friendly measures remain critical factors in promoting health equity for underserved populations in Thailand. Besides alcohol gel, KMITL also produced crude Andrographis tablets and nasal sprays for the prevention of COVID-19 infection in the population.

At the peak of the pandemic, it was evidenced that the KMITL-made medical devices were also in demand in other countries in the region due to similar medical, health care personnel, infrastructural and monetary shortages. The cost-efficient KMITL medical device development model was well received beyond Thailand's borders in Myanmar, Laos and Cambodia as over 100 units of essential high-flow nasal cannula devices, automatic ambubag devices, and swabbing stations were purchased from KMITL for use in their own respective countries to help manage the COVID-19 pandemic. Moving forward, more device innovations will be developed not only to meet the Thai demands, but also those in neighboring countries with the same health care context. Thus, KMITL will continue to lead the way towards more effective and efficient medical device solutions on a regional level.

Tomorrow's Hospital, King Mongkut's Chaokhunthahan Hospital

With continued growing demand for more domestic devices to help manage the COVID-19 situation in Thailand and to address other societal issues including a staggering increase in elderly population, King Mongkut Chaokhunthahan Hospital (KMCH) under royal patronage of the supreme patriarch was founded in 2021. Its main purpose is three-fold, 1) to develop value-based and impactful MedTech innovations for society, 2) develop Health Tech innovations for Ageing societies and for those Ageing in Place, 3) to become Thailand's International Organization for Standardization (ISO) Medical Device Testing Center.

To create a self-sustainable health care ecosystem for the promotion of health equity for all Thai and foreigners, the KMCH is focused on achieving the intended goals of the hospital through a sophisticated use of technology, networks and collaborations with strategic partners. KMCH is intended to lift the nation out of the vicious cycle of dependency on imported medical devices which continues to create great disparities to impoverished people and elderly populations. KMCH is geared to become Thailand's most innovative hospital which will emphasize on research and development of locally produced medical innovations and devices to help reduce the heavy economic and infrastructural burden in the health care sector.

Collaborative goals include harnessing the power of the Faculty of Medicine, KMITL and provide a training hub for medical and scientific students and researchers. In addition, KMCH will provide an outlet for Thailand's medical, scientific and engineering researchers to develop locally produced medical devices and innovations in order to help reduce health care expenditures every year. Since the domestic medical device market is still in its infancy, KMCH will play a major role in bringing the nation's brightest minds together to capitalize on home-grown medical innovations, research and development.



Figure 17. King Mongkut Chaokhunthahan Hospital, Bangkok, Thailand.

In 2022, the Thai domestic medical device market is forecasted to be worth US\$2.0 billion in 2022, with a Compound Annual Growth Rate (CAGR) of 7.5% between 2018 and 2022 (AndamanMedical, 2021), therefore, there is much room to help regenerate the economy and become a beacon of medical device innovations in the future while at the same time, offer a specialized hospital setting for one of Thailand's most foreseeable societal demands, elderly care.

Collaborations for Optimized Health Care Access at KMCH

Globalization provides a flat health care environment that converges physical and virtual innovations. According to the UN, in order to rollout adequate health care for developed countries, technologies in medical fields are necessary to propel less developed nations and regions to rapidly catch up with those that are more advanced ("Globalization of healthcare", 2012). Unfortunately, a flattened health care landscape and COVID-19 pandemic has put a great strain on medical physicians, nurses and other health care professionals (WHO, 2019). The impending lockdown and quarantine measures have stunted the growth prediction in Thailand an all-time low at 2.2 percent (down from 3.4 percent) for 2022. It is forecasted that economic activity is not likely to return to pre-pandemic levels until after 2022, with a gradual and uneven recovery (Belhaj et al., 2021).

To cope with these staggering medical personnel shortages and the digital divide, the KMCH will utilize many of the world's most innovative medical systems to offer customized health care to all patients with the development of value-based and impactful MedTech innovations for society. Collaborations with global technological industry giants and Thailand's leading insurance providers allows for more effective and more extensive outreach without creating a load on medical care providers. In addition, telemedicine, once a dream, but now a reality in real practice, will become the mainstay for a more remote and agile setting where a comprehensive health care ecosystem can be always accessible via KMCH and its network of hospitals and partner organizations, both public and private, from all 77 provinces in Thailand. Innovative Elderly Care at KMCH

It is estimated that by 2040, 17 million Thais will be 65 years or older. (World Bank, 2016) With over a quarter of the population in position to be exposed to elderly diseases including arthritis, osteoporosis, heart disease, neuro-degenerative diseases including stroke, dementia, Alzheimer's, Parkinson's Disease, chronic kidney disease, diabetes mellitus, access to effective and efficient health care is imperative.

KMCH will not only become an elderly hub as the nation's specialized hospital for the elderly but it will also be home to groundbreaking initiatives to develop Health Tech innovations for Ageing societies and for those Ageing in Place. Researchers, innovators, physicians, physical therapists and many other health care professionals will make up a team of multi-disciplinary knowledge that will help seek out new state-of-the-art innovations to help reduce the physical and metal burden of commuting to the hospital, especially in an elderly state.

Since the state of the elderly varies, Thailand's Long-Term Care (LTC) initiatives developed by the National Health Commission Office (NHCO Thailand, 2020) give way to new and innovative approaches. These include a new concept for membership health care services to provide elderly members key access to expedited health care outlets in the KMCH hospital will allow elderly patients to receive proper medical attention in the comforts of their own home.

Depending on the type of care that is needed by the eldery, active or dependent, KMCH and its team of health care professionals offer remote health care and at-home diagnostic devices that are developed locally as cost-effective and time-efficient tools to aid this growing demographic group. From environment modification, health literacy and health promotion devices, it can offer the elderly the freedom and flexibility to engage with their health status, reducing the need for health care providers. While for the dependent, medical devices to aid the community LTC, volunteer and family members can be locally developed and customized for each community/home-based need.

*Our Own National Testing Center for Medical Devices* 

It is undeniable that the heavy dependence on imported medical devices and supplies from USA, Europe, Japan and other nations creates a barrier to providing adequate health services to the entire Thai population. In 2021, the Thai Food and Drug Administration (Thai FDA) issued new medical device regulations as part of an effort to align the country's regulatory system with rules established in the ASEAN Medical Device Directive (AMDD).

Currently, it takes anywhere from 2-8 months, and sometimes even longer, for the approval of medical device imports in Thailand (Thai FDA, 2022). The process depends heavily on product registration and product specifications, which some products may be outside of the Thai FDA's scope of knowledge. At which time, the product or device must gain approval rom the host nation's FDA body. This back-and-forth between the two or sometimes, three governing bodies, causes a delay and backlog in importation of medical devices. Especially in emergency times including the recent COVID-19 Pandemic, a shortage of respirators and other essential medical devices occurred in part, by this strict regulation for such imports.

Some reasons for this overly long approval process include, 1) heavy import taxation cost, 2) time to receive approval from the Thai FDA, 3) lack of knowledge/experience in medical devices in the approval process. Since the Thai FDA is responsible for all food and drug approval, it has been burdened with yet another arm of regulatory work in the medical device approval process. With expertise in the first two, the latter poses as a gap in know-how as now there must be more acquisition of medical device experts to contribute in the medical device and innovations industry.

As such, the KMCH, the hub for medical device innovation and development in the region, is gearing up its medical device clout with plans to establish the National Testing Center for Medical Devices (NTCMD). This independent body will be similar to that of the TFDA but with the main purpose to grant regulatory approval for both domestic and foreign medical devices and supplies that will either be imported from abroad or made here in Thailand. This governing body will allow for experts in the field to take part in the approval process in order to expedite the use of medical devices and to reduce the time from product development to time these products can be used in the medical and health care markets.

Working alongside the TFDA, the NTCMD will be able to specialize in the medical device regulatory and approval field while the TFDA can focus on its core competencies in food and drug regulation. This allocation of duties can help alleviate the burden on already strained government agencies like the TFDA and has the potential to shorten the regulatory approval process for more efficient and effective action, helping desperately needed local, cost-effective medical devices to the Thai population. This initiation of the NTCMD by KMCH will upscale Thailand's role in the medical device and innovation industry, ultimately helping the nation become more independent in the global health care ecosystem on the whole.

#### Conclusion

The COVID-19 pandemic has disrupted the entire world, giving way to many new opportunities to scale up current health care systems in Thailand and reduce the dependency on costly and scarce imported medical devices. King Mongkut's Institute of Technology Ladkrabang (KMITL) has led the way to developing local medical devices to serve the needs of the nation's citizens during the pandemic. To navigate future health care trends of disease migration and elderly population, the establishment of the King Mongkut Chaokhunthahan Hospital (KMCH) under royal patronage of the supreme patriarch, will become an integral part of a new, globalized medical ecosystem where remote treatment, health equity and lower economic burden are a reality for underserved and elderly populations throughout the nation.

### Acknowledgement

We would like to thank the King Mongkut's Institute of Technology Ladkrabang, its former President, Professor Dr. Suchatvee Suwansawat, Acting President, Associate Professor Anuwat Jangwanitlert, Ph.D., all Vice Presidents and Assistant Presidents, all Deans, all Directors and the entire Administrative Team along with all staff of the institute for their help and support to achieve our COVID-19 goals during the pandemic.

#### References

AndamanMedical. (2021). *Thailand's Medical Device Market*. Retrieved April 1, 2022, from https://andamanmed.com/target-markets/thailand/ Bangkokpost. (2021a). *Uncertainty continues*. Retrieved March 15, 2022, from https://www.bangkokpost.com/business/2162323/uncertainty--continues.

Bangkokpost. (2021b). *Warning: Merge ahead*. Retrieved March 15, 2022, from https://www.bangkokpost.com/business/2184587/warning-mer-ge-ahead

Bangkokpost. (2022). *Demographic doomsday*. Retrieved March 15, 2022, from https://www.bangkokpost.com/business/2248547/demographic--doomsday

Bank of Investment of Thailand. (2022). *Medical Device Industry in Thailand.* Retrieved April 1, 2022, from https://www.boi.go.th/upload/content/ Infopack\_MedDevice.pdf

Belhaj, N., Belghith, H., Arayavechkit., T. (2021). *Impact of COVID-19 on Thailand's households – insights from a rapid phone survey*. Retrieved March 21, 2022, from https://blogs.worldbank.org/eastasiapacific/impact-covid-19-thailands-households-insights-rapid-phone-survey Bohr, A., Memarzadeh, K. (2020). The rise of artificial intelligence in healthcare applications. Artificial Intelligence in Healthcare, 25-60. doi: 10.1016/B978-0-12-818438-7.00002-2

Department of Disease Control Ministry of Public Health Thailand. (2021a). *Clinical practice guideline for diagnosis, treatment and prevention of COVID-19 infection for health personnel in healthcare facilities.* Retrieved March 21, 2022, from https://ddc.moph.go.th/viralpneumonia/eng/guideline\_hcw.php

Department of Disease Control Ministry of Public Health Thailand. (2021b). *Corona virus disease (COVID-19): Thailand situation*. Retrieved March 21, 2022, from https://ddc.moph.go.th/viralpneumonia/eng/index.php

Elango, D. (2020). COVID-19 effects on tourism and business in Thailand. Retrieved March 21, 2022, from https://ssrn.com/abs-tract=3769908

Ferguson, N. M., Laydon, D., Nedjati-Gilani, G., Imai, N., Ainslie, K., Baguelin, M., Ghani, A. C. (2020). Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand. Imperial College COVID-19 Response Team, doi: doi.org/10.25561/77482 Jackson, J.K., Weiss, M.A., Schwarzenberg, A.B., Nelson, R.M., Sutter, K.M., Sutherland. M.D. (2021). Global economic effects of COVID-19. Congressional Research Service.

Kenan Foundation Asia. (2022). *3 consequences of COVID-19 on Thai Education*. Retrieved March 15, 2022, from https://www.kenan-asia.org/ covid-19-thai-education/

Hoy, C., Wood, T., Moscoe, E. (2021). *The drivers of COVID-19 vaccine hesitancy and how to address them: Evidence from papua new guinea.* Retrieved March 15, 2022 from https://blogs.worldbank.org/developmenttalk/ drivers-covid-19-vaccine-hesitancy-and-how-address-them-evidence-papua-new-guinea

International Trade Association. (2022). *Thailand-Country Commercial Guide: Medical Devices.* Retrieved March 21, 2022, from https://www.trade.gov/ country-commercial-guides/thailand-medical-equipment Manakitsomboon, H. (2021a). *Total number of doctors in* 

*Thailand in 2021, by administration*. Retrieved March 28, 2022, from https://www.statista.com/ statistics/995658/thailan-

d-total-number-doctors-administration/#:~:text=In% 202020%2C%20 the%20total%20number,amounted%20to%20around%2036.5 %20tho-usand

Manakitsomboon, H. (2021b). *Ratio of doctors to population Thailand 2011-2020*. Retrieved March 28, 2022, from https://www.statista.com/statistics/1191929/ thailand-doctor-ratio-to-population/

Ministry of Public Health. (2021). Strategic plan: Covid-19 strategy: Managing the new wave of the covid-19 epidemic. Ministry of Public Health. National Health Commission Office Thailand. (2020). Development of Long-Term Care for Dependent Elderly People. Retrieved March 28, 2022, from https://www.adb.org/sites/default/files/publication/661736/thailand-country-diagnostic-study-long-term-care.pdf

Parpart, E. (2020). BOT cuts policy interest rate while Thai baht strengthens with hopes or tourism recovery. Retrieved April 1, 2022, from https://www.thaienquirer.com/13308/bot-cuts-policy-interest-rate-while-thai-bahtstrengthens-with-hopes-for-tourism-recovery/

Ruksakulpiwat, S., Zhou, W., Chiaranai, C., Saengchut, P., Vonck, J.E. (2022). Age, sex, population density and COVID-19 pandemic in Thailand: A nationwide descriptive correlational study. *Journal of Health Science and Medical Research*, 40(3). doi: dx.doi.org/10.31584/jhsmr.2021836

RYT9 (2021). *KMITL announces successful development of KMITL High--Flow Oxygen Concentrator with remote monitoring capabilities*. Retrieved April 1, 2022, from https://www.ryt9.com/en/prg/250815

Thammachote, P., Trochim, J.I. (2021). *The impact of the COVID-19 pandemic on Thailand's agricultural export flows*. USAID Feed the future initiative, USA.

Uansri, S., Tuanggratananon, T., Phaiyarom, M., Rajatanavin, N., Suphanchaimat, R., Jaruwanno, W. (2021). Predicted impact of the lockdown measure in response to coronavirus disease 2019 (COVID-19) in greater Bangkok, Thailand, 2021. *International Journal of Environmental Research and Public Health*, 18(23), 12816. doi: doi.org/ 10.3390/ ijerph182312816

Unicef. (2020). *Policy brief: The impact of COVID-19 on children.* Retrieved April 1, 2022, from https://unsdg.un.org/sites/default/files/2020-04/160420\_Covid\_Children\_Policy\_Brief.pdf

Unicef. (2021a). *Mission: Recovering education in 2021*. Retrieved April 1, 2022, from https://www.unicef.org/reports/mission-recovering-educa-tion-2021

Unicef. (2021b). *COVID-19 pandemic continues to drive poor mental health among children and young people*. Retrieved April 1, 2022, from https://www.unicef.org/thailand/press-releases/covid-19-pandemic-continues-drive-poor-mental-health-among-children-and-young-people

United Nations. (2020). Social impact assessment of COVID-19 in Thailand. UK: Oxford Policy Management Limited.

World Health Organization. (2020). *Situation report-60 SITUATION IN NUMBERS total (new) cases in last 24 hours WHO RISK ASSESSMENT global level very high*. Retrieved April 1, 2022, from https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200320-sitrep-60-covid-19.pdf?sfvrsn=8894045a\_2

World Health Organization. (2022). *WHO Coronavirus (COVID-19) Dashboard.* Retrieved April 1, 2022, from https://covid19.who.int/ World Health Organization. (2020). *THAILAND How a Strong Health System Fights a Pandemic.* Retrieved April 1, 2022, from https://www.who. int/docs/default-source/coronaviruse/country-case-studies/thailand-c-19-case-study-20-september.pdf

World Bank. (2021). COVID-19 Crisis Lowers Thailand's Growth, Continued Support for the Poor Needed. Retrieved April 3, 2022, from https://www. worldbank.org/en/news/press-release/2021/07/15/covid-19-crisis-lowers-thailand-s-growth-continued-support-for-the-poor-needed World Bank. (2016). Thailand Economic Monitor - June 2016: Aging Society and Economy. Retrieved April 3, 2022, from https:// wwwworldbank.org/en/country/thailand/publication/thailand-economic-monitor-june-2016-aging-society-and-economy#:~:text=Thailand%20Economic%20Monitor%20%2D%20June%20 2016%3A%20 Aging%20Society%20and%20Economy,-This%20page%20in&text=Thailand's%20economy%20shows%20signs%20of,compared%20to%20 0.9%25%20in%202014.

# Continuity of Education in the Post-Pandemic Era: Implementation of the Smart Postman Concept in the Sri Lankan Educational System

Kaushalya Yatigammana<sup>1\*</sup>, Gamini Wijayarathna<sup>2</sup> <sup>1</sup>Department of Commerce & Financial Management, Faculty of Commerce & Management Studies, University of Kelaniya, Sri Lanka.

<sup>2</sup>Department of Software Engineering, Faculty of Computing and Technology, University of Kelaniya, Sri Lanka.

\*Corresponding author: kaushalya@kln.ac.lk

#### Introduction

The Covid-19 pandemic challenged the sustainability of the widely accepted and well-tested face-to-face teaching and learning pedagogy and opened its vulnerability to crisis situations like the Easter Sunday attack in April 2019 in Sri Lanka and the spreading of the Coronavirus worldwide in 2020. Sri Lanka has also had no other option but to switch to online learning immediately as a recovery option similar to other countries in the world for uninterrupted education of the country. The Ministry of Education, Sri Lanka, has further extended the means of reaching students by state owned Gurudegdara Educational TV channel through "Eye" and "Nethra" channels of the Sri Lanka Rupavahini Corporation, Radio Gurugedara and E-Thaksalawa (https://www.e-thaksalawa.moe.gov. Ik. in addition to the online teaching during Covid-19 pandemic since 65% of the student population has no Internet access for online education (State Ministry of Education Reforms, Open Universities and Distance Learning Promotion, 2021).

The weakness of the guidelines prepared by the Ministry of Education is that it does not consider the possibility of delivering pre-recorded multimedia lessons to the students and letting them study these materials offline. The guidelines address the use of Internet, Television, Radio, and Printed materials only. However, it leaves room for such offline learning too.

"Selection of printed subject contents on behalf of the students who do not have access to distance education through online or other electronic methods and preparation of relevant lessons in simple language so that it is easily comprehensible." (State Ministry of Education Reforms, Open Universities and Distance Learning Promotion, 2021)

We address the serious issue of connecting the 65% unconnected student population (Department of Census and Statistics, 2020) in Sri Lanka through a hybrid delivery mechanism using Bluetooth technology in addition to the Internet to deliver the micro content and the health issues related to online learning in the Smart Postman project we describe in this chapter.

## Adaption of Microlearning

Microlearning is a popular learning concept used in the corporate sector (Redondo, Rodríguez, & Es, 2021). Microlearning (ML) provides meaningful bit-sized content to the learners to achieve a specific learning experience. ML is mainly used in the corporate sector to give busy professionals a learning experience within a shorter period. As these ML contents focus on a specific topic/learning objective and are more generic, they can be used repeatedly in any context once developed. Therefore, ML gives a lot of cost savings to the industries it adapts. (Mohammed, Karzan, & Nawroly, 2018). Due to the advantages of ML, it can be adapted in the education sector to mitigate the following problems that arise with the mass adoption of online learning due to the Covid 19 Pandemic.

1. Poor Internet connection prevents students from connecting to online sessions, downloading large files, and they consume a lot of space in the devices and require multiple attempts in downloading.

2. Teachers find it difficult of sending multimedia lessons through social media due to maximum limitations on uploading file size

3. Starring long hours in front of a computer screen which is not suitable for the students' health

Therefore, through this Smart Postman project, it is suggested adapting ML to solve the problems mentioned above.

### Hybrid Connectivity model

The Smart Postman project implemented a hybrid connectivity model in which micro contents (digital learning materials) are delivered to the students using the internet in the areas where connectivity to the internet is available and the Bluetooth technology in the coverage holes. There are two main features of the Smart Postman project:

1. Use of microlearning to create microcontent to reduce the size of a file traveling in the communication network and to reduce health issues of students sitting and staring long hours at a small screen

2. Use of hybrid connectivity mode to deliver micro contents through the Internet and the Bluetooth technology in the coverage holes.

#### Methodology

This Study conducted in two phases. In the first phase it was implemented in a higher educational institute i.e in University of Kelaniya, in Sri Lanka and in second phase it was implemented in general education system as a pilot project in Polonnaruwa district in Sri Lanka.

# Case I: Higher education sector (Microcontent based Blended learning using Internet connectivity)

The Micro Learning (ML) concept was tested with 79 students who follow the Management of Technology course unit in the Department of Commerce and Financial Management, University of Kelaniya. This was a two-credit course unit that was supposed to cover 30 hours of learning. After experiencing the students' difficulties of connecting to live lectures every week and also experiencing the difficulties of uploading a two-hour recorded lecture to the LMS, the following procedure (a hybrid method of using asynchronous and synchronous learning) was implemented as a solution for this.

1. Mini videos (pre-recorded micro-lessons) were prepared for each lesson based on the learning objectives to be achieved. The time span of these videos was 10-15 minutes. These videos were uploaded to the LMS.

2. Supplementary materials were also uploaded, such as webpages,

YouTube videos, chapters, etc.

3. Activities were added as assessments which should be completed and submitted through LMS every week.

4. A live lecture (Face-to-face) was conducted in every three weeks to discuss the matters related to asynchronous lectures in previous weeks. Case II: General education sector (Microcontent based Blended learning using hybrid connectivity: Internet and Bluetooth)

A pilot study was conducted using 2 two schools in Polonnaruwa district of the North Central Province in Sri Lanka. One school namely, Jayanthipura junior school is situated 215km away from Colombo on the A11 Road and 1km away from the A6 highway (Ambepussa - Trincomalee H/W). Other school, Divulankadawala President's college is located in Hingurakgoda, which is 15km away from Minneriya, which is on the A6 highway (Ambepussa - Trincomalee H/W).

They have been using online teaching as instructed by the Ministry of Education. They have also been using a distribution of printed materials for the students who have no Internet access or connecting devices, through a person designated as a school postman. We have applied a hybrid mode of delivery, that is, both Internet and Bluetooth connections, to deliver the micro-lessons created by the teachers using the Smart Postman project, which will be described as follows.

Designing of Micro contents

It was a challenging task of designing micro-lessons for the teachers in the field of the general education sector, as it is a pretty new teaching methodology for them. The micro lesson design methods already developed by the scholars are considered tool development. The local teachers in Sri Lanka have difficulties in understanding and absorbing highly technical procedures. Therefore, our initial task was to develop a set of simple guidelines on the following:

- 1. How to identify the content to be created as a micro content
- 2. How to develop a lesson plan for micro-content
- 3. How to develop the script for the micro-content

4. How to convert the micro lesson into digital content

How to identify the content to be developed as a micro content

The National Institute of Education (NIE) has given the mandate to prepare curriculums for national general education. The recommended curriculum for school education can be downloaded from https:// nie.lk/ndownload. A Concept map has been prepared using the curriculum introduced by the National Institute of Education (NIE), Sri Lanka, to develop micro lesson plans based on the existing syllabus by teachers themselves for their respective subjects. Guidance of identifying the micro-content for a subject prepared is shown in Appendix A.

The curriculums prepared by the NIE has the following structure:

- 1. Lesson
- 2. Competency level
- 3. Learning outcomes
- 4. Activities

The bottom level "Activities" have been selected for developing Micro Contents. The flowchart shown below depicts the process adapted for Micro Content developments.

#### How to develop a lesson plan for micro-content

After identifying the micro-content to be developed by following the procedure above, the next task of the teacher is to develop the lesson plan which suits the micro-content. Even though the teachers are trained and experienced in preparing lesson plans for face-to-face lessons, developing a lesson plan for micro-content, which is going to be developed as digital content, was a challenge. Therefore, we had to develop a template/guide for this purpose.

This guideline is shown in appendix B. According to the guideline, teachers should fill the content they are going to cover under a specific competency level and also should identify the images they are going to use for the content too.

*How to develop the script for the micro-content* 

The next task of the teachers in developing micro-content is to write the script. They were asked to write the script as a story that would attract the students to the content. Also, at the scriptwriting stage, we specifically requested them to concentrate on the timing factor. We developed a guideline for developing the script too, and it is shown in Appendix B.

How to convert the micro lesson into digital content

After writing the script as the next task, they record the lesson using Mp3 recorders on their smartphones. In this process, we found that some teachers are too fast in voice recording and some are very slow, and some of them are moderate in speed. Thus, we analyzed the word count per minute to speak in order to understand a lesson and found that 90-100 words per minute are the best word count to be spoken. During this stage, teachers gathered the relevant images (including animated gifs), recorded lessons, and they also prepared the additional note to be given to the students as a text file.

Microcontent creation using NeLCon Studio Software

As a solution for the problems mentioned in the above section, University of Kelaniya introduced a software tool named NeLCon Studio which can be used to develop digital educational materials easily with less file size. NeLCon Studio facilitates educators to develop e-learning content using recorded MP3 voice, multiple images, and text (Yatigammana & Wijayarathne, 2020). During this training process, we encouraged teachers to develop micro-learning content for 8-15 minutes. The purpose of this was fourfold.

1. To provide a lesson with meaningful content to grab the essence of the topic.

2. To increase the retention rate of the students for digital content.

3. To minimize the health issues of the students by sitting in front of a digital screen for long hours

4. To reduce the file size of a lesson to overcome the problem of less

bandwidth of the Internet.

Appendix C shows the screen-captured of the micro-lessons developed by the teachers using NeLCon Studio. Once the student downloads the file, they can go through it repeatedly using the NeLCon Player app (Google Play Store) without the Internet. The Figure 3 depicts this procedure graphically.

*Quality assurance guidelines for digital contents of the University of Kelaniya* While training teachers on NeLCon Studio, the problem encounte-

red was to evaluate the quality of the digital lessons developed. Measuring the quality in digital educational materials has not been introduced to the quality assurance process of Sri Lanka until such time. Therefore, University of Kelaniya developed a quality assurance guideline for the first attempt of that nature in Sri Lanka (Wljayarathna, Yatigammana, & Priyankara, 2020). This guideline can be accessed thorough https://units.kln. ac.lk/qac/images/Policy\_on\_Digital\_resources.pdf

Results

## Case I: Higher education sector-University of Kelaniya, Sri Lanka

Student feedback was obtained during the semester, and Figures 1 and 2 show that they have accepted this teaching method over fully online learning sessions.

1. How do you like the pre-recorded structured video lessons that I am giving? 49 responses.



Figure 1: Likeness of pre-recorded video lectures.

8. How do you like the new method of teaching adopted? 49 responses.



Figure 2: Likeness of the new teaching method adopted.

Therefore, to continue the education in a turbulent environment for a less privileged community, the most preferred method would be:

1. Microlearning content, i.e., between 10-15 min of a video lesson

2. Face to screen lessons (online, real-time) only to discuss the matters arising from the lessons.

3. Activity/ activities to be done at home

Case 2: Smart Postman project General education sector (Microcontent based Blended learning using hybrid connectivity: Internet and Bluetooth)

Feedback from the teachers participating in the Smart Postman project.

A Google form with two open-ended questions and 18 Likert scales (1 to 5) survey questions were given to teachers involved with the Smart Postman project to get the feedback from them on the project, the use of Micro Contents in teaching and learning, and the process of creating Micro contents from the curriculums, and the Bluetooth delivery of lessons. Even though there were 25 teachers involved with the project, only Ten (10) responded due to the ongoing strike by the teachers and principals in Sri Lanka during the project. The subject areas of teachers who participated in the survey are Primary education, Dancing, Geography, Science, Mathematics, ICT, and Engineering Technology. The feedback received are shown in Table 1.

Question	1	2	3	4	5
Did you know about micro lessons before this project? (1 - Yes, I knew very well, 5 - No, knew nothing)				2	8
What is your opinion on imparting the required knowledge to the students through micro lessons? (1 - This method can provide more knowled- ge in a short period of time, 5 - This method does not provide the required knowledge to the students)	10				
Do you think limiting the time of a micro les- son to 15 minutes is in line with the learning pattern of the students? (1 - Yes, it fits very nicely, 5 - No, it does not fit at all )	10				
Do micro lessons help to reduce students' mental and physical problems? (1 - Yes, micro-lessons help to minimize the mental and physical problems of students, 5 - No, it will only aggravate the mental and physical problems of the students)	7	3			
Is the purpose of this project successful in distributing micro-lessons to students via Bluetooth? (1 - Yes, successful, 5 - No, failed)	3	6	1		

Table 1: Feedback from the teachers for Smart Postman Project.

Is the methodology used to prepare the micro lesson plan successful? (1 - Yes, this enabled me to present the highlights of the lesson in a very short time and in a concise manner, 5 - No, it is a failure)	7	3		
Was the method used to prepare the script for the micro lesson successful? (1 - Yes, very successful. It helps to manage time and adjust the images to suit the con- tent of the lesson, 5 - No, it is very unsuccessful)	7	З		
What is your opinion about adding a short note to the micro lesson? (1 - Very good, 5 - No, it's better to use that space to show the image)	8	1		1
Will this project take education in Sri Lanka in a different direction? (1 -Yes, it points in a very good direction, 5 -No, it only gets worse)	8	1		
What is your opinion about creating NeLCon lessons by including recorded sound, short notes, and images? (1 - It was very easy, 5 - No, it's a very difficult task)	1	7	1	1

These responses show the acceptance of Micro-Learning and the delivery of digital lessons using Bluetooth technology by the participating teachers of the two schools.

## Conclusion

The Covid 19 Pandemic increased the disparity of the education system in emerging economies. It challenged the concept of "equal education for all." To shed light on the unprivileged learners in the community, the Smart Postman project was launched by the University of Kelaniya, Sri Lanka.

Through the Smart Postman project, we have addressed two critical issues of online learning in Sri Lanka. Those are

1. Connectivity issues

2. Health issues of the students

Smart Postman project successfully implemented a solution with

1. Micro-content based Blended learning

2. Hybrid connectivity model with Internet and Bluetooth connectivity.

We believe that this is an eye-opening experience for policymakers. The benefits of this exercise will not reach every corner of the country unless policymakers realize the advantages of adapting microcontent-based blended learning as a teaching and learning pedagogy in Sri Lanka and encourage the Department of Post of Sri Lanka to implement the concept of Smart Postman Island wide. Government support is a must for this kind of paradigm shift to happen in Sri Lanka. The Ministry of Education should expand the possibility of higher education institutes in Sri Lanka to engage in this kind of research and development work in digital learning, especially in online examinations.

The most welcome guidelines issued by the Ministry of Education (State Ministry of Education Reforms, Open Universities and Distance Learning Promotion, 2021) requested the content developers to submit their digital lessons to be included in their e-repository: e-thaksalawa. These guidelines should be expanded by incorporating similar approaches we used to identify, design, and construct micro-contents. If not, it will produce a disorganized e-repository where a massive number of similar micro-contents are stored. The learning community will have difficulty of finding the most suitable micro-contents for them. Automated cataloging of micro-content should be implemented. This needs more research on metadata should be promoted, and an appropriate metadata schema should also be adopted. A well-designed metadata scheme will help to create catalogs for efficient searching and connecting different micro contents.

The present form of online learning influenced by connectivity, health, education, social and economic factors. The policymakers should adapt a sound ecosystem for digital learning which can address all these issues in one model. However, it is difficult to find such an ecosystem. Therefore, more research on designing a suitable digital learning ecosystem should also be promoted.

#### References

Department of Census and Statistics. (2020). *Sri Lanka Labour Force Survey.* Ministry of Economic Policies and Plan Implementati.

Mohámmed, G., Karzan , K., & Nawroly, S. (2018). The Effectiveness of Microlearning to Improve Students' Learning Ability. *International Journal of Eductaional Research Review*, 3(3), 32-38.

Redondo, D., Rodríguez, C., & Es, L. (2021). Integrating micro-learning content in traditional e-learning platforms. *Multimed Tools Appl,* 80, 3121–3151.

State Ministry of Education Reforms, Open Universities and Distance Learning Promotion. (2021). *Circular and Guidelines on Distance Learning for School Education in Sri Lanka*. State Ministry of Education Reforms.

WIjayarathna, G., Yatigammana, K., & Priyankara, C. (2020). Assurance of Quality of Digital Learning Resources. University of Kelaniya.

Yatigámmana, M., & Wijayarathne, P. (2020). NelCon Studio: An e-learning Content Development / Playing platform for Blended Learning and Micro--learning. *Solid State Technology*, 63(2). Appendix A: A Concept Map prepared to decide Micro Contents for the subject "Sinhala Language" for Grade 5 classes.



#### Procedure of developing micro content Appendix B: Templates for micro lesson planning and script

#### SMART POSTMAN PROJECT Lesson Planning

		Α	rm	Fo
--	--	---	----	----

(Fill only one form	n for each lesson plan)
School	
Name of the	
Teacher	
Subject	
Grade	
Competency	
(With number)	
Pre-Competency	
(With number)	
Post	
(with number)	
Learning	1.
Objectives	2.
	3.
	4.
Date	

#### SMART POSTMAN PROJECT Lesson Planning <u>Form B</u>

eparing the lesson in microlearning mode

۱.	Use	one	model	for	one	skill	level.	
		Eil+I	bree for	rme	for	three	competency	Invol

Competency Competency level

number)		
Learning Objectives	Content of the subject	Minutes
1.	Content of the Subject 1 1.	
	2.	
	Pictures	
	1.	
	2.	
	3.	
2.	Content of the Subject 2	
	1.	
	2.	
	3.	
	Pictures	
	1.	
	2.	
	3.	

#### SMART POSTMAN PROJECT Lesson Planning <u>Form C</u>

After Work/Homework Enter at least one	<ol> <li>Homework relevant to making sure the content of the lesson is understood</li> </ol>
homework for each homework type	<ol><li>Homework related to applying the content of the lesson to the students in their daily life</li></ol>
	<ol> <li>Homework to develop creative skills in students</li> </ol>
Recommendation - Principal	
Recommendation- Director NELRC	
Date	

#### SMART POSTMAN PROJECT

#### Instructions for writing e-learning scripts

1. Identify the student group relevant to the lesson and understand their nature

- 2. Plan the lesson using the given formats so that the lesson flows correctly and important parts of the lesson are not missed.
- 3. Use conversational, non-formal (informal) language in the same way you teach students in the classroom. But always protect professionalism.
- 4. Use speech, tone, and language suit to students
- 5. Address students directly. That is, you, yours, we, and so on.
- 6.Adjust the script so that it has a connection to the students and their environment, i.e.
- get information from things related to the daily life of the students.
- 7. Avoid re-reading the text displayed on the screen. In addition to what appears on the screen, make descriptions.
- 8. Manage time accurately according to the diagram on the screen and in accordance with the subject matter therein
- 9. Use short sentences (this is especially important when teaching complex subjects)
- 10. Use authorial language for an engaging, positive, and motivating speech
- 11. Avoid word of mouth, vernacular traditions, vernacular references, etc.
- 12. Avoid using any words that are difficult for students to understand
- 13. It is better to shorten the script by removing information, words and phrases that are not important to the skill and without repeating the same thing
- 14. Speak only in relation to the topic

First picture of the lesson

- 15. It is not necessary to fill in the blanks / parts with words that require silence
- 16. Read the script aloud before recording
- 17. If the recording is done by someone else, let the voice recorder read the script aloud first. Sometimes you must change the script from person to person.
- 18. Use the format below to write your script
- 19. Try to keep the number of words between 85 and 95 in a minute. If it exceeds 100 words, reconsider changing it. Exceeding 100 words can make it difficult to understand. 20. Prepare the first and last images according to the format below .

Final Picture of the lesson

The message given to the students by the lesson After Class work/Homework

SMART POSTMAN PROJECT



iting the script of the microlearning lesson to re ord in NeLcon Studio

1. Use one form for one competency level. 2. e.g. Fill in the three forms for three competency levels



Subject Photograph of the Grade teache Name of the micro lessor Name of the Learning Objectives teache There may be more than one If one learning outcome is divided into several

lessons, use (Part 1) (Part 2)

Appendix C: NeLCon Lessons

Name of the School

First image of a lesson prepared according to the instructions provided.



An image in the middle of a lesson



Last image of a lesson prepared according to the instructions provided.





# Concert and receptions

ASAIHL 2022 Warsaw guests are kindly invited to the concert and reception which will take place on the September 26<sup>th</sup> and 27<sup>th</sup> from 18:00 to 20:00 in The Columned Hall on the Main Campus.



# Information about the Concert and the Artists



Silken Amber (Jedwabny bursztyn) Maria The project bv Prof. Pomianowska and Mingije Yu is a meeting of two distant musical cultures of the world. A journey of imagination in which on the distant 800 vears long Silk Road wandering musicians from China meet with Polish troubadours. They sing together, play together and learn from each other a different way of thinking about the shaping of emotions or the flow of time in music. The programme will include traditional Chinese and Polish pieces, as well as compositions by Maria Pomianowska's compositions in the style of "world music" dedicated to unusual string instruments.

Prof. Maria Pomianowska has been researching Asian musical cultures for over 30 years, creating projects together with musicians from Iran, India, China, Korea, Japan and the Middle East. She plays many Asian string instruments. In the Polish-Chinese project, Prof. Maria Pomianowska will present the sound of instruments that she reconstructed 27 years ago together with Prof. Ewa Dahlig and the luthier Andrzej Kuczkowski.

Mingjie Ýu comes from the Hubei province, where for years she has been studying the playing of an instrument zheng dating back to ancient times0. During the concert, the artist will present several varieties of the Chinese zither. Mingjie is visiting Poland as a student of Prof. Maria Pomianowska at the Academy of Music in Cracow. She is learning Polish obereks, songs and selected F. Chopin's mazurkas translated into the Chinese zheng zither language.

The concert will thus combine the sound of ancient Chinese zithers with the sound of reconstructed old Polish string instruments.



# ASAIHL 2022 tours

We are happy to invite you to discover one of the most famous Polish cities – Warsaw, Krakow, or Gdansk during the tours designed exclusively for the participants of the ASAIHL2022. See the details below and book your tour today! https://abpoland.com/tours/asaihl-2020-tours

