

A grayscale electron micrograph of a coronavirus particle, showing its characteristic spherical shape and the dense, textured surface of its spike proteins. The particle is centered in the upper half of the frame, with a dark, out-of-focus background. The text is overlaid on the lower half of the image.

Position Paper on COVID-19



Position Paper on COVID-19

Prepared by:
ASM Special Interest Group on COVID-19

Position Paper on COVID-19

©Academy of Sciences Malaysia 2021

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data
Position Paper on COVID-19 / Prepared by: ASM Special Interest Group on COVID-19.

Mode of access: Internet

eISBN 978-983-2915-85-0

1. COVID-19 (Disease).
 2. COVID-19 Pandemic, 2020-.
 3. Government publications--Malaysia.
 4. Electronic books.
- I. ASM Special Interest Group on COVID-19.
616.24144

All Rights Reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior permission in writing from the Academy of Sciences Malaysia.

Academy of Sciences Malaysia
Level 20, West Wing, MATRADE Tower
Jalan Sultan Haji Ahmad Shah off Jalan Tuanku Abdul Halim
50480 Kuala Lumpur, Malaysia

6 /
FOREWORD

8 /
PREFACE

10 /
MEMBERS OF THE SIG ON
COVID-19

11 /
STAKEHOLDERS
INVOLVEMENT

12 /
LIST OF ABBREVIATIONS

14 /
LIST OF FIGURES

14 /
LIST OF TABLES

16 /
EXECUTIVE SUMMARY

18 /
INTRODUCTION

24 /
FINDINGS AND
DISCUSSION

78 /
APPLICATION OF THE
10-10 MYSTIE FRAMEWORK
DURING THE COVID-19
PANDEMIC

86 /
RECOMMENDATIONS

102 /
CONCLUSION

104 /
REFERENCES

114 /
APPENDIX



Professor Emerita Datuk Dr Asma Ismail FASc
President
Academy of Sciences Malaysia

The COVID-19 pandemic caused by the SARS-CoV-2 virus resulted in significant changes at a massive scale to the world we live in today. In curbing the rapid infectivity of this highly adaptable virus, governments and societies across the world employed various measures and outlined strategies that required undivided commitment from all.

In line with the Academy of Sciences Malaysia's (ASM) mandate in providing the best scientific advice and advocacy that is independent, credible, relevant, and timely, we responded by establishing a Special Interest Group (SIG) on COVID-19. This SIG was established in the early 2020 following the heightened discussion regarding an outbreak of a contagious disease of zoonotic origin at the time. The SIG embarked on a two-pronged initiative to address the short- as well as the long-term need of the nation with regards to addressing the COVID-19 pandemic.

The SIG's short-term goal was to keep the society aware of the aetiology of COVID-19. The SIG, through ASM, published several factsheets on COVID-19 covering aspects including the virus' characteristics, epidemiology, diagnostics, therapeutics, disinfection, and development of vaccines to improve public knowledge to stem the tide of mis-, mal- and dis-information. As the public gained access to accurate yet easy to digest information on COVID-19, they became more informed and amenable to measures introduced by the Government in curbing the spread of the virus as observed from adherence to COVID-19 standard operating procedures (SOP) and the full vaccination of 97.6% adults in Malaysia by December 2021.

As a long-term measure, the SIG embarked on preparing this Position Paper on COVID-19 which discusses Malaysia's preparedness and readiness towards the outbreak of infectious diseases by providing an in-depth case study of COVID-19 spread and its management in Malaysia. Several recommendations on potential strategic interventions have been put forward for consideration to improve our state of readiness for future outbreaks. As we transition towards the endemic phase of COVID-19, newer challenges will arise, and preparedness, quick thinking, and agile decision-making capabilities shall remain important.

The insights presented by this paper shall serve as a precursor to ASM's journey to mainstream Planetary Health, which recognises the inextricable relationship between flourishing natural systems and resources to human health and the health of our planet.

FOREWORD

Several key initiatives were undertaken by ASM in tandem with the development of this Position Paper to complement national response in addressing the pandemic and recovery phase. These included the development of 11 factsheets and the National Immunisation Plan in collaboration with the Ministry of Science, Technology and Innovation and the Ministry of Health Malaysia, leveraging the knowledge and experience of members of this SIG among others in ASM's vast Expert Network.

On behalf of ASM, I would like to thank all ministries, agencies, industry partners, civil society organisations, professional bodies, and the numerous individuals who have contributed their experiences and ideas in making this study possible. Warmest congratulations and a big thank you to the SIG on COVID-19 members led by Professor Dr Rosnah Mohd Zain FASc and the sub-group leaders: Professor Datuk Dr Lokman Hakim Sulaiman FASc on Malaysia's Preparedness for Outbreak of Infectious Diseases Sub-group, Professor Dato' Dr Syed Mohamed Aljunid FASc on the Post-Pandemic Analysis Sub-group, as well as Professor Datin Dr Sameem Abdul Kareem on the Application of Artificial Intelligence (AI) and Big Data Analytics (BDA) Sub-group. Sincerest appreciation to all sub-group members and the ASM Management for the unrelenting hard work and commitment in producing this report.

Finally, I hope that this position paper will benefit the whole-of-nation and whole-of-society approach in the continuous battle against COVID-19 and serve as one of the building blocks in the restoration and preservation of our Planetary Health.



Professor Dr Rosnah Mohd Zain FASc
Chairperson
ASM Special Interest Group on COVID-19

The COVID-19 crisis poses a massive challenge for the world. Almost everyone and everything are affected. While it was primarily a health crisis to begin with, its impact is now evident across various social and economic sectors, as well as industries. The global impact of COVID-19 pandemic have been expected to be immense and long-lasting . Currently, coming into the third year of the pandemic, country leaders are still taking stock of how and when the crippling effect of the SARS-CoV-2 virus pandemic will end.

It has been emphasised that preparedness for the next epidemic or pandemic pathogen should not begin when the current emergency is over (COVID-19 Health Operations and Technical Lead, Emerging Diseases and Zoonoses Unit Head, Health Emergencies Programme, World Health Organisation - Nature Medicine 2021) . Therefore, as early as March 2020, when the pandemic was first declared, in realising the ever-evolving nature of the COVID-19 pandemic at that time, Academy of Sciences Malaysia (ASM) has agreed that efforts should be focused on addressing the immediate concerns of the outbreak through the production of a series of fact sheets. Furthermore, with the availability of the group of ASM experts, an ASM Special Interest Group (SIG) on COVID-19 was formed with the aim of assisting the Malaysian Government in addressing issues relating to the current and future outbreak. Therefore, the SIG was tasked to provide responses and opinions which are backed by facts which could then be communicated to the ministry, and thus assisting them in addressing the overwhelming public response on COVID-19.

The SIG set out to gather accurate information and data regarding COVID-19 from various sectors and relevant ministries/government agencies for the purpose of communication to the public, to support efforts of raising their knowledge and awareness on the disease, as well as stemming the spread of misinformation. Accordingly, the objective of the SIG on COVID-19 is to identify good practices, lessons learned, as well as gaps in preparedness and response to COVID-19 spread and management in Malaysia, i.e.:

PREFACE

- To assess Malaysia's state of readiness in tackling infectious disease outbreak through an in-depth case study of COVID-19 spread and management in Malaysia
- To discuss and make recommendations on potential strategic interventions that would allow for improved state of readiness in Malaysia for episodes of infectious disease outbreaks in the future

This position paper would not materialise without the support and commitment of many of the experts from ASM Fellows, the Associate Members, the Young Scientist Network, and experts from non-ASM experts. My gratitude goes to all the Head of the Task Forces and their team members for all their dedication and hard work, which have enabled us to come up with this report. It is hoped that this report will give an insight into the considerations on the planning efforts by all relevant authorities in effectively controlling this current COVID-19 or any other future outbreak.

¹Kandel, N., Chungong, S., Omaar, A., and Xing, J. (2020). Health security capacities in the context of COVID-19 outbreak: an analysis of International Health Regulations annual report data from 182 countries. *The Lancet*. 395, 10229, 1047-1053.

²Van Kerkhove MD, (2021). COVID-19 in 2022: controlling the pandemic is within our grasp. Published online: 14 December 2021

MEMBERS OF THE SIG ON COVID-19

Professor Dr Rosnah Mohd Zain FASc (Chairperson)
Professor Datuk Dr Lokman Hakim Sulaiman FASc (Head of Malaysia Infectious Disease Preparedness and Response Sub-group)
Professor Dato' Dr Syed Mohamed Aljunid FASc (Head of Post-Pandemic Analysis Sub-group)
Professor Datin Dr Sameem Abdul Kareem (Head of the Application of AI and BDA for Infectious Disease Research Sub-group)
Professor Datuk Dr Asma Ismail FASc
Datuk Professor Dr Awg Bulgiba Awg Mahmud FASc
Academician Emeritus Professor Dato' Dr Lam Sai Kit FASc
Academician Tan Sri Dato' Dr M. Jegathesan FASc
Professor Datin Paduka Dr Teo Soo Hwang FASc
Professor Dato' Dr Adeeba Kamarulzaman FASc
Professor Dato' Dr Balwant Singh Gendeh FASc
Professor Dr Sazaly Abu Bakar FASc
Professor Dr Shamala Devi K.C. Sekaran FASc
Professor Dr Rofina Yasmin Othman FASc
Professor Dr Raymond Ooi Chong Heng FASc
Dr Goh Swee Hock FASc

MEMBERS OF THE SIG ON COVID-19 SUB-GROUPS

A. MALAYSIA INFECTIOUS DISEASE PREPAREDNESS AND RESPONSE:

Dr Tee Kok-Keng
Dr Phang Kean Chang
Dr Hadzliana Zaina
Dr Le Cheng Foh
Dr Lai Pei Kuan
Dr Alan Khoo

B. POST-PANDEMIC ANALYSIS:

Professor Dr Mohamed Rusli Abdullah
Professor Dr Jamalludin Abdul Rahman
Professor Dr Maznah Dahlui
Professor Ir Dr Denny K. S. Ng
Associate Professor Dr Azimatun Noor Aizuddin
Associate Professor Dr Aznida Firzah Abdul Aziz
Associate Professor Dr Aniza Ismail
Associate Professor Dr Tuti Ningseh Mohd Dom
Associate Professor Dr Oi Boon Hong @ Ong Boon Hoong
Dr Aidalina Mahmud
Dr Kew Si Na
Dr Mohammad Firdaus Abdul Aziz
Dr Mohd Hafiz Jaafar
Dr Amirah Azzeri
ChM Dr Shahrul Nizam Ahmad
Dr Heo Chong Chin

C. APPLICATION OF AI AND BDA FOR INFECTIOUS DISEASE RESEARCH:

Associate Professor Dr Nor Liyana Mohd Shuib
Associate Professor Dr Norisma Idris
Associate Professor Dr Chan Chee Seng
Associate Professor Dr Chiew Thiam Kian
Dr Muhammad Shahreeza Safiruz Kassim
Dr Liew Chee Sun
Dr Hoo Wai Lam
Dr Lim Chee Kau
Noordalilia Ilyana Kiwam
Khairatul Alyani Binti Badari
Jaafar Zubairu Maitama

CONTRIBUTORS TO THE APPLICATION OF 10-10 MySTIE FRAMEWORK

Professor Dr Mahendhiran Sanggaran Nair FASc
Dr Ooi Der Jiun

MAIN WRITER & EDITOR

ChM Dr Shahrul Nizam Ahmad

ASM MANAGEMENT

Puan Hazami Habib, Chief Executive Officer
Puan Nitia Samuel, Chief Strategy Officer
Norazwa Musiran, Senior Analyst
Muadz Norazan, Analyst

STAKEHOLDERS INVOLVEMENT

Ministry of Health
Ministry of Women, Family & Community Development
Ministry of Defence
Ministry of Higher Education
Ministry of Education
Ministry of International Trade & Industry
Ministry of Science, Technology & Innovation
Universiti Malaya
Universiti Sains Malaysia
Universiti Kebangsaan Malaysia
Universiti Putra Malaysia
Universiti Teknologi Malaysia
Universiti Teknologi MARA
Universiti Malaysia Sabah
Universiti Malaysia Sarawak
Universiti Utara Malaysia
Universiti Pendidikan Sultan Idris
Universiti Malaysia Kelantan
Universiti Malaysia Terengganu
Universiti Pertahanan Nasional Malaysia
Universiti Tun Hussein Onn Malaysia
Universiti Teknikal Malaysia Melaka
Universiti Malaysia Perlis
Universiti Malaysia Pahang
International Islamic University Malaysia
Universiti Sultan Zainal Abidin
Universiti Sains Islam Malaysia
Universiti Kuala Lumpur
Multimedia University
Universiti Teknologi Petronas
Universiti Tenaga Nasional
Monash University Malaysia
Sunway University Malaysia
University of Nottingham Malaysia
Universiti Selangor
UCSI University
Taylor's University Malaysia
MAHSA University
International Medical University Malaysia
SME Corporation Malaysia
MERCY Malaysia
Pertubuhan IKRAM Malaysia

LIST OF ABBREVIATIONS

Abbreviation	Definition
AI	Artificial Intelligence
AMM	Academy of Medicine Malaysia
APHM	Association of Private Hospitals Malaysia
APSED	Asia Pacific Strategy for Emerging Diseases
ARIMA	Auto-Regressive Integrated Moving Average
ARP	Account Reconciliation Packages
ASM	Academy of Sciences Malaysia
BDA	Big Data Analytics
BPN	<i>Bantuan Prihatin Nasional</i>
BSC	Biosafety Cabinet
CCM	Companies Commission of Malaysia
CDC	Centre for Disease Control and Prevention
CFR	Case Fatality Rate
CMCO	Conditional Movement Control Order
CPRC	Crisis Preparedness and Response Centre
CT	Computed Tomography
DOSM	Department of Statistics Malaysia
EIP	Epidemic Intelligence Programme
EIS	Employment Insurance System
EPF	Employees Provident Fund
ERP	Employment Retention Programme
FDI	Foreign Direct Investment
FETP	Field Epidemiology Training programme
FGD	Focus Group Discussion
FMFTA	Federation of Malaysian Fashion and Textile Association
FMM	Federation of Malaysian Manufacturers
FTTI	Find-Test-Trace-Isolate
GCI	Global COVID Index
GDP	Gross Domestic Product
GHSA	Global Health Security Agenda
GIS	Geographic Information Systems
GISAID	Global Initiative on Sharing Avian Influenza Data
GISRS	Global Influenza Surveillance and Response System
GP	General Practitioner
GVC	Global Value Chains
ICT	Information Communication Technology
ICU	Intensive Care Unit
IHL	Institute of Higher Learning
IHR	Internal Health Regulations
IHSR	Institute for Health Systems Research
ILO	International Labour Organisation
IMD	Institute for Management Development
IMR	Institute for Medical Research
IMU	International Medical University
JEE	Joint External Evaluation
JHU	John Hopkins University
KPDNHEP	Ministry of Domestic Trade and Consumer Affairs

MAEPS	Malaysia Agro Exposition Park Serdang
MAPCU	Malaysian Association of Private Colleges and Universities
MARGMA	Malaysian Rubber Glove Manufacturers Association
MCO	Movement Control Order
MINDEF	Ministry of Defence
MITI	Ministry of International Trade and Industry
MLT	Medical Laboratory Technologist
MNC	Multi-National Corporations
MOH	Ministry of Health
MOHR	Ministry of Human Resources
MOSP	Malaysia Open Science Platform
MOSTI	Ministry of Science, Technology and Innovation
MPMA	Malaysian Plastics Manufacturers Association
MQA	Malaysian Qualifications Agency
MySED	Malaysian Strategy for Emerging Diseases
NACCHO	National Association of County and City Health Officials USA
NADMA	National Disaster Management Agency
NCD	Non-Communicable Diseases
NGO	Non-Governmental Organisation
NHSA	National Health Security Agenda
NIPPP	National Influenza Pandemic Preparedness Plan
NPHL	National Public Health Laboratory
NSC	National Security Council
PCR	Polymerase Chain Reaction
PHEP	Public Health Emergency Preparedness
PIP	Pandemic Influenza Preparedness
POE	Point of Entry
POS	Point of Sales
PPE	Personal Protective Equipment
PPPS	Public private partnership
PRIHATIN	Prihatin Rakyat Economic Stimulus
PUI	Person Under Investigation
PUS	Person Under Surveillance
RAT	Rapid Action Team
RMCO	Recovery Movement Control Order
RTK	Rapid Test kit
SAGE	Scientific Advisory Group of Experts
SEIR	Susceptible, Exposed, Infections, and Recovered
SIMKA	Public Health Laboratory Information System
SME	Small & Medium-Sized Enterprises
SMTA	Standard Material Transfer Agreement
SOCISO	Social Security Organisation
SOP	Standard Operating Procedure
SRF	Special Relief Facility
TEMCO	Targeted Movement Control Order
TEPHINET	Training Programmes in Epidemiology and Public Health Intervention Network
UNWTO	World Tourism Organisation
WHO	World Health Organisation
WSP	Wage Subsidy Programme

LIST OF FIGURES

Figure 1: Global distribution of emerging and re-emerging infectious diseases (1996 – 2019)	17
Figure 2: Pandemic trigger, preparedness, and response framework	26
Figure 3: Malaysia scores for each of the element of IHR competencies as measured by JEE scoring methodology (2nd Edition)	28
Figure 4: COVID-19 diagnostic testing capacity as of 2nd July 2020	31
Figure 5: COVID-19 cases in Malaysia (25th January – 14th April 2020)	34
Figure 6: The phases of MCO in relation to COVID-19 epidemiologic curve	35
Figure 7: Capacity indicator score for IHR core competencies in the WHO Western Pacific Region countries which have completed the JEE	40
Figure 8: Trend of COVID-19 cases (as of 8th February 2021 in the WHO Western Pacific Region countries which have completed the JEE)	40
Figure 9: Average PPE utilisation rate per hospital, per patient and per staff per day	42
Figure 10: Donations received by MOH	43
Figure 11: Average days of stock for various PPE units at MOH facilities as of 13th April 2020	43
Figure 12: Graphic from the survey, “PPE Availability and Guideline Awareness in Malaysia’s Health Care Facilities (Experience with PPE Shortage)”	44
Figure 13: Graphic from the survey, “PPE Availability and Guideline Awareness in Malaysia’s Health Care Facilities (Opinion on Adequacy of PPE Protection)”	44
Figure 14: Top Exporters of certain COVID-19 goods, 2018	45
Figure 15: Global Trade Networks of Select PPE Products, 2018	46
Figure 16: Bursa Malaysia-listed companies new ventures in COVID-19 related services	48
Figure 17: COVID-19 waves in Malaysia	53
Figure 18: Rt for COVID-19 in Malaysia	55
Figure 19: The CFR for COVID-19 as of 7th December 2020	57
Figure 20: Breakdown of SME Categories in Malaysia	74
Figure 21: SMEs distribution by size, employees, and sectors in Malaysia	74
Figure 22: UIS Indicators – (Malaysia) Enrolment by Level of Education – Enrolment by International Standard Classification of Education (ISCED) Level	79
Figure 23: Potential Losers and Winners during and after the pandemic	84
Figure 24: 2020 Forecast for International Tourism Receipts	85
Figure 25: The 8Es of Post-COVID-19 Information Management Research	94
Figure 26: Trend of Research Topic of COVID-19	95
Figure 27: Number of Children Affected by School Closures Globally	96
Figure 28: AI and BDA Issues and Challenges	104
Figure 29: Number of COVID-19 cases by Epidemiologic week in relation to test sample positivity rate (SPR)	121
Figure 30: National health security threat from migrant workers. The source country of these workers is endemic of these exotic, severe and emerging infections	125
Figure 31: Impact of AI/BDA Recommendations	136
Figure 32 - The Implications of COVID-19 Act	140

LIST OF TABLES

Table 1: Scoring for each indicator reflecting the IHR (2005) core competencies used by JEE	27
Table 2: Threshold of lockdown in selected countries.	39
Table 3: Ethical Principles	49



EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This position paper on COVID-19 encompasses three main parts of discussions gathered by the respective subgroups, namely Malaysia Infectious Disease Outbreak Preparedness and Response, Post-Pandemic Analysis and Application of Artificial Intelligence and Big Data Analytics (BDA). The findings from each subgroup were collected from literature review, survey and focus group discussions (FGD) with experts from various related backgrounds. Malaysia Infectious Disease Outbreak Preparedness and Response subgroup assessed beyond the core competencies as outlined by the International Health Regulations (2005) (IHR) and the Malaysian Strategy for Emerging Disease (MySED) on preparedness and response. Post-Pandemic Analysis subgroup covered the impact of COVID-19 pandemic on health system and socio-economic status of population of Malaysia. The group also reported the analysis on the roles of stakeholders in public and private sector as well as research and development during the COVID-19 pandemic. Application of Artificial Intelligence (AI) and Big Data Analytics (BDA) subgroup covered on the strengths and weaknesses of the current AI and BDA applications in tackling and handling the COVID-19 pandemic in Malaysia. The group also provided some recommendations on the directions and strategies for future disease outbreaks from AI and BDA's perspective.

The subgroups have highlighted the crucial issues and concerns regarding the management and initiatives taken by authorities and stakeholders throughout a year of the pandemic. In terms of preparedness, there were concerns on the basis for each decision made on MCOs, diagnostic capacity, laboratory availability, PPE supply, hospital facilities, pharmaceutical stockpiling and Rapid Action Team (RAT). Post-Pandemic Analysis group emphasised on the data scarcity, heavy workload of primary care teams, public-private partnerships and illegal immigrants. Three main sectors were reported to have been affected by the pandemic, namely education, tourism and SMEs. In addition, the importance of sustainable funding and resources and the exploration of new research area, such as zoonosis were amongst the important things addressed herein. The AI and BDA subgroup reported about the COVID-19 initiatives using AI and BDA applications, including dashboard, modelling, diagnostic and contact tracing.

Based on the highlighted issues, the subgroups have proposed recommendations for the authorities and policymakers to consider to better prepare the nation for future pandemic, should it recur. Those recommendations include the establishment of a national policy and guideline on national mobilisation of resources as well as the independent Scientific Advisory Group of Expert (SAGE) during public health emergencies, to improve national laboratory capacity and response to major outbreak, along with to review the policy on unskilled foreign workers to reduce health security risk policy on strategic industries for national health security agenda (NHSA). As for the socio-economic sectors, a few areas of concern have been put forward, such as governmental support for SMEs, the adaptability of SMEs with the current technology, and application and the improvement of education ecosystem, i.e., internet connectivity and salvaging private higher learning institutions. Smart tourism, capacity and capability building, data sharing and collaboration, and digital transformation were suggested to be seriously looked into and made improvement on in order to lessen the impact of the current and future pandemic.

The legal perspective on the introduction of The Temporary Measures for Reducing the Impact of Coronavirus Disease 2019 (COVID-19) Act 2020 and implication of the act introduced by the government was also discussed herein. Issues and concerns, such as the inability to perform contractual obligations, implication on Housing Development Laws, insurance, Insolvency Act 1967, and responsibility of employer at workplace were also included.

INTRODUCTION



INTRODUCTION

COVID-19 has been declared as a pandemic by World Health Organisation (WHO) on 11th March 2020. After a year, there have been 114,853,685 confirmed cases of COVID-19, including 2,554,694 deaths, as reported by WHO. Vaccination programme has just begun, where 248,987,115 vaccine doses administered and 144,891,811 persons vaccinated with at least one dose, globally. There have been 305,880 confirmed cases of COVID-19 with 1,148 deaths reported in Malaysia, thus far. Malaysia has received a few batches of vaccines with 17,064 vaccine doses administered.

The global community continue to be challenged by emerging and re-emerging infections as a public health problem. Over the last three decades or so, about 40 emerging and re-emerging infections (Figure 1) have made their appearances globally (Morens et al., 2004). Although majority were self-limiting, some were devastating with high fatality rates and damaging socio-economic impact. We have had our share of experience in newly emerging infection in the form of Nipah virus outbreak in 1998-1999 with a case fatality of almost 40%, crippling the billion-ringggit pig farming industry (Chua, 2003). However, none of those infection escalated into a pandemic although there were some concerns with SARS, H5N1 and Mers-CoV. H1N1 was by definition, a pandemic but fortunately a mild pandemic.

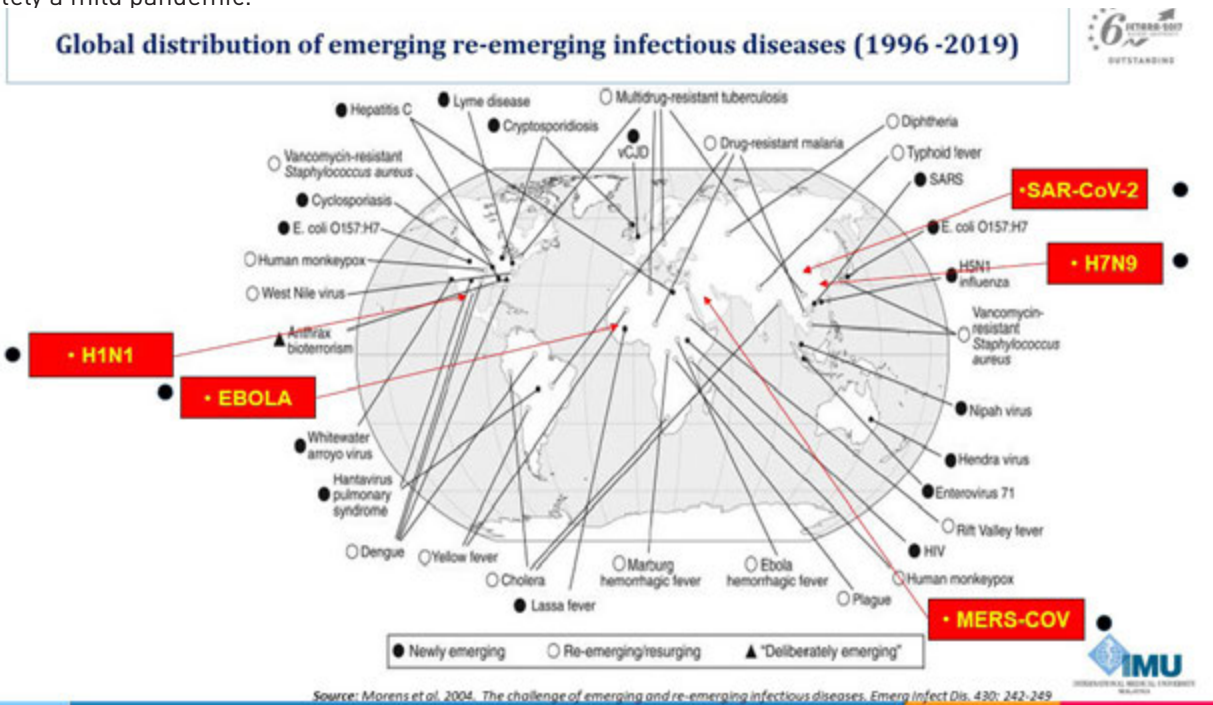


Figure 1: Global distribution of emerging and re-emerging infectious diseases (1996 – 2019) [1]. The highlighted viruses are the most recently emerging.

A large percentage of new and existing infectious diseases in human originated from animal infections (zoonoses) with more than 200 known types of zoonoses (WHO, 2020i). Although not all zoonoses cause pandemics, most pandemics are caused by zoonoses (The Lancet, 2020). This includes the current SARS-CoV-2 which causes the pandemic COVID-19 infection. Amidst conspiracy theories, genetic studies pointed to the Sarbecovirus of the horseshoe bat, as its origin (Boni et al., 2020). The phylogenetic profile of a virus isolated from Malayan pangolins, which has a high Chinese medicinal value, pointed it to be the probable intermediate host (Lam et al., 2020). In Nipah virus, the transmission was from the flying foxes to pigs and to humans (Chua, 2003).

The SAR-CoV-2 virus turned out to be a highly infectious agent. Within just 6 months of its first reporting, it had spread to the entire world from its original epicentre in Wuhan, China, causing a pandemic which was last seen 100 years ago in 1918, caused by the Spanish Flu (Burki, 2020). By 31st December 2020, more than 80 million cases and almost 2 million deaths were reported globally. Malaysia reported the first imported case on 25th January 2020 involving a tourist from China who came with his family members on a holiday trip to Malaysia and Singapore.

Malaysia did well in containing the first two waves of SARS-CoV-2 infection early in the pandemic. In many ways the effectiveness of this initial response reflected the preparedness of the nation to deal with outbreak caused by a newly emerging pathogen. This pandemic provided an opportunity to review our preparedness and response, so that we are more prepared and respond better in the future. Even when the COVID-19 pandemic ends, the threat of infectious disease outbreaks will continue.

The Asia-Pacific Region including Malaysia continues to be threatened by public health emergencies caused by outbreaks of emerging and re-emerging infectious diseases, catastrophic natural disasters, and act of terror including bioterrorism. Emerging and re-emerging infectious diseases, such as Nipah virus, SARS, Avian Influenza, Influenza A (H1N1), Ebola, MERS-CoV, Zika and recently Rabies have caused significant burden and challenges to the national healthcare systems and to the economic growth and development of nations. To address these challenges, Malaysia first developed the Malaysian Strategy for Emerging Diseases (MySED I) Workplan (2012-2015) which provided a common framework for action to implement and strengthen WHO-IHR (2005), and for detecting, preparing, and responding to public health emergencies. It was formulated as part of Malaysia's continuing commitment towards meeting the core capacity requirements to ensure national, regional, and global health security (MOH, 2012). There were 7 focus areas in the MySED I (2012-2015) Workplan which include Surveillance, Risk Assessment and Response, Laboratory Services, Zoonoses, Infection Prevention and Control, Risk Communication, Public Health Emergency Preparedness, and Monitoring and Evaluation.

Evaluation of MySED I (2012 – 2015) was conducted in 2016 which confirmed the importance and relevance of MySED to implement the requirements and obligations under the Internal Health Regulations (IHR) (2005). In line with the Asia Pacific Strategy for Emerging Diseases (APSED) III, the WHO Joint External Evaluation (JEE) and the Global Health Security Agenda (GHSA) documents, while the Ministry of Health (MOH) Malaysia reviewed the MySED I (2012 – 2015) Workplan and identified the need to further enhance its public health response and preparedness strategies. Malaysia Strategic Workplan for Emerging Diseases and Public Health Emergency II or MySED II Workplan (2017-2021) was subsequently introduced (MOH, 2017). The development of MySED II was indeed timely as Malaysia braced the onslaught of a severe pandemic towards the end of MySED II plan of action in 2020. Now is also an opportune time for us to review the preparedness plan under a real case scenario of how we responded to the current COVID-19 pandemic.

Currently, Malaysia is battling with the third wave of the COVID-19 outbreak. The daily new positive cases have already reached four digits. While the situation in Sabah is still worrying, the increasing number of new cases in Klang Valley and Negeri Sembilan had created a new challenge to the MOH, especially when it involved mainly the foreign and also illegal workers. The nature of their living arrangements, population density, health status and compliance to Standard Operating Procedures (SOPs) had resulted in the development of new clusters with higher positivity rate.

A few clusters were recorded from the immigration detention centres and prisons. The situation worsened by the state election in Sabah which also contributed to the third wave of COVID-19 pandemic in Malaysia. The majority of the states in Malaysia were still under the Conditional Movement Control Order (CMCO - with few localities under the Enhanced MCO - EMCO) until 6th December 2020. Only Malacca, Johor, Kedah, and Terengganu continued under the Recovery Movement Control Order (RMCO) until the end of 2020.

On 11th January 2021, the Malaysian Government announced that the MCO will be enacted again starting on 13th January 2021 until 26th January 2021 in all Federal Territories, Selangor, Malacca, Johor, Sabah, and Penang, CMCO in Pahang, Kelantan, Terengganu, Negeri Sembilan, Perak and Kedah, and RMCO in Sarawak and Perlis. This was announced after the daily positive cases recorded were exceeding 2000 cases since early January 2021. It was followed by the emergency proclamation in Malaysia until August 2021 (or earlier, depending on the COVID-19 situation) which has been assented by King Abdullah Ahmad Shah on 12th of January 2020. The proclamation was made to control and flatten the daily COVID-19 positive cases in Malaysia.

Objectives of The Position Paper

To perform a short study and prepare a position paper on COVID-19 in Malaysia that analyses and identifies the strength and weaknesses of current processes in tackling and handling the COVID-19 pandemic, as well as to provide recommendations on the direction and strategies on policies for future disease outbreaks.

This report is divided into 3 main scopes;

Scope 1 : Malaysia Infectious Disease Outbreak Preparedness and Response

The scope of the assessment covers beyond the core competencies as outlined by the International Health Regulations (2005) (IHR) and the Malaysian Strategy for Emerging Disease (MySED) on preparedness and response. It includes pharmaceutical stockpiling, non-pharmaceutical preparedness and capacity and ethics during outbreak response.

Scope 2 : Post-Pandemic Analysis

There are five main scopes of the analysis which are on the situational analysis COVID-19 in Malaysia and the region, followed by the analysis of the impact of COVID-19 on healthcare system, the impact of COVID-19 pandemic on socio-economic status of population of Malaysia, the analysis of the roles of stakeholders in public and private sector in managing COVID-19 pandemic and lastly the analysis on the roles of research and development in relation to COVID-19 pandemic.

Scope 3 : Application of Artificial Intelligence (AI) and Big Data Analytics (BDA) for Infectious Disease Researches

Aside from understanding the status and identifying the strengths and weaknesses of current AI and BDA applications in tackling and handling the COVID-19 pandemic in Malaysia, this position paper also recommends directions and strategies for future disease outbreaks from AI and BDA's perspective.

Methodology

Scope 1

Assessing National Infectious Disease Outbreak Preparedness and Response: Key Concept and Approach

The MySED I (2012 – 2015) and MySED II (2017 – 2021) were developed and planned as comprehensive strategies (all hazards approach) involving multiple stakeholders (not limited to MOH) towards fulfilling obligations of IHR core capacities and strengthening national capacities to prevent, detect, respond to and mitigate health security threat, including pandemic threat. In this assessment, it is therefore appropriate that these strategic plans be used as the basis of assessing the preparedness of the country in responding to emerging infection and disease outbreak, such as COVID-19.

Assessment of National Outbreak Preparedness and Response Capacity

The scope of MySED II (2017 – 2021) was to strengthen and further improve the public health security systems and its functions required for public health emergency preparedness (PHEP) and response for all hazards. In line with the National Security Council (NSC) Directive No. 20 and Mechanism of National Disaster Management and Relief, MySED II aims to provide a high-level framework that can give a common direction and approach to all stakeholders towards preparedness and response to public health emergency. It adopted all hazards approach of the APSED III which emphasises on multi-sectoral approach in capacity strengthening and response (WHO, 2017). In addition, MySED II strengthens the core public health functions, as well as many key healthcare systems, such as the healthcare workforce, service delivery, information and technology system, as well as in leadership and governance, in order to support a more resilient healthcare system (MOH, 2017). There were 8 focus areas in the strategic plan which include:

- Public health emergencies preparedness
- Surveillance, risk assessment and response
- Laboratory capacity
- Zoonoses
- Prevention
- Risk communication
- Regional preparedness, alert and response
- Monitoring and evaluation

The Plan of Actions were developed through multi-sectoral stakeholder engagements which were very comprehensive. For each focus area, the expected outcomes were determined and strategic actions were outlined with measurable action plans and indicators. It was intended that the development and implementation of MySED II will be supported by relevant supporting legislations and guidelines, such as the NSC Directive 20, Prevention and Control of Infectious Disease Act 1988 (Act 342), Food Act 1993 (Act 281), Poisons Act 1952 (Act 366) and various National Guidelines and Standards.

As stated earlier, the IHR (2005) is a legally binding instrument that requires signatory countries to have the minimum capacity to detect, assess, report, and respond to any potential international public health emergency and events. In 2016, the monitoring and evaluation framework of the IHR was revised to include the compulsory State Party Annual Reporting, as well as voluntary after-action reviews, simulation exercises and the conduct of a JEE. The aim of the JEE is to measure the country-specific status and progress in preventing, detecting,

and rapidly responding to public health events and to identify and prioritise urgent priority actions to further enhance the capacity and capability of the health security system. The JEE tool consists of 19 technical areas and 49 indicators, with attributes that reflect various levels of capacity and capability (WHO, 2018).

The JEE for Malaysia was carried out between 21st – 25th October 2019 by an international independent team comprises 11 members representing 7 Member States [Australia (MOH), Canada (Health Canada), Germany (Port Health), Japan (MOH), South Korea (MOH), UK (PHE) and US (CDC)] and 3 international/regional organisations, namely World Organisation for Animal Health, WHO-Papua New Guinea Office and the WHO-Western Pacific Regional Office (WHO, 2020c). The evaluation process includes review of documents, site visits and interviews with key informants, not only involving MOH sites and personnel but also other relevant agencies. The MySED II was amongst the key documents being used for this assessment. The key findings of this JEE were reported herein as part of the assessment outcomes of the national outbreak preparedness of this paper.

Apart from the JEE Report, publications by the MOH in describing national response to the pandemic were also reviewed. One of the most important references was the eBook, 'Malaysia Health Sector Response to COVID-19 Pandemic' produced by the Institute for Health System Research, National Institutes of Health, MOH. The eBook narrated the timeline from the importation of the first case to the surge of cases during the second wave and provided comprehensive reporting on Malaysia's responses to the early phase of the pandemic (IHSR, 2020). Other publications and literature that dealt with preparedness and response were also reviewed. Analysis on the COVID-19 trend was carried out on the only aggregated COVID-19 data made available to the public through the Director General of Health daily press statement, as well as from Worldometer, a free reference website (<https://worldometer.info/coronavirus/>).

Upon review of the MySED II strategic action plans, it was obvious that various other important aspects of outbreak and public health emergency preparedness response were not covered under this strategic plan of actions. These include amongst others, the health-related industries involved with relevant supplies, such as Personal Protective Equipment (PPE), reagents and critical equipment, pharmaceutical stockpiling strategy for impending pandemic, and ethical issues surrounding outbreak response. During the early phase of the COVID-19 pandemic, issues related to these areas had surfaced and widely reported in both the mainstream media and social media. One of the most glaring issues was the shortage of PPE, not only for healthcare workers but also to the public. The scope of this position paper was widened to also include these areas.

Pharmaceutical Stockpiling

Literature search was conducted to gather information on pharmaceutical stockpiling as part of pandemic preparedness with keywords, such as stockpiling, pandemic preparedness, and antiviral. A thorough review was subsequently conducted based on the retrieved literature. While there is plenty of information with regards to pharmaceutical stockpiling for influenza pandemic preparedness, information on pharmaceutical stockpiling for non-influenza pandemic is still considered lacking at this stage.

National Capacity for Non-Pharmaceutical Supplies

An overview of Malaysia's preparedness against outbreak of infectious diseases was conducted from the aspect of non-pharmaceutical supplies including PPE through a literature review and brief desktop study of relevant articles on the issue. To further understand the market of non-pharmaceutical supplies in the country, market and industry data requests were submitted to the Ministry of International Trade and Industry (MITI), as well as the Ministry of Domestic Trade and Consumer Affairs (KPDNHEP). Nevertheless, both Ministries did not respond to our enquiry. Engagements with other relevant stakeholders were also further solicited for pertinent information for recommendations to be crafted on this aspect of preparedness.

Ethical Issues in Outbreak Investigation and Response

In MySED II, very little was deliberated regarding the ethical issues in an outbreak management. The only statement pertaining to ethics appeared under Risk Communication strategy, as a broad statement as follow: "In addition, it is important that one is aware of the legal and ethical implications inherent to public health in handling risk communication in a health crisis situation. The key personnel trained need to have a good understanding of the various elements discussed so that the rights, dignity, and honour of the target group is not compromised".

To provide a broader perspective on ethic and outbreak response, literature search was carried out on the topic focusing on ethical issues during outbreak investigation and response.

Scope 2

Post-Pandemic Analysis

The studies started by searching related publications from literatures, mainstream news and verified social media postings on announcements made by the authorities pertaining to policy, guidelines, and budget to manage COVID-19 pandemic in Malaysia. As to determine the implications of the pandemic to the healthcare system, impact of COVID-19 on the socio-economic situation in Malaysia and the roles of various stakeholders, including R&D in managing the post-pandemic and beyond, a focus group discussion (FGD) amongst the stakeholders had been applied as the main method of data collection since it could best highlight the actual scenarios. In addition, FGD is the best method to capture the information and policy related to COVID-19 management and control which are very dynamic. A systematic approach in conducting the FGD had been planned and conducted as follows; 1) formulating the research question, 2) protocol development, 3) soliciting participants, 4) arranging times and medium, 5) facilitating focus group discussion, 6) transcribing, 7) analysing data and 8) reporting the findings. In total, three separate FGDs were conducted in December 2020 covering the various scopes of Post-Pandemic Analysis that involved various top levels of stakeholders from different organisations.

Scope 3

Application of Artificial Intelligence (AI) and Big Data Analytics (BDA)

To achieve the aim of this position paper, a task force was formed, which includes researchers from various backgrounds. The task force conducted resourcing and advocacy activities to collate relevant information for this paper. Data collections were conducted in three phases: 1) Literature Analysis; 2) Data Collection through surveying the institutions; 3) Online survey with individuals and online discussion with the Malaysia Open Science Platform (MOSP) initiative.

An online discussion on Microsoft Teams with the MOSP Initiative, launched by the Ministry of Science, Technology and Innovation (MOSTI) was held on 5th February 2021 to explore how the MOSP Initiative could play a crucial role in complementing and supporting AI and BDA projects in future pandemics.

Data collected were collated with duplications removed. A total of 107 projects (44 identified in Phase 1 and 63 identified in Phase 2) related to COVID-19 involving Malaysian institutions and individuals were identified, including projects which do not employ AI or BDA techniques. Additional information about the projects was retrieved from online resources to complement the data collected before analysing the data. In Phase 2, 30 respondents had responded to the survey.

FINDINGS AND DISCUSSION



Scope 1

Malaysia Infectious Disease Outbreak Preparedness and Response

Global Preparedness for the Pandemic

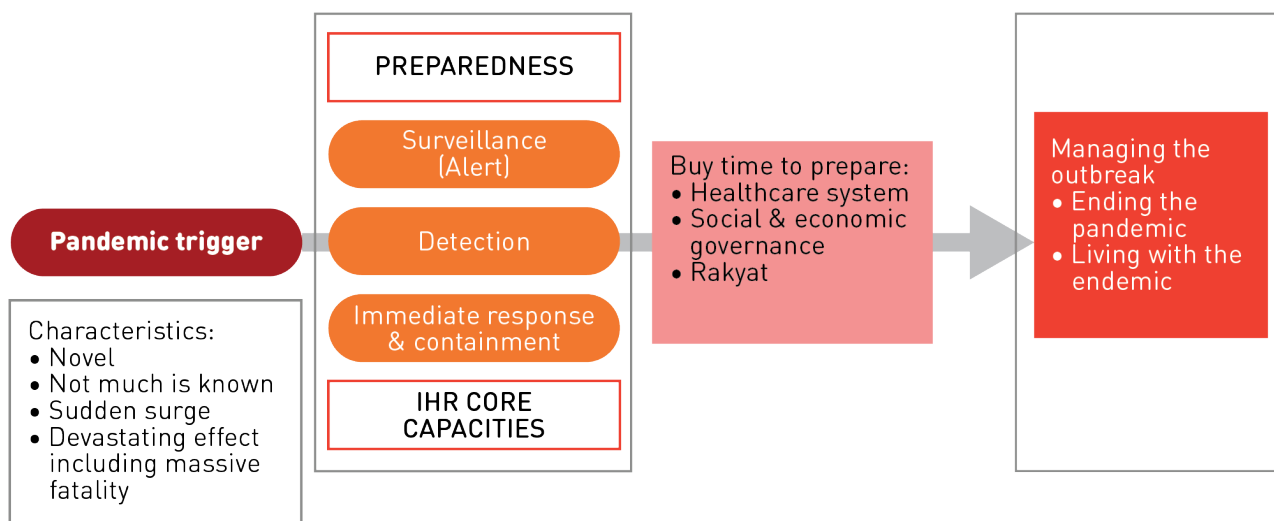
The world community, through WHO, has been preparing for a pandemic for a long time. Preparedness, through national core capacities strengthening to detect, prepare for and respond to health emergencies, such as a severe pandemic, is the cornerstone of handling public health emergency. One of the important WHO instruments is the IHR (2005). IHR provides an overarching legal framework that defines the countries' rights and obligations in handling public health events and emergencies that have the potential to cross international borders. It is an instrument of international law that is legally-binding on 196 countries, including the 194 WHO Member States (WHO, 2021). WHO outlined the 7 areas of work to assist member states in meeting the obligations of the IHR. The 7 areas of work are:

1. Foster global partnerships
2. Strengthen national disease prevention, surveillance, control, and response systems
3. Strengthen public health security in travel and transport
4. Strengthen WHO global alert and response systems
5. Strengthen the management of specific risks
6. Sustain rights, obligations, and procedures
7. Conduct studies and monitor progress

Strengthening national disease prevention, surveillance, control and response systems capacity will enhance disease prevention, surveillance, control and response systems at international level (WHO, 2007).

It is important to appreciate that when we are dealing with a pandemic, we are dealing with something novel, an infection that is new. Thus, initially not much is known about SARS-CoV-2 virus, how it spread, what its infectivity like, who are at risk, what is the nature and severity of the disease it causes and how to prevent and treat the infection. Being new, everyone is susceptible and therefore there is potential for a sudden surge in cases, that may overwhelm the healthcare and cripple the socio-economic systems. An effective and efficient surveillance system will keep us on alert and our capacities readiness to diagnose and mount immediate containment response. It would also allow us to buy the precious time to prepare the healthcare system, socio-economic governance and the people to brace through the pandemic in the long run, either towards the goal of ultimately ending the pandemic or to learn to live with the infection in an endemic state (Figure 2). These are the broad objectives of IHR and national capacity building.

A more recent development specifically towards pandemic preparedness was the establishment of the Pandemic Influenza Preparedness Framework, or PIP-Framework. It was developed by member states, unanimously adopted at the 64th World Health Assembly, and came into effect on 24th May 2011 (WHO, 2011). Its key goal is to improve and strengthen sharing of influenza viruses with pandemic potential and to improve access of developing countries to vaccines and other related supplies. The Global Influenza Surveillance and Response System (GISRS), a network of WHO National Influenza and Collaborating Centres, play a key role in coordinating influenza surveillance and sharing of biological materials (Hay and McCauley, 2018). By accessing these materials, i.e., the virus, which is the key element in the development of vaccines and other related supplies, industries signed Standard Material Transfer Agreement (SMTA) and contributed to PIP-Framework, to a tune of USD28 million annually. This fund is used towards capacity building of member states in the areas of disease burden studies, pandemic preparedness and deployment planning, risk communication and community engagement, regulatory capacity and laboratory and surveillance capacity.



Lokman Hakim S, 2021

Figure 2: Pandemic trigger, preparedness, and response framework

Another global initiative which has also contributed significantly to the early understanding of the SARS-CoV-2 virus, and subsequent developments of response tools from diagnostic, treatment, to vaccine development, is GISAID. The acronym derived from a letter to the Nature journal for a Global Initiative on Sharing Avian Influenza Data (Bogner et al., 2006). Launched during the 61st WHA in 2008, GISAID is an open access system designed by the scientist for the scientist. It provides an alternative to the restrictive public domain-based influenza genomic databases. (Shu and McCauley, 2017). It also plays a vital role in the bi-annual influenza vaccine recommendation by the WHO-GISRS and contributed significantly to the early sharing of vital genomic information of SARS-CoV-2 virus when it first emerged. To date, more than 300,000 full genomes of the virus have been shared from all over the world through this platform, providing important information on the evolution and geographical signature of the virus, as well as vital information on the mutation which may influence transmissibility, pathogenesis and disease, and impact on vaccine. The number of genome sequence sharing is also unprecedented in the history of infectious disease outbreak.

IHR, PIP-Framework, GISRS and GISAID are parts of the global preparedness initiatives, which contribute towards early response to the pandemic. Their role cannot be underestimated and underscore the importance of investment in preparedness strategies. For example, a rapid sharing of genome sequence by China, help speed up the development of diagnostic protocol for COVID-19. The virus was first identified on 3rd January 2020 and the first protocol of RT-PCR for COVID-19 diagnosis, was established merely 20 days later, on 23rd January.

Malaysia Outbreak Preparedness and Response Capacity

a. Malaysia IHR (2005) core capacities: Findings of the WHO-JEE

According to JEE Implementation Guideline, the IHR (2005) core competencies are grouped into four elements, namely Prevent, Detect, Respond and IHR Related Hazards and Points of Entry (POE). Within these elements there are 49 indicators across 19 technical areas. Each indicator has attributes that reflects various level of capacity with a given score ranging from 1 to 5 (WHO, 2018). The score and the colour code which reflects the country level of capacity to institutionalise technical area competencies are summarised in Table 1.

Table 1: Scoring for each indicator reflecting the IHR (2005) core competencies used by JEE

SCORE	COLOUR CODE	DESCRIPTION
1	Red	No capacity: Attributes of a capacity are not in place.
2	Yellow	Limited capacity: Attributes of a capacity are in development stage (implementation has started with some attributes achieved and others commenced).
3	Yellow	Developed capacity: Attributes of a capacity are in place; however, sustainability has not been ensured (such as through inclusion in the operational plan of the national health sector plan with a secure funding source).
4	Green	Demonstrated capacity: Attributes are in place and sustainable for a few years and can be measured by the inclusion of attributes or IHR core capacities in the national health sector plan and a secure funding score.
5	Green	Sustainable capacity: All attributes are functional and sustainable, and the country is supporting one or more other countries in their implementation. This is the highest level of the achievement of implementation of IHR core capacities.

Malaysia scored highly in all the 4 elements of competency ranging from 81.25% to 90% with an overall score of 82.8% (Figure 3). Out of these, 33% of the indicators achieved the highest level of sustainable competencies with a score of 5 while 58.3% achieved demonstrated level of competencies (score of 4). As for the remaining 10.4% of the attributes, there were evidence that the capacities have been developed and in place, but sustainability has yet to be assured.

The JEE team described many strengths in our preparedness capacities. One of the highlights is the existence of documented step-by-step, long-term strategy (MySED I, 2011- 2015; MySED II, 2017 – 2021) with specific measurable indicators for each plan of action. Malaysia also demonstrated well-established mechanisms for command, control, and coordination of multi-sectoral health emergency preparedness and response, as guided by the NSC Directive 20 and facilitated by the National Disaster Management Agency (NADMA), while the MOH Crisis Preparedness and Response Centre (CPRC) provides the functional centre for preparedness planning, synthesising information and coordinating healthcare sector responses.

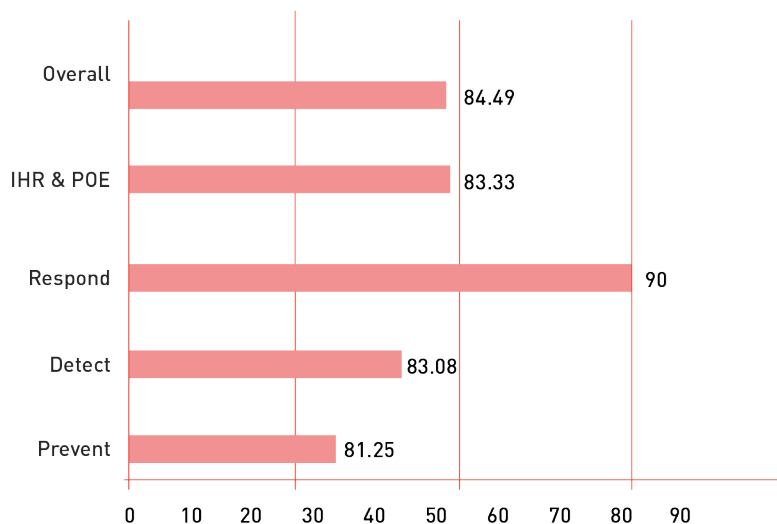


Figure 3: Malaysia's scores for each of the element of IHR competencies as measured by JEE scoring methodology (2nd Edition)

The country subscribed to multi-sectoral approach to health security with the involvement of all sectors in the preparation and implementation of MySED strategy and plan of action with established and functioning national, state and district disaster committee. We also have a functioning surveillance system with real time data management at national, state and district level. These data are analysed on a daily basis and informs risk assessment, response decision-making and risk communication to decision makers and the public at large. There was evidence of a culture of continuous improvement through regular simulation exercises involving various stakeholders, after-action reviews and various other reported assessments which help to strengthen preparedness for health security.

b. Legal framework for outbreak preparedness and respond

The Prevention and Control of Infectious Disease Act (Act 342) 1988 provides a strong legal foundation in responding to infectious disease outbreak. Provisions were in place in this Act to support the execution of implementation strategies to respond to disease outbreak in order to contain and control the spread. During this current COVID-19 pandemic, relevant sections of the Act were invoked to compel the notification of the infection by medical practitioners and laboratories, declaration of an outbreak, establishment of isolation and quarantine centres and execution of isolation and quarantine orders, establishment, and enforcement of pandemic actions SOPs, closure and decontamination of premises and enforcement of Movement Control Order (MCO). The Act provides the provision for the Minister of Health to gazette Regulations to support the implementation and enforcement of the Act in responding to disease outbreak. In this regard, the Minister has acted speedily to establish the Regulations to enforce the MCO and the SOPs.

One important element of the Act is a penalty for contravening the Act or non-compliance to SOPs under the Regulation. Public compliance to rules and regulations is very important to ensure effective control. While in most situation the authority relies on public health education and voluntary compliance, enforcement of the law is necessary to enhance compliance on important interventions, such as observation of MCO and quarantine order. Although the Act provides penalty for non-compliance of such order, there were complaints of double standard in enforcement (Nor Ain Mohamed Radhi and Arfa Yunus, 2020). The maximum compound value of RM1,000 was also deemed as too low in certain circumstances to warrant a serious compliance, especially amongst large corporate entities (FMT, 2020a). Proclamation of Emergency by the King on 11th January 2021 was said to be based on the need to further strengthen legislations to manage COVID-19, amongst others, on

acquisition of resources from the private sector, and to impose higher penalties for contravening the regulations (BERNAMA, 2021). Changes to the law requires amendment passed by Parliament, which will take time. However, others argued on the political motive for the advice to the Proclamation of Emergency (Lim, 2021). In retrospect, the Act does provide sufficient power with regards to requisition of premises to carry out any provision of the Act (Section 26). On the issue of low compound for noncompliance, the Act provides the power for the Director General of Health to close any premise for a certain period (Section 18), which is much more powerful deterrent to most business entities. Indeed, closure of businesses has been effectively implemented during the first MCO under the existing Act.

c. Diagnostic Capacity

Access to specific and sensitive diagnostic tests is critical in the management of infectious disease outbreak. Malaysia scored 80% in this element with a maximum score of 5 for laboratory system for detection of priority disease and a score of 4 for effective national laboratory network (WHO, 2020c). The Virology Unit, Infectious Disease Research Centre, Institute for Medical Research (IMR) is the national reference laboratory for outbreak investigation. The laboratory has vast experience, expertise, and capacity in detecting viral infections of public health importance. This unit has dealt with major viral outbreaks in the country, such as Hand, Foot and Mouth Disease (HFMD, 1998), Nipah Virus (1998), Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV, 2003), Pandemic Influenza H1N1 (2009), Middle Eastern Respiratory Syndrome Coronavirus-2 (MERS-CoV-2) and Zika (2016). The country learnt the importance of molecular diagnosis during pandemic H1N1 when at that time, IMR and National Public Health Laboratory (NPHL), Sungai Buloh were the only MOH centres that can perform Polymerase Chain Reaction (PCR)-based testing for infectious diseases. Since then, all the General Hospital laboratories in all the states were equipped with this capacity.

IMR received the first batch of the COVID-19 PCR diagnostic reagent on 21st January 2020 and by 30th January 2020, all the 12 state MOH hospitals and 4 public health laboratories were trained on the method. As part of the preparedness programme, MOH has established the National Laboratory Technical Committee which meet annually with representative from the academic institutions and private laboratories. The NPHL which coordinated COVID-19 testing for the general public, conducted training for academic and private laboratories. In January 2020 when the pandemic reached Malaysia, there were only 2 laboratories performing COVID-19 testing, the IMR and NPHL. By February, the service was expanded to all NPHL and MOH state hospital laboratories, increasing the capacity to 3,390 per day. By middle of June 2020, in collaboration with Ministry of Higher Education, public and private universities and private laboratory services, the national diagnostic capacity was increased to 30,812 test per day (Figure 4) (IHSR, 2020).

The International Medical University (IMU), a private medical university in Kuala Lumpur was the first to respond to call for national service by NPRL (PKC et al., 2020). It provided the service for free with the reagents and consumables provided by the Government, also similar arrangement made with other public academic laboratories.

No.	MOH Hospital	Maximum capacity	No.	IMR & PHL	Maximum capacity	No.	Academic/ University	Maximum capacity	No.	Academic/ University	Maximum capacity
1	Hospital Sultanah Bahiyah	132	1	IMR, NIH Setia Alam	5000	1	UM Medical Centre	400	1	Lablink (M) Sdn. Bhd (KPJ)	2000
2	Hospital Pulau Pinang	75	2	NPHL Sungai Buloh	1500	2	Hospital Canselor Tuanku Muhriz, UKM	192	2	Neogenix Laboratories Sdn. Bhd	700
3	Hospital Raja Permaisuri Bainun	186	3	PHL Ipoh	700	3	UKM Medical Molecular Biology Institute	192	3	Gribbles Pathology	1000
4	Hospital Sungai Buloh	450	4	PHL Kota Bharu	500	4	IIUM Medical Centre	30	4	Clinipath (M) Sdn. Bhd	3000
5	Hospital Kuala Lumpur	300	5	PHL Johor Bahru	1000	5	USM Hospital	30	5	BP Healthcare Group	5000
6	Hospital Tuanku Jaafar	200	6	PHL Kota Kinabalu	1000	6	UITM Teaching Hospital	200	6	Pantai Premier	1500
7	Hospital Melaka	96	Army Hospital		Maximum capacity	7	UPM Teaching Hospital	40	7	Sunway Medical Centre	500
8	Hospital Sultanah Aminah	500	1	Hospital Angkatan Tentera Tuanku Mizan	300	8	UMS	140	8	Borneo Medical, Kuching	192
9	Hospital Sultanah Nur Zahirah	140	2	Hospital Angkatan Tentera Lumut	10	9	UNIMAS	150	9	Gnosis	2000
10	Hospital Raja Perempuan Zainab II	200	MOSTI		Maximum capacity	10	TIDREC	100	10	IJN	270
11	Hospital Umum Sarawak	1000	1	Malaysian Genome Institute	80	11	IMU	200	11	Synapse	1000
12	Hospital Tengku Ampuan Afzan	200				12	IPPT USM	45	12	Subang Jaya Medical Centre	200
13	Hospital Queen Elizabeth I	200							13	Oncode	500
14	Hospital Sibul	184							14	Geneflux	1000
15	Hospital Miri	180							15	DNA Laboratories Sdn. Bhd	500
16	Cancer Research Institute	282							16	MyGenome Institute Sdn. Bhd	1128
17	Hospital Bintulu	94							17	Bionexus	192
18	Sarawak Heart Centre	94									

Total number of laboratories = 56 ; Total maximum capacity = 37004

Figure 4: COVID-19 diagnostic testing capacity as of 2nd July 2020.
Private laboratory services are provided with a fee from the patient (IHSR, 2020)

However, one important observation was that, except for MOH state hospitals, most of the academic laboratories and private laboratory chains were concentrated in Peninsular Malaysia. As the number of cases increases, the number of testing also thousandfold increases. In Sabah, the Public Health Laboratory Kota Kinabalu could only manage 1,000 test per day. As the outbreak in Sabah escalated, thousands of samples were sent to laboratories in the Peninsular on daily basis for diagnosis. Logistic challenges in Sabah further compounded the delay from the time of actual sample collection, testing and release of the results. As early as April 2020, issue of test result backlog had been acknowledged by the MOH with more than 8,000 test results pending (CodeBlue, 2020b). By October 2020, the backlog of testing in Sabah reached more than 10,000 (FMT, 2020b). Delay in diagnosis compromises the individual patient case management as well as the control of the infection in the general population.

In the current state, RT-PCR is not an efficient platform for routine testing for infectious disease. It is time-consuming with a practical turn-around-time of at least 24 hours. Samples usually need to be sent to centralised laboratories. In such situation, automation in the work processes, such as sample processing and dispensing is helpful for high-throughput testing. The test is also expensive which raise the question of cost-effectiveness of RT-PCR in mass screening strategy. In the early phase of the pandemic, the shortage of reagents because of increased global demand for testing, further contributed to the delay and efficiency of testing. Sample pooling, a strategy deployed for early comprehensive screening of influenza viruses and the human immunodeficiency virus (Sullivan et al., 2011) and now for SARS-CoV-2 (Abdalthamid et al., 2020; Hogan et al., 2020; Lohse et al., 2020; Yelin et al., 2020) has been demonstrated to be a cost effective method to increase viral detection capacity in large scale diagnostic testing, as well as for community screening, without compromising on the testing accuracy. While most reported procedure pooled the sample during PCR reaction, the IMU team which helped with COVID-19 testing for NPHL, when challenged with limited reagent supplies, developed the protocol on pooling the sample before RNA extraction, consequently saving the expensive extraction kits and PCR reagents (Lim et al., 2020). This is a useful innovation for resource strained laboratories, especially in developing countries. With this approach it is much more feasible and affordable for large community screening by PCR. The published paper was shared with the MOH in September 2020 but to date, there was no official endorsement from the MOH which limit its use by private laboratories, although it is learnt that MOH laboratories did practice sample pooling.

The other concern related to diagnosis backlog is data-driven decision making by MOH and the government. In infectious disease outbreak, the epidemiology (epi) curve is a very useful and important tool in understanding the progression of the illness in an outbreak over time, and aid in decision making. Various parameters can be used to construct the epi curve - date of onset of illness, date of notification, date of diagnosis and/or date of sample collection which provide different set of information. However, epidemiologist must be aware the inherent difficulty and limitations of each parameter and the importance of the quality of data in interpreting the epi curve. It is learnt that all major decisions, such as MCO order, extension or downstaging the various MCO steps (CMCM, RMCO, EMCO) and more recently on proclamation of the state of emergency, were primarily based on the epidemiological trend of COVID-19 and in particular the projected number of cases, the calculated R0 value, daily number of cases and death. However, the number of reported cases is influenced by the testing strategy. Targeted testing may not reflect true number of cases in the population. Furthermore, delayed reporting would need to be taken into consideration. The issue came to limelight when the Chief Minister of Selangor claimed that the recent spikes of record-high daily number of cases were contributed by delayed reporting, some as long as 10 days (Dzulkifly D, 2021). Although the issues of backlog and the daily reported number of cases has been acknowledged by the DG of Health since October 2020 (Chung N, 2020), there has yet to be any news which suggest that the problem had been rectified. Uncleaned data will affect the epidemiological statistics, calculation of R0 value and accuracy of various projection models. These are important issues to consider ensuring that major decisions on pandemic management by the government are based on good science. MOH is the most trusted source of information on COVID-19 in Malaysia (Mohamad et al., 2020). Basic issues in data management in outbreak response related to delayed reporting may compromise the public confidence in the health system and the government. The public trust deficit will certainly complicate effort towards public compliance which is critical in outbreak intervention strategy.

d. Malaysia Early Response to COVID-19 Importation and Spread

Malaysia responded very well to the first wave of imported cases and their close contacts beginning 5th February 2020. This was achieved through aggressive travellers screening at POE, contact tracing and testing of close contacts of confirmed cases. The first case of COVID-19 in Malaysia was imported from China through a Chinese tourist on 25th January 2020. Within 6 days, 8 cases were detected amongst close contacts of the index case, whereby all were imported from China. The first Malaysian tested positive for COVID-19 was reported on 4th February. He had a history of attending a meeting in Singapore attended by participants from China. Up to 15th February, a total of 22 cases were reported with no new cases for almost 2 weeks (Shah et al., 2020).

A large international religious gathering of more than 14,000 participants, more than 10,000 of whom were Malaysians, was held from 27th February to 1st March 2021 at Sri Petaling Mosque, Kuala Lumpur. Malaysia received a notification on 11th March from Brunei National Focal Point for IHR that one of their citizens who participated in the religious gathering was tested positive for COVID-19 (Mat et al., 2020). It was indeed a significant event which triggered the second wave with hundreds of cases being reported daily and which prompted the government to resort to the nationwide MCO (Safuan and Edinur, 2020). The index case was never determined. In fact, the DG of Health was quoted that 986 people who attended the religious gathering were classified as the index cases (CodeBlue, 2020e), rather unconventional for an epidemiological investigation. There were about 1,500 foreign participants from India, South Korea, Brunei, China, Japan and Thailand that attended the religious gathering and most probably have arrived earlier than 27th February 2020. Outside China, COVID-19 was first reported earlier than Malaysia in Thailand (8th January), Japan (16th January), South Korea (20th January) and India (27th January). The possibility of the infection being introduced by these foreign participants could not be conclusively ruled out. The possibility was high considering that international travellers were not yet required to produce COVID-19 free status and undergo a period of quarantine at that time. Two weeks later after the gathering, the cumulative positive cases showed an exponential increase with daily cases reaching 200 – 300 cases (Figure 5).

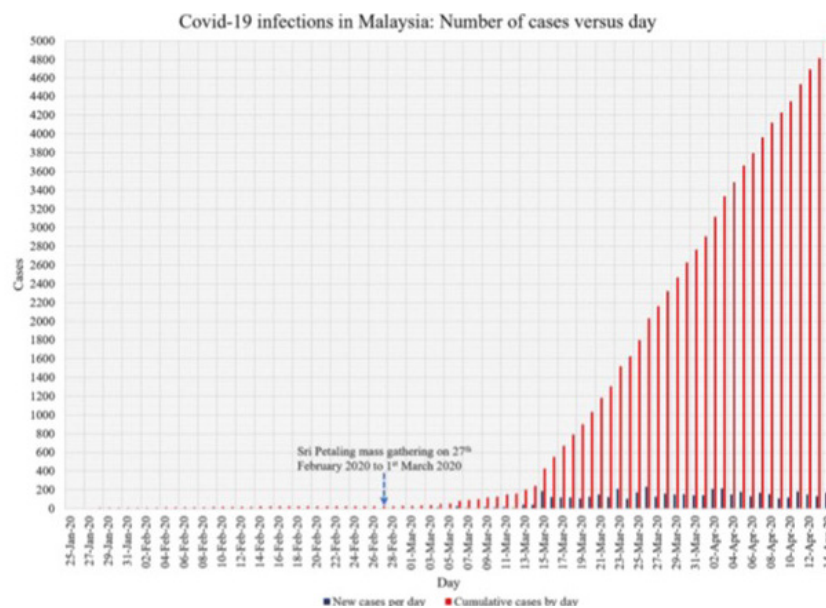


Figure 5: COVID-19 cases in Malaysia (25th January – 14th April 2020)
Sourced from (Mohamad et al., 2020)

The drastic MCO enforced throughout the country was unprecedented in the history of public health response to infectious disease outbreak. It began on 18th March and lasted for about 6 weeks until 3rd May 2020. It was then followed by CMCO from 4th May to 9th June and Recovery RMCO from 10th June to 31st August 2020 (IHSR, 2020). JP Morgan released their epidemiologic model report on 23rd March 2020 within the first week of MCO, forecasting that the peak infection will happen by the middle of April at around 6,300 cases (Kim and Wang, 2020). However, Malaysia did extremely well in flattening the epidemiologic curve. The number of cases did not exceed 3,000 cases a week with daily cases of not more than 400. It was brought down to a single digit and at certain times, enjoyed zero reported cases (Figure 6). During this early stage, the MOH policy was to admit all positive cases to COVID-19 designated hospitals regardless of their clinical status. Malaysia is probably the only country that has this policy (Sim et al., 2020). However, although this approach ensured proper isolation of positive cases and close monitoring in case of disease deterioration, inherent to this approach is the utilisation of expensive resources of hospital care and increased potential exposure and risk to hospital staff who are the last line of defence.

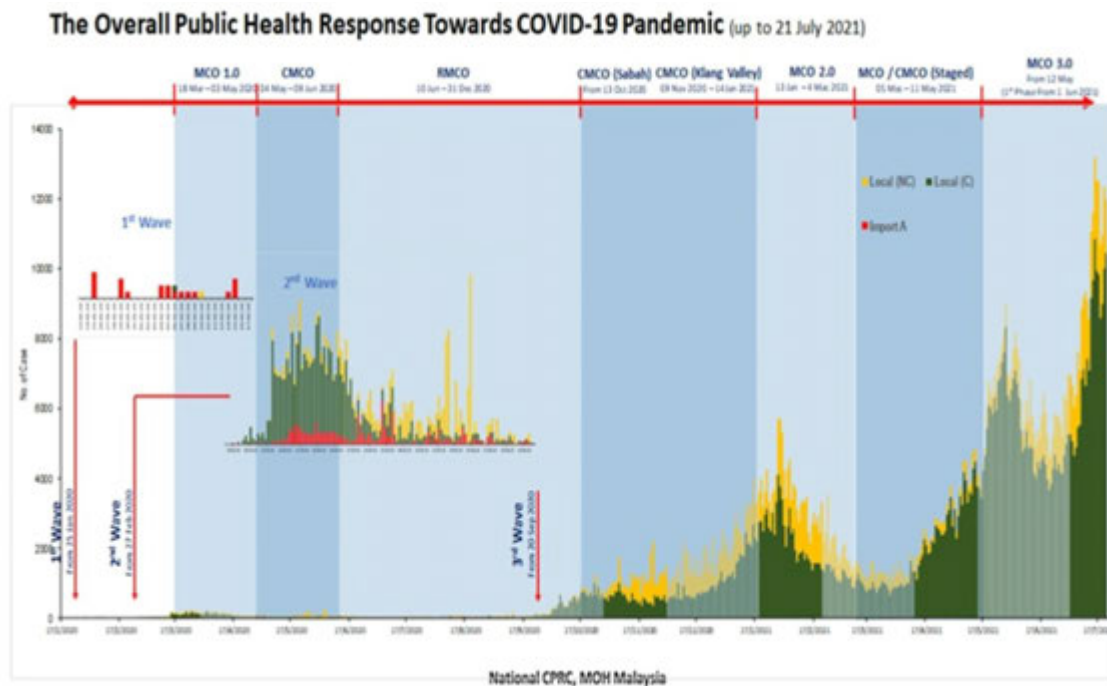


Figure 6: The phases of MCO in relation to COVID-19 epidemiologic curve. (CMCO = Conditional MCO, RMCO = Recovery MCO). Adapted from (IHSR, 2020)

Aggressive screening at POEs, extensive investigation and testing of People Under Investigation (PUI) and tracking and testing of close contacts resulted in early case detection and early isolation of the positive cases and quarantine of the negative close contacts. These are fundamentals in outbreak containment when no effective treatment is available to treat the infected who is the source of infection to others. However, MCO by itself should not be the means to the end of the pandemic. No doubt that lockdown on social and economic activities is effective in breaking the transmission chain but the impact on the economy is tremendous (Atalan, 2020). The tourism industries suffered an estimated loss of RM3.37 billion in the first 2 months of 2020 (Dzulkiyly D, 2020). The small and medium enterprises (SME) were the most hit which could lead to a permanent shut down, loss of employment and bankruptcy (Cheng, 2020). During the first MCO, Malaysian economy was reported to have contracted between 3.5% to 5.5% (Jaafar, 2021). WHO too do not advocate lockdown as the primary means of controlling this virus and is only justified to buy time to “reorganise, regroup, rebalance your resources, protect your health workers who are exhausted” (Doyle, 2020; Elyatt, 2020).

e. Post MCO 1.0 – Economic Stimulus Package, Public Health Functions and Mitigating Response

After successfully containing the second wave, the government announced the Prihatin Rakyat Economic Stimulus package (PRIHATIN) worth RM250 billion to safeguard the people’s welfare, support businesses and strengthen the economy (Shah et al., 2020; PMO, 2020). This includes RM 1 billion specifically for the MOH for purchases of equipment and services, on top of RM500 million allocated earlier and RM600 million for the healthcare personnel special allowances and incentives. This is an opportune time for MOH to strengthen the capacities of the healthcare system to respond should the number of cases increase again. Indeed, this is the main objective of flattening the epi curve, to “buy time” to prepare and enhance the healthcare system so that it will not be overwhelmed. However, a second wave developed before the healthcare system could be fully prepared.

Sabah started to observe increasing number of cases in August 2020, even before the Sabah state election in September. The state election was largely blamed for the increasing number of cases, not only in Sabah but also in Peninsular Malaysia, especially in Selangor. Clusters amongst migrant workers and in prison and detention centres were the initial driver of the cases. However, by October 2020, sporadic cases in the community begun to increase significantly. Despite obvious widespread community transmission, there was no clear official declaration of a migration to mitigation phase in the outbreak management. The strategies have remained primary containment in nature with targeted screening and continuing phases of MCO.

The RM1 billion allocation for COVID-19 alone was indeed huge. In comparison, the total 2020 MOH operational budget was RM27.9 billion (total budget RM30.6 billion). Out of this, RM16.5 billion was for emolument and RM11.4 billion was for programme activities (CodeBlue, 2020c). Thus, the RM1 billion allocation is about 10% of the total budget for the entire health and medical programme activities of MOH and this allocation is only for COVID-19 activities! With this allocation, we should be able to improve not only diagnostic capacities but

also accessibility. Affordability of the test is key to ensure that those who need to be tested will be tested. With the advent of Rapid Test kit for SARS-CoV-2 antigen (RTK-Ag), the efficiency and rapidity of test result should have been resolved. However, RTK-Ag was not widely used until around October 2020 when the situation in Sabah was not under control. Even now (at the point of writing), RTK-Ag is not widely available in all MOH facilities. Apparently, this is being limited by MOH requirement for a laboratory Biosafety cabinet (BSC) Level II and Medical Laboratory Technologist (MLT) to perform the test (MOH, 2020b). Whereas WHO guideline defines RTK-Ag as easy-to-use, at or near point of care without the need for laboratory infrastructure and expensive equipment (WHO, 2020a). All that is needed is a trained staff with appropriate PPEs and well-ventilated working areas. Therefore, limiting RTK-Ag to Klinik Kesihatan with BSL-II, and thus limiting access to it, reduces the potential this test could play within the context of the pandemic management.

The cheapest RTK-Ag of about RM70 per test (at this point) offered by Non-Governmental Organisation (NGOs) is expensive which, in turn, limits accessibility. This is an important issue which needs to be considered by MOH in order to ensure easy access to testing for early detection and early isolation of positive cases, the very fundamental element of infectious disease control. In highly infectious disease like COVID-19, the first principle is to Find-Test-Trace-Isolate (FTTI.) Except during the early phase of the pandemic, we have failed in this area. Testing should be made readily accessible through a widespread distribution of diagnostic test at point-of-care sites (including private General Practitioner clinics), preferably at subsidised cost. Subsidy for such tests should be considered as a priority by the MOH as it could help with pandemic management.

Based on MOH own report of its response to COVID-19 (IHSR, 2020), MOH strategies have been heavily focused on enhancing hospital capacities to deal with increasing number of cases, including those requiring intensive care. The number of hospital beds including intensive care beds were increased significantly. The number of available ventilators increased from 526 to 1034, whereby several non-hospital facilities were converted to low-risk hospitals, further increasing the number of beds available for COVID-19 patients (Rahman, 2020). All these are very essential enhancement of the healthcare system.

However, similar enhancement of the public health frontline was not visible. There was no significant change in the number of Rapid Action Team (RAT) of the District Health office to carry out case investigation, contact tracing and testing, the capacity to diagnose, transportation, capacity to carry out proper surveillance and monitoring and community engagement and empowerment activities. Except for the early phase of MCO, mobilisation of volunteers in above key areas was not sustained thereafter. As a result, as the number of cases in community increases, the public health functions for early detection and early isolation is compromised. The community at large has not been engaged effectively to support the public health functions. In fact, MOH policy of not disclosing the neighbourhood where cases are could be interpreted as a message that community assistance is not required. Community empowerment plays an important role in case detection, contact tracing and ensuring the community's compliance to pandemic SOP. Malaysia should have learned from our successful neighbour, Thailand in mobilising 1 million volunteers and the use of Information Communication Technology (ICT) in contact tracing and monitor and tracking patients under investigation (Ministry of Public Health Thailand, 2020).

It is important that MOH emphasises and is seen to emphasise the critical role of public health. Many experts had been critical on how the government and MOH in particular, has been managing COVID-19 after the first MCO. However, they had difficulty to engage with the MOH and in desperation to see significant changes in how COVID-19 is being managed, this led to an open letter to the Prime Minister undersigned by 46 eminent persons, scientists, and technocrats calling for the back-to-basics management of the pandemic and establishment of an independent COVID-19 Task Force (CodeBlue, 2020d).

f. MCO 2.0 and Proclamation of Emergency

As the number of cases continue to increase to four digits, the government announced the implementation of MCO 2.0 nationwide, excluding Sarawak beginning 13th January 2020. Prior to that, on 11th January 2020, the Yang DiPertuan Agong, on the advice of the Prime Minister, signed the Proclamation of Emergency. Both the MCO and Emergency were subjected to various interpretations on the reasons and purpose of the declaration. It was widely speculated that the justification for the MCO 2.0 and Emergency was based on the critical situations of increasing number of cases being admitted to Intensive Care Unit (ICU) and increasing number of deaths over the months. Nevertheless, an open letter signed by the 10 former Presidents of Bar Council, argued on the legitimacy of the reason in the light of the reach of the Prevention and Control of Infectious Diseases Act 1988 and the implementation of the MCO (Ahmad Naqib Idris, 2020).

Epidemiologically, there are several issues regarding the justification for MCO 2.0. Firstly, the increasing trend was based on notified cases to MOH and as previously discussed, the daily number of cases does not reflect the real situation because of the backlog in test results reporting. Secondly, the use of absolute number of cases has little value in describing the risk of infection. Mukim with 40 or more cases is considered as red

areas, whereas in terms of risk, it makes a lot of different between 40 cases in Petaling district compared to 40 cases in Bentong, Pahang. While the absolute number of cases could be useful in estimating the need for healthcare, particularly intensive care, the numbers would need to be matched to the healthcare capacity of the locality. A better indicator of population risk is to use incidence rate. Between 1st to 13th January 2021, the total number of cases reported in Selangor were 9,735, Kuala Lumpur (3,299), Pahang (529) and Terengganu (247). Correspondingly, the incidence rate of COVID-19 during the first two weeks of 2021 for Selangor, Kuala Lumpur, Pahang, and Terengganu was 154.56, 184.59, 32.49 and 20.86 per 100,000 population, respectively which would appear to be very low to justify for a lock down, what more for Emergency Proclamation. Indeed, Malaysia's threshold to lockdown, except for China, appears very low as compared to other countries (Table 2). However, because testing is targeted and may not represent true incidence in the community, assumptions used to estimate the true incidence should be highlighted along with other objective measures used. Finally, the number of deaths and number of cases occupying the ICU beds. Of course, it is worrying to see that almost 90% of the 442 ICU beds have been occupied in the weeks before the proclamation. With such an announcement, the public would like to know about the 1,120 ventilators (Figure 10) received through donations (IHSR, 2020) during and after the MCO 1.0 as those number of ventilators would have been adequate to support a 3-fold increase in the intensive care bed capacity. In summary, the legitimacy of the MCO and the advice for Emergency Proclamation would need to be proven using good science.

Table 2: Threshold of lockdown in selected countries.
Source: Worldometer COVID-19

Country	Number of cases (2 nd – 15 th January 2021)	Incidence per 100,000 population	Lockdown status
UK	716,230	1,052.04	Partial lockdown
Spain	296,069	633.10	Extension emergency
France	229,702	351.47	Not yet
China	1,437	0.99	Lockdown on affected city
Malaysia	33,693	103.38	Partial lockdown

g. Level of Preparedness and Capacity to Respond

We have compared the level of preparedness amongst countries in the WHO Western Pacific Region, which have completed the JEE by WHO and relates it to their overall performance in managing COVID-19 based on current trend of the infection. As of December 2020, 12 countries have completed the JEE, and the report published. However, being a very small country, the Pacific Islands state of Micronesia was excluded in the comparison (Figure 7). Malaysia's level of preparedness score is comparable to other more developed countries like Australia, Singapore, Japan, Republic of Korea and New Zealand, whereby majority of the 19 technical areas were scored of 4 and above (WHO, 2020h). Although Malaysia performed well in containing the initial importation and subsequent spread of COVID-19 cases, however, unlike other countries in the region, Malaysia has not been able to sustain the level of response in mitigating the pandemic. Malaysia continues to show increasing trend of COVID-19 infection despite 4 weeks into MCO 2.0, at a steeper rate than Japan (Figure 8). In fact, Vietnam which has a lower level of preparedness competency compared to Malaysia, has significantly lower number of cases and death, whereas in the Philippines, the rate of increase continues to show a flattening trend. While IHR 2005 preparedness competency level is important for effective initial containment at national level, understanding the epidemiology and the fundamentals of infectious disease outbreak management, is of paramount importance for an effective outbreak control. Policy decisions must be based on good science, good understanding of the epidemiology of the infection and driven by good data. Considering that the extended MCO also causes collateral damages to livelihood, the principle of "primum non nocera" (do no harm) applies not only to individual patient care but also to public health policies and decisions.

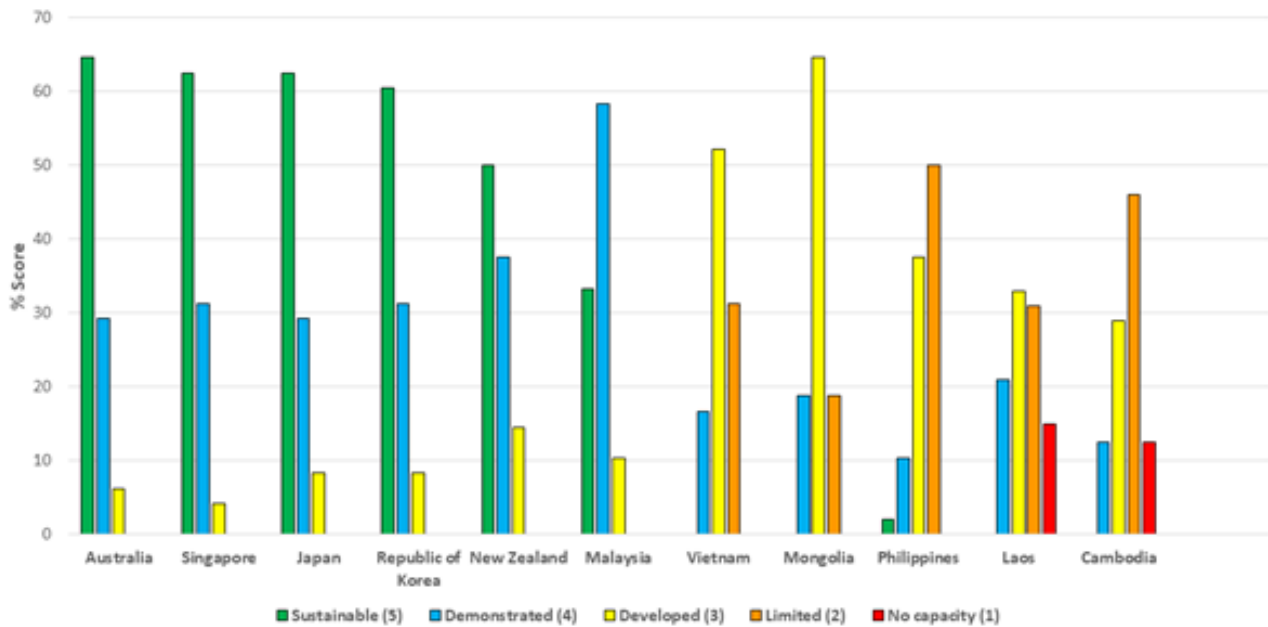


Figure 7: Capacity indicator score for IHR core competencies in the WHO Western Pacific Region countries which have completed the JEE

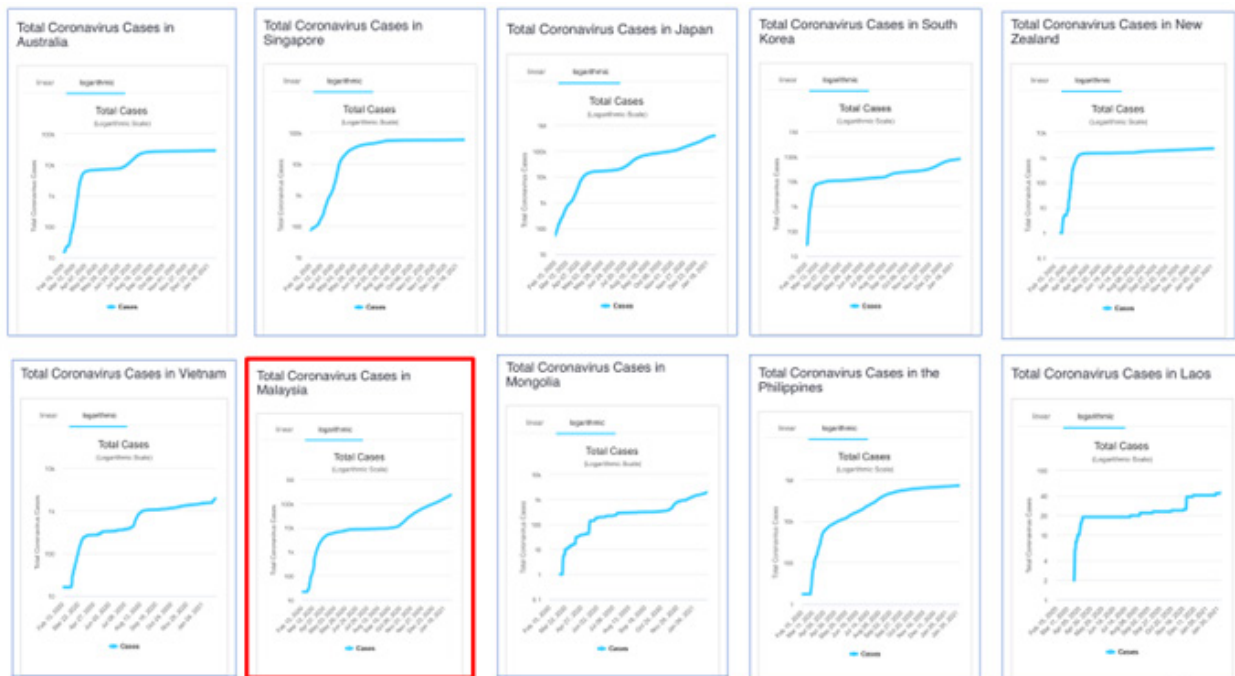


Figure 8: Trend of COVID-19 cases (as of 8th February 2021) in the WHO Western Pacific Region countries which have completed the JEE

Pharmaceutical Stockpiling

a. Current global practice

Many countries have been actively involved in pharmaceutical stockpiling for influenza pandemic preparedness. For instance, as part of the National Influenza Pandemic Preparedness Plan (NIPPP) in 2005, MOH Malaysia had stockpiled 505,800 treatment packs with 10 tabs each of Oseltamivir (Tamiflu) capsules from Ranbaxy to treat 2% of the population; 220,000 doses of Fluarix injections which is a Type A Influenza vaccine, and 126,450 treatment packs with 20 capsules in each pack of Zanamivir capsules to treat 0.5% of population. The Cabinet had approved a budget of RM4.84 million for vaccines and RM39.75 million for anti-viral drugs, respectively (MOH, 2006).

At the ninth ASEAN-Japan Summit on 13th Dec 2005, the Prime Minister of Japan announced that Japan would provide ASEAN with 500,000 courses of Tamiflu and PPE for 700,000 persons. By 2010, Thailand had set up stockpiles of 3.25 million tablets of antiviral drugs (Oseltamivir) for treatment of up to 325,000 patients, as well as raw materials for domestic manufacturing of Oseltamivir antiviral drugs for up to 1.625 million patients (Rajaratnam, 2009). Besides, Singapore has also stockpiled the neuraminidase inhibitors, Oseltamivir, as part of its influenza pandemic preparedness strategy (Rajaratnam, 2009).

b. Rationales for Stockpiling

Antivirals will be in extremely short supply during a pandemic. In the absence of a stockpile, the chance of antivirals becoming available will be low (WHO, 2004). Also, global demand would far outstrip production capacity at the time of a pandemic.

Stockpiling could smoothen the process of healthcare systems tapping into stockpiles more quickly than they can procure (Jamison et al., 2017). Besides, it is also known as a cost-effective and cost-saving measure with low costs per death prevented. The costs involved by pharmaceutical interventions, such as vaccines and antiviral therapies were also reportedly in the midrange. For instance, during the 2009 influenza pandemic, antiviral stockpiles cost USD519,000 and vaccination cost USD297,000 as compared to school closure which cost USD9,860,000; quarantine USD2,210,000; antiviral therapy USD1,770,000; and social distancing USD1,640,000 (Jamison et al., 2017).

In addition, scaling up of commercial production of the antivirals may not be possible if a complex production process is involved. Due to the complicated steps involved in Tamiflu production process, generation of large quantities of this drug will not be immediately feasible (Elbe et al., 2014). Moreover, some strain-specific influenza vaccines require at least 6 months to produce (de Jong et al., 2004).

c. How Much to Stockpile?

A study conducted in Canada using a Dynamic Model structured by age and chronic health conditions suggested a 17.5% of stockpile size is sufficient for most scenarios if vaccines can be ready 3 months after a viral emergence (Greer and Schanzer, 2013).

A study using an epidemic-economic model suggested that under perfect allocation, higher resourced countries should aim to store antiviral stockpiles which able to cover at least 15% of their population, rising to 25% with 30% misallocation (Carrasco et al., 2011). Meanwhile, many other literatures suggested stockpiling should cater 15% - 40% of the nation's total populations (Rajaratnam, 2009; NACCHO, 2019; IDSA and SHEA, 2005; Arino et al., 2009; Hurt, 2019) Nevertheless, none of these previous examples reach that level of population coverage, thus far.

In the current COVID-19 pandemic, in which evidence for effective antiviral agents rapidly evolve over time due to the active research of the international research community, decisions to identify for stockpiling is more challenging and may need to be reviewed frequently.

Non-Pharmaceutical Supplies

a. Background

As PPE's function as a barrier to the transmission of COVID-19, having an adequate PPE supply is imperative in maintaining the safety of the healthcare frontliners as they strive to manage the pandemic. With the announcement of COVID-19 as a global pandemic, WHO estimated a global monthly consumption of approximately 89 million face masks, 76 million examination gloves and 1.6 million medical goggles needed to equip the relevant personnel. As such, it was forecasted that PPE manufacturing must be increased by at least 40% due to the dramatic rise in demand and that stockpile depletion could lead to production backlogs of 4 to 6 months (WHO, 2020f). In addition, several other factors also contributed to the shortages of non-pharmaceutical supplies, including panic buying, supply hoarding and PPE misuse due to insufficient guidelines and regulations. In terms of Malaysia's PPE consumption, MOH reported that as of April 2020, its PPE usage amounted to approximately 59 million units monthly (Tuah, 2020). On this, border closures and trade restriction have significantly increased the lead time for global PPE production and distribution forcing the government to turn to domestic industries to increase the PPE supply. Figure 9 and Figure 10 below show the average daily PPE utilisation rate in hospitals as well as donations received by MOH in response to the PPE supply issue mentioned.

Overall utilisation	Surgical Mask (usage pcs/day)	Isolation Gown (usage pcs/day)	N95 Mask (usage pcs/day)
Per Hospital/Day	2,732.2	546.1	478.7
Per Patient/Day	37.1	6.8	5.6
Per Staff/Day	9.4	1.7	1.6

Figure 9: Average PPE utilisation rate per hospital, per patient and per staff per day
Adapted from (MOH Procurement and Privatisation Division, 2020)

Type of donations	Quantity
Ventilators	1,120 unit
Equipments (Medical equipment / machines including patient monitor, Ultrasound, Dialysis, thermometer)	311,093 unit
Consumables	70,270,295 unit
Other donations (Non-medical equipment such as bed, kiosks, filters / air conditioning, vehicles, mobile phones, TVs, printers, etc.)	21,046 unit
Cash	RM550,000.00
The total number of contributors	502
Estimated Total Value of Contribution	RM225,394,077.46

Figure 10: Donations received by MOH [71]

b. Malaysia's PPE Shortage

Initially, it was assured that Malaysia was not facing the issue of PPE shortage with the only challenge involved would be in terms of distribution and logistics (JR and Chung, 2020). Nevertheless, this had changed within a week, whereby it was announced on 14th April 2020 that on average, the MOH's PPE supply will only last for two weeks as denoted in Figure 11.

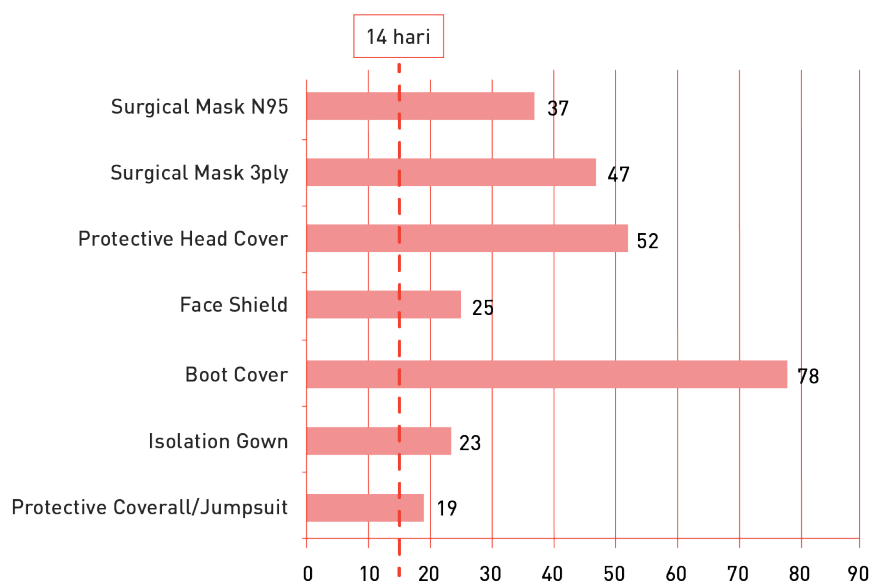


Figure 11: Average days of stock for various PPE units at MOH facilities as of 13th April 2020
Sourced from (MOH, 2020e)

The PPE supply issue was also highlighted in the findings by a survey conducted by a team of 5 doctors, namely Dr Timothy Cheng, Dr Nur Asyikin Mohd Yunus, Dr Imran Idris, Dr Khairil Idham Ismail, Datuk Dr Amar-Singh HSS from 13th April to 19th April 2020 involving 788 healthcare workers from the public and private sectors (Su-Lyn, 2020). Through the survey, it was observed that the PPE supply problem was more pronounced in private clinics and hospitals at 83%; followed by 77% in MOH hospitals; 69% in state health departments, district health offices, and public health clinics (Klinik Kesihatan); and 53% in public university hospitals (Figure 12).

I have experienced shortage of PPE (n=788)

No
Yes

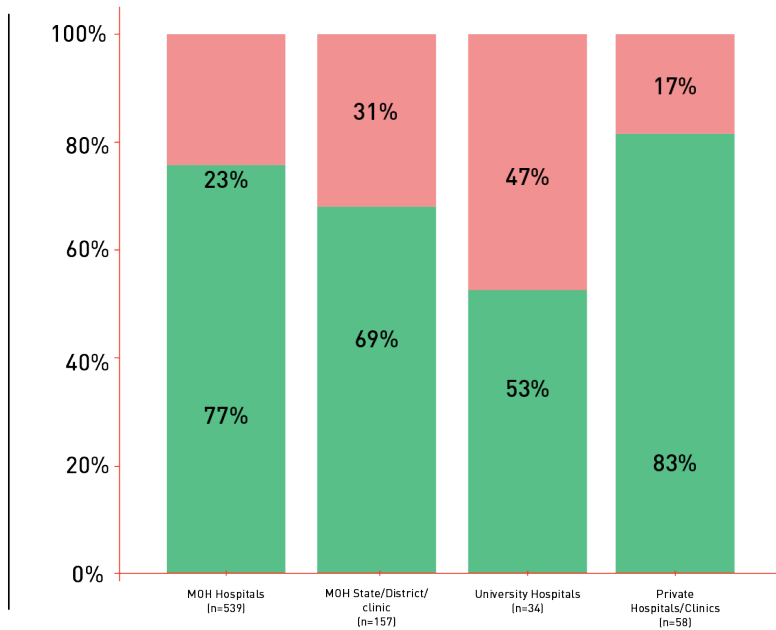


Figure 12: Graphic from the survey, “PPE Availability and Guideline Awareness in Malaysia’s Health Care Facilities (Experience with PPE Shortage)”
Adapted from (Su-Lyn, 2020)

The same survey also reported that almost half (41%) of the respondents felt inadequately protected by PPE against the risk of coronavirus transmission in their workplace. In the survey, the healthcare workers at state health departments, district health offices, and public health clinics felt adequately protected by PPE at 71%, followed by 59% of respondents at university hospitals, 57% at MOH hospitals, and 43% at private clinics and hospitals (Figure 13).

I feel adequately protected by PPE at my center (n=788)

No
Yes

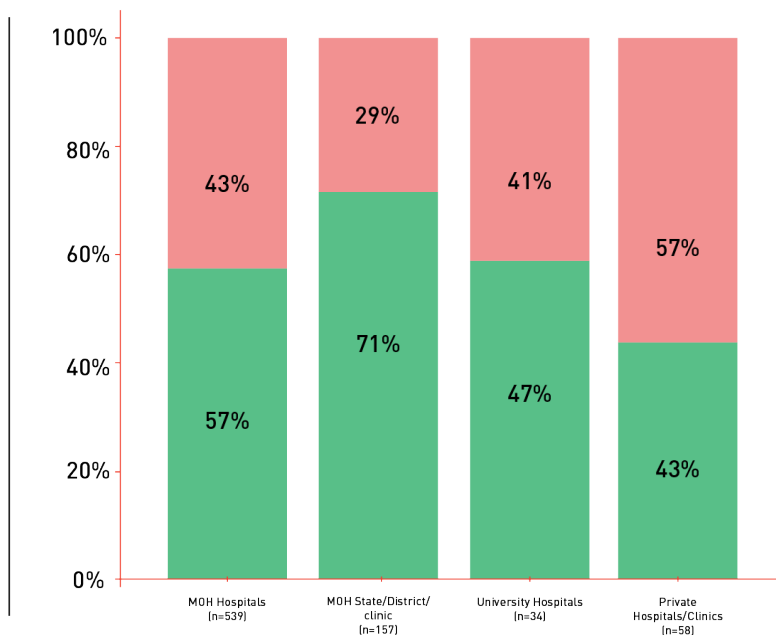
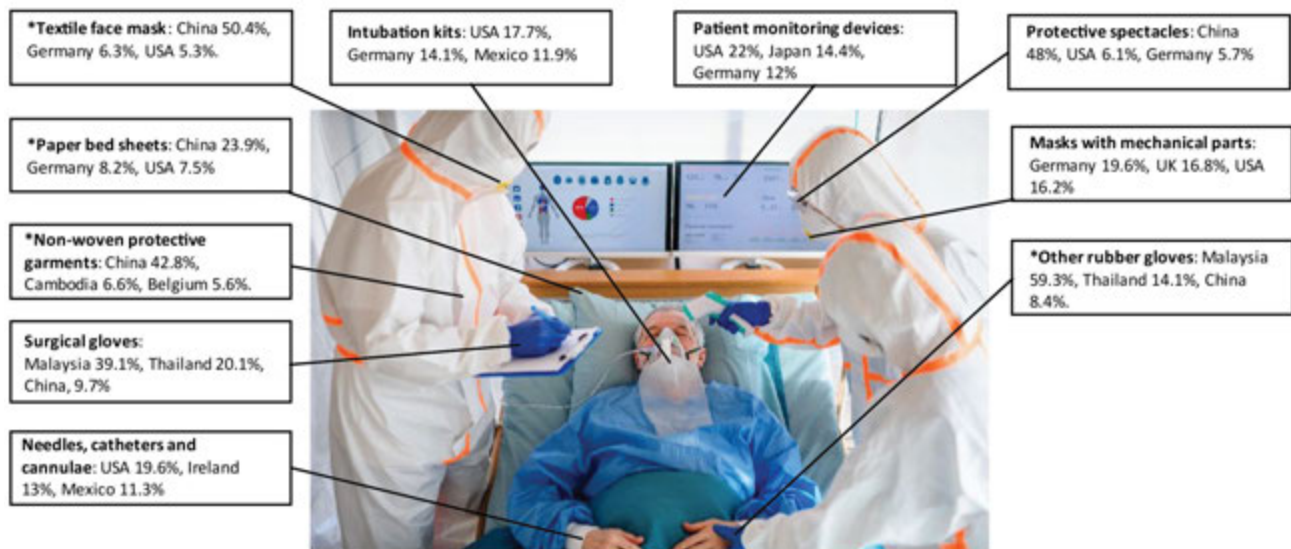


Figure 13: Graphic from the survey, “PPE Availability and Guideline Awareness in Malaysia’s Health Care Facilities (Opinion on Adequacy of PPE Protection)”
Adapted from (Su-Lyn, 2020)

The findings thus confirmed that there were indeed issues with PPE supplies to healthcare workers dealing with the COVID-19 pandemic. The rapid change in status from having adequate supply to having limited PPE stock within one week suggested that there may be an underlying coordinating issue leading to potential breakdown in communication channels. Furthermore, there is a need to be consensus on infection control guidelines with the agreement by the various health institutions to adhere to the said guidelines. This would require discussion, decision, and agreement between the various infection control/ occupational and safety healthcare units across Malaysia. Nonetheless, in the effort of saving and limiting the usage of PPE, the aspect of safety should never be compromised.

c. Global PPE Shortages

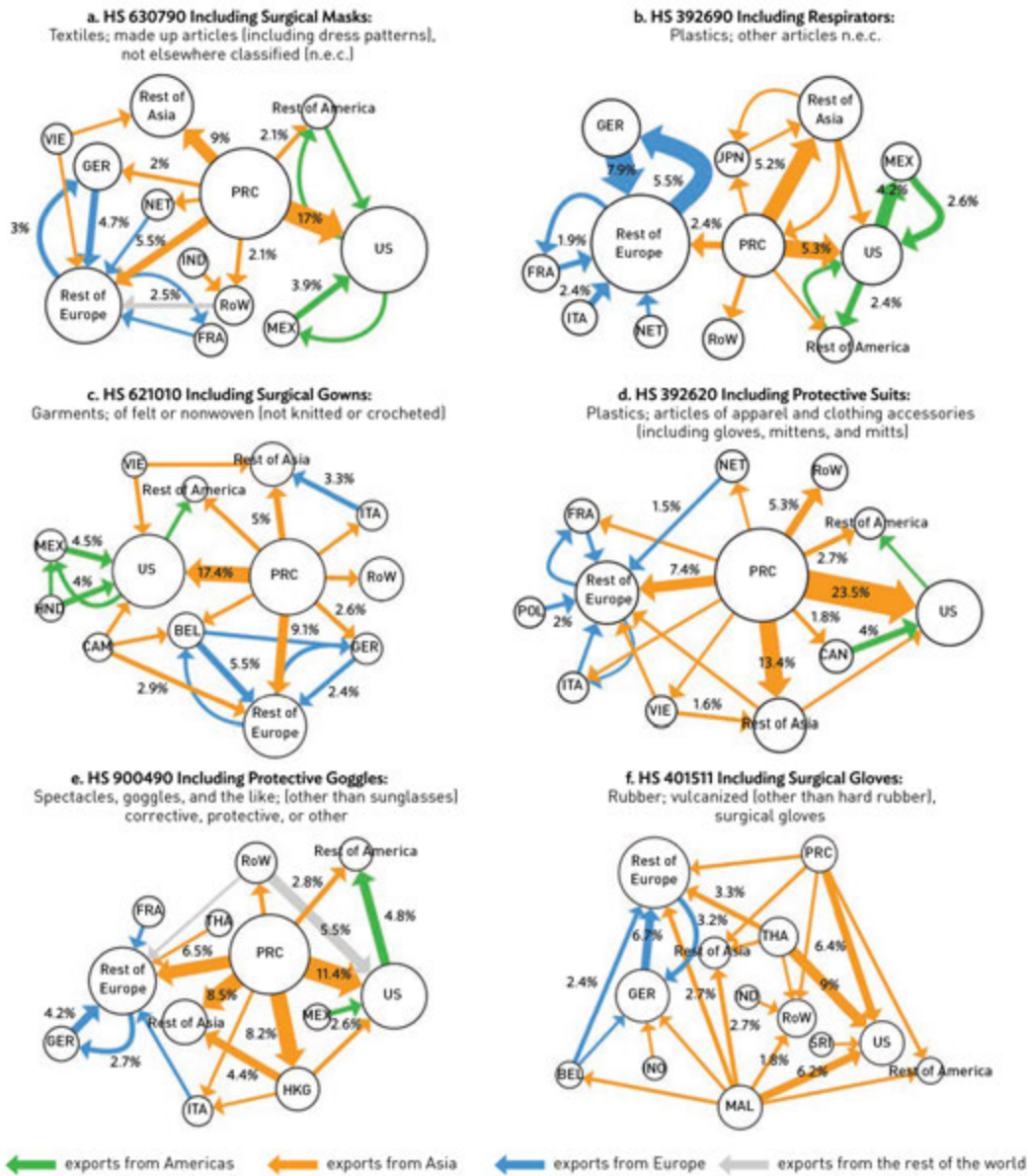
Prior to the COVID-19 crisis, there was an interdependence of trade and production for medical supplies, with advanced industrial countries like the United States and Germany specialising in the relatively high-tech medical devices sector, while low-cost production hubs, such as China and Malaysia leading the production of less technologically sophisticated PPE products, including face masks, surgical gloves, and medical gowns (Figure 14) (Gereffi, 2020). Simply put, the global PPE supply chain is highly interconnected involving multiple suppliers in various countries (Figure 15).



Note: For illustrative purposes only. The products marked with an * belong to broader categories of goods than those captured in the shares meaning that these include other products which might not be essential in the fight against COVID-19.

Source: OECD calculations using World Customs Organisation list of COVID-19 goods and BACI data. Photo from BBC news.

Figure 14: Top Exporters of certain COVID-19 goods, 2018
Adapted from (OECD, 2020b)



BEL = Belgium; CAM = Cambodia; CAN = Canada; FRA = France; GER = Germany; HKG = Hong Kong, China; HND = Honduras; HS = Harmonized System; IND = India; INO = Indonesia; ITA = Italy; JPN = Japan; MAL = Malaysia; MEX = Mexico; NET = Netherlands; POL = Poland; PPE = personal protective equipment; PRC = People's Republic of China; RoW = rest of the world; SRI = Sri Lanka; THA = Thailand; US = United States; VIE = Viet Nam; n.e.c. = not elsewhere classified.

Notes: The size of the nodes represents the economy's total trade [exports plus imports] of the concerned commodity group. The thickness of the lines represents the value of the flow of goods between economies. Some lines show the share of exports to the total global exports of the commodity group. For clarity, only exports with high values are represented by the lines.

Source: ADB calculations using data from United Nations. Commodity Trade Database. <https://comtrade.un.org> (accessed 22 March 2020).

Figure 15: Global Trade Networks of Select PPE Products, 2018
Adapted from (Park et al., 2020)

Since the COVID-19 outbreak, the PPE supply chain could not cope to meet the surge in demand. Constraints in supply and logistics, including export bans for PPE and key materials have come into stark focus. Abrupt supply disruptions in China, the major producer of PPE in the global trade network and the first country to be hit by COVID-19, resulted in spill-over impacts on Asia and the rest of the world (Park et al., 2020). This is further exacerbated by trade restrictions and export bans in more than 20 economies involved with PPE production and distribution.

This has consequently re-ignited the age-old debate about the supply chain risks associated with international production. However, there is no evidence that economies would have fared better in the absence of global value chains (GVCs), as government lockdowns have also affected the supply of domestic inputs. Most importantly, COVID-19 has highlighted both the strengths and weaknesses of GVCs, including for the supply of essential products. The experience suggests that international production networks can be disrupted and play a role in the propagation of economic shocks across countries and industries. Nonetheless, they also play an important role in aiding firms and countries to recover faster (OECD, 2020a).

More resilient production and distribution networks would need to be achieved through better risk management strategies at the firm level, putting the emphasis on risk awareness, greater transparency in the value chain and promoting agility. Sourcing strategies may differ across activities depending on the level of acceptable risk, with supplier diversification and 'just in case' processes as an objective for essential activities. In addition, it is also essential that governments support the efforts of firms to build more resilient GVCs by collecting and sharing information on potential concentration and bottlenecks upstream, developing stress tests for essential supply chains, and creating a conducive regulatory environment which is not a source of additional, policy-related, uncertainty (OECD, 2020a).

d. Malaysian PPE Industry

As highlighted previously, Malaysia is one of the world's top producers of medical gloves. In its 2020 Industry Brief, the Malaysian Rubber Glove Manufacturers Association (MARGMA) estimated global demand for rubber gloves in 2020 to be around 330 billion units with Malaysia to export 225 billion units (worth RM20 billion) in 2020 up from 170 billion units (RM 17.3 billion) in 2019, contributing to 65% of total world gloves requirement. It was further noted that investments in automation and digitalisation should help Malaysian medical glove manufacturers cement their position at the forefront of the global industry, which looks likely to see elevated long-term growth as a result of government stockpiling and heightened awareness around personal hygiene (MARGMA, 2020).

On the other hand, pre-COVID-19, production of other PPE equipment domestically was still limited with Malaysia relying mostly on import. Hence, with the government turning to domestic manufacturing of PPE to cover the supply deficit due to slow-down in international trade, there is an increasing number of Bursa Malaysia-listed companies announcing plans to divert their production and distribution capabilities into manufacturing medical products and equipment, such as face masks and shields, hand sanitisers and disinfectant products, as well as medical ventilators as shown in Figure 16.

Overall utilisation	Surgical Mask (usage pcs/day)	Isolation Gown (usage pcs/day)
Notion VTec Bhd	PPE production	14.1
SCGM Bhd	PPE production	4.5
Top Glove Corp Sdn. Bhd	Manufacturing face masks	123.0
Karex Bhd	Manufacturing hand sanitisers	-5.4
MyEG Services Bhd	Distribution of COVID-19 rapid test kits	33.6
Ho Wah Genting Bhd	Distribution of COVID-19 diagnostic products	190.9
Permaju Industries Bhd	Bottling and distribution of sanitiser products	24.4
DRB-Hicom Bhd	Manufacturing face shields	-38.7
Caely Holdings Bhd	Marketing of fabric face masks and PPE	-10.9
LYC Healthcare Bhd	Marketing of cleaniless, hygiene and sanitation services	36.7
Sanichi Technology Bhd	Production of medical ventilators	30.0
AT Systematization Bhd	Production of medical ventilators	25.0
PNE PCB Bhd	Production of medical ventilators	106.0

Figure 16: Bursa Malaysia-listed companies new ventures in COVID-19 related services
Adapted from (Zainul, 2020)

With the Malaysian industries rallying to the government's call for domestic PPE supply, it was reported that as of May 2020, Malaysia was producing 5 million PPE units per month with further ability to ramp up production (Carvalho, 2020). This effort includes collaboration of several manufacturing sectors in boosting PPE production, including specialised swab sticks for mass testing. On the latter, a team of public health and medical experts have been working with the Malaysian Plastics Manufacturers Association (MPMA) and Malaysian Petrochemicals Association to produce approximately 1.2 million specialised swab sticks and expedite the process of obtaining necessary funding and approvals for clinical trials, as well as approval from the Medical Devices Authority. A rapid expansion from minimal capacity for uncoated and coated PPE was observed through the facilitation of MPMA in collaboration with the Federation of Malaysian Fashion and Textile Association (FMFTA) which contributed in terms of cutting and sewing PPE (BusinessToday, 2020).

When the pandemic subsides along with the demand for PPE, an economically viable approach to sustain the capacity to rapidly increase production during future emergencies would be needed.

Ethical Issues in Outbreak Investigation and Response

Infectious disease outbreak of novel pathogen will remain a constant threat to global community. Pandemic may overwhelm the healthcare system and resources needed to address them. Difficult decision may need to be made on when, how and whom the limited resources should be allocated. Public health interventions may be harsh and draconian, such as the mandatory lockdown of unprecedented scale as seen in some countries during the current pandemic. Isolation and quarantine order, closure of schools and religious centres, culling of animals and live stocks, compelling people to testing, treatment and vaccination, restrict the rights and freedom of individuals and population and may go against moral and spiritual believe and obligations. In such situation, very often there will be ethical tension and conflict between collective goods and individual rights. WHO has produced a guidance on managing ethical issues in infectious disease outbreak (WHO, 2016). However, locally endorsed ethical guidelines could not be found regarding the MOH SOPs and guidelines. Therefore, it is recommended to develop a national ethical framework for infectious disease outbreak and pandemic response.

a. Ethics during disease outbreak conceptual framework

The ethics framework is purposed to help healthcare workers, hospital administrators and policy makers to decide how to allocate the resources as they may become scarce within a pandemic for instance COVID-19. Rather than stipulating general rules, it relies of expert judgement in response to different scenario or circumstances along the way. Many ethical issues constantly arise during public emergencies, for example, who will be allocated the vaccine when it is available, who decides on the priorities on what basis? They all are ethical decisions that require serious ethical reflection.

The ethical principles listed in Table 3 below might be helpful in deciding on the prioritisation of resources allocation (WHO, 2020b).

Table 3: Ethical Principles

Principle	Description	Practice implication
Equality	Each person's interest should count equally unless there are good reasons that justify the differential prioritisation of resources. Irrelevant characteristics of individuals, such as race, ethnicity, creed, ability or gender, should not serve arbitrarily as the basis for the differential allocation of resources. This principle can be used to justify the allocation of resources by a lottery – that is, randomly by chance – or by a system of first come, first served.	May be most appropriate to guide the allocation of scarce resources amongst individuals or populations who can be expected to derive the same benefit from the resource, for example, vaccines amongst high-risk populations, or ventilators amongst those with similar clinical indicators for benefit.
Best outcomes (utility)	This principle can be used to justify the allocation of resources according to their capacity to do the most good or minimise the most harm, for example, using available resources to save the most lives possible.	May be most appropriate to guide the allocation of scarce resources that confer substantially different benefits to different individuals, for example, ventilators to those expected to derive the most benefit.
Prioritise the worst off	This principle can be used to justify the allocation of resources to those in greatest medical need or those most at risk.	May be most appropriate to guide the allocation of resources that are designed or intended to protect those at risk, for example, PPE for healthcare workers, vaccines for those most at risk of infection and severe illness, or those most in need, as in the case of provision of drugs in short supply to those needing them most urgently.
Prioritise those tasked with helping others	This principle can be used to justify the allocation of resources to those who have certain skills or talents that can save many other individuals, or because something is owed to them on account of their participation in helping others.	May be most appropriate to guide the allocation of resources to healthcare workers, first responders, etc.

b. Should Routine Care for Patients Change in an Outbreak?

Declaration of Geneva: "The health of my patient will be my first consideration"

Declaration of Helsinki: "Promote and safeguard health & well-being of the patient"

It is the primary obligation of every healthcare worker – to do what is best for the patients and to reassure the standard of care will remain in place during the pandemic. However, consequences of the constraints imposed, the range of options for what is "best" might be altered. For example, some routine follow-ups may be rescheduled and the number of patients visiting hospital might be limited (probably due to scarcity of PPE or medical facilities). It is crucial for healthcare organisations to rearrange/revise their existing policies to mitigate the possible harms to the patients, as well as to inform the public about the changes made.

c. Should Research be Conducted During an Outbreak?

During the outbreak, due to the scarcity of resources: limited supplies of PPE, therapeutics, manpower, etc., there is constant argument whether research should be conducted. Innovation via research is vitally essential to fill in the knowledge gap of the novel disease, to enhance the healthcare system, searching for potential interventions that might be beneficial to the patients, engaging community to maximise the societal significance, so on and so forth. However, it is important that the stakeholders, such as hospital administrators and research ethics committee to ensure that research activities will not impede clinical care as large portions of resources might be used up in research. Besides, the research during pandemic should be governed/monitored appropriately to protect the well-being and welfare of research subjects (consent-taking process, fair selection, risk-benefit ratio). Researchers/clinicians have obligations to ensure not merely the individuals, but, where possible, the community involved in research will receive greater priority in access to the relevant interventions. On the other hand, it is critical that research is not hampered by unnecessary bureaucracy as the results of the research is needed urgently and is expected to benefit others beyond the study subjects.

Research Preparedness for Infectious Disease Outbreaks

In an infectious disease outbreak caused by a novel infectious agent, the role of research complements those of disease control laboratories. In an ideal scenario, the disease control laboratories would establish assays based on reported nucleic acid sequence of the infectious agents and ensure that appropriate laboratories are capable of providing the accurate and timely testing. A national diagnostic referral laboratory would ensure genomic surveillance is carried out and input the data into a database linked to high quality clinical and epidemiological data. This database would be made available to the research community. The referral laboratory would analyse the viral isolated from cases from super-spreader events as well as those from prolonged viral shedders. The referral laboratory would make available deeply sequenced viral isolates, panels of sera (and if possible cryopreserved immune cells) from previously infected/ immunised individuals to the research community. The referral laboratory would participate in follow-up of individuals who had been immunised and be involved with investigations of breakthrough infections. The referral laboratory would work closely with the research community. The research community would carry out research which would produce knowledge about the disease which are yet to be reported in the scientific literature, as well as developed novel diagnostics, therapeutics and vaccines which are not yet available in the world.

The COVID-19 pandemic demonstrated the role of research in a dramatic way to the world. A previously unknown virus was identified, new knowledge on the epidemiology of transmission and pathophysiology of the disease was unravelled, novel diagnostic assays (including point of care diagnostics) were developed, drugs were repurposed to treat a previously unknown disease and novel vaccines were developed at an unprecedented pace.

Although the country could depend on research carried out in other countries to answer many questions related to the pandemic, there is still a need for local research. Furthermore, research in Malaysia could be useful to contribute to generation of knowledge about this new disease. Such activities would also help the country to be more prepared for future pandemics, as well as to deal with peculiarities within the local settings. As long as the disease transmission continues, there remain a risk of development of viral variants which could be unique to the country. The capacity to detect these variants by genome sequencing and to link these data to high quality clinical and epidemiological data is important to distinguish variants of concern from other variants of no significant consequences. Disease registries could be useful in this regard. Antigenic analysis would need to be performed in reference laboratories. Such potential variants of concern would need to be studied in depth by the research community. Pipelines for in vitro and in vivo testing would be useful to compare novel variants with deeply sequenced reference standards in terms of transmissibility, pathogenicity/disease severity, immune protection (from previous infection and from the vaccines used in the country), as well as potential for affecting response to treatment. In addition, the potential effects on diagnostic tests which are used in the country would be important. Research could also be embedded within public health interventions and clinical care. During vaccine rollout, long term follow-up of individuals would be useful. Sieve analysis conducted on breakthrough

cases would be most enlightening. Free availability of samples and data and efficient sharing of reagents would be important to support research. Availability of pseudo-type virus neutralising assays and other reagents which utilises specific components of the virus (in contrast with whole live virus) would allow more studies to be carried out in the more commonly available BSL-2 laboratories.

The research capability of the country needed to be strengthened in order to be more ready to diagnose unknown diseases, as well as developing new diagnostic assays, treatment and vaccines for novel diseases within a short span of time. Therefore, it is timely to consider a new approach to bring together researchers across the public and private universities and organisations as well as the industry. Issues hindering research which were identified in the 2013 report "PRA Performance Evaluation: Unlocking Vast Potentials, Fast-Tracking the Future" by the National Science and Research Council, Malaysia would need to be addressed urgently.

Scope 2

Post-Pandemic Analysis

Situational Analysis of COVID-19 Outbreak in Malaysia

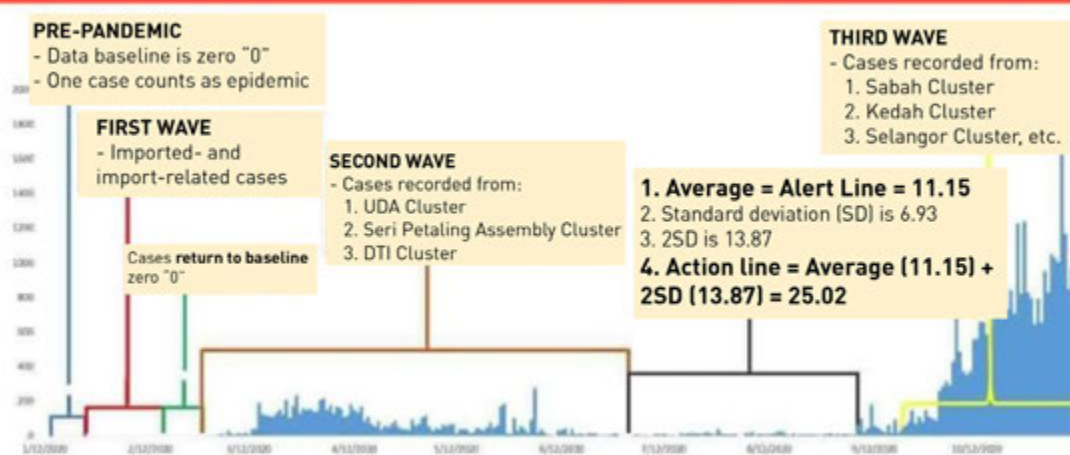
Epidemiology

a. Outbreak Waves

Malaysia is currently facing the third wave of the pandemic (Figure 17). The first official statement from MOH with regards to COVID-19 was on 6th of January 2020, responding to a cluster of pneumonia cases in Wuhan, China (MOH, 2020c). On 23rd January of the same year, MOH reported the first case of COVID-19 from a 66-year old Chinese tourist who entered Malaysia through Singapore (MOH, 2020d). These cases, mainly from China, formed the first wave of COVID-19 outbreak in Malaysia (Shah et al., 2020; Ganasegeran et al., 2020).

The first wave was contained successfully as no new cases were reported until 27th of February 2020. Nevertheless, two clusters originated from Case Number 26 with a travel history to Shanghai, China and a mass religious gathering in Sri Petaling from 27th February to 1st March 2020 had resulted in sudden increase in the number of new cases and led to the second wave (Ganasegeran et al., 2020). As a result, the Malaysian government decided to enact the first phase of MCO on 18th of March 2020 (Shah et al., 2020; Mat et al., 2020; Sim et al., 2020; Ganasegeran et al., 2020; Jaafar and Azzeri, 2020).

COVID-19 PANDEMIC WAVES IN MALAYSIA @ 11 NOV 2020



Source: National Crisis Preparedness and Response Centre (CPRC), MOH

Figure 17: COVID-19 waves in Malaysia
(Source: Facebook Noor Hisham Abdullah, 11th November 2020)

Since then, Malaysian underwent few phases of MCO before being replaced by CMCO from 4th May 2020 and RMCO from 10th June 2020 (Ganasegeran et al., 2020). RMCO was scheduled to end on 31st of December 2020. In between that, the Malaysian government also enacted the Targeted Movement Control Order (TEMCO), and Enhanced Movement Control Order (EMCO) to specific locations and localities with sudden surge of COVID-19 cases. After the introduction of RMCO, the average reported number of daily new positive cases was approximately eleven per day, up until 20th of September 2020.

However, a few clusters were recorded from the immigration detention centres and prisons. The situation worsened by the state election in Sabah which also contributed to the third wave of COVID-19 pandemic in Malaysia. The majority of the states in Malaysia were still under the CMCO (with few localities under the EMCO) until 6th December 2020. Only Malacca, Johor, Kedah, and Terengganu continued under the RMC0 until the end of 2020.

On 11th January 2021, the Malaysian Government announced that they will enact the MCO again starting on 13th January 2021 until 26th January 2021 in all Federal Territories, Selangor, Malacca, Johor, Sabah, and Penang, CMCO in Pahang, Kelantan, Terengganu, Negeri Sembilan, Perak and Kedah, and RMC0 in Sarawak and Perlis. This was announced after daily positive cases recorded were exceeding 2000 cases since early January 2021. It was followed by the emergency proclamation in Malaysia until August 2021 (or earlier, depending on the COVID-19 situation in Malaysia) which has been assented by King Abdullah Ahmad Shah on 12th of January 2020. The proclamation was made to control and flatten the daily COVID-19 positive cases in Malaysia.

b. Clinical Findings

Malaysia was reported having a low Case Fatality Rate (CFR) of 1.2% (Sim et al., 2020). Almost half of the COVID-19 positive cases admitted to the hospital in Malaysia were asymptomatic and categorised into Stage I (50.2%). 31.6% were presented with Stage II (symptomatic without pneumonia). 17.2% were diagnosed with pneumonia and were categorised into Stage III (without hypoxia) and Stage IV (with hypoxia). Only 1.1% of the total number of COVID-19 positive cases were categorised into Stage IV (critically ill). Stage I-III were classified as mild while Stage III-IV as severe disease. Majority of the patients were male (70%), Malay (58.4%) with the median age of 34 years old. Amongst the factors that were significantly associated with severe disease were older age (>51 years), those with chronic illnesses, presented with symptoms, abnormal chest x-ray and high C-reactive protein (CRP). The most common comorbidity recorded was hypertension (15.8%) followed by diabetes mellitus (9.8%), asthma (3.3%) and cardiovascular disease (3.2%) (Sim et al., 2020). Diabetes mellitus, hypertension and age were also significantly associated with higher mortality rate with an adjusted odds ratio of 12.23 [95% CI, 4.126-36.272], 3.576 [95% CI, 1.694, 7.548] and 1.079 [95% CI, 1.064, 1.095], respectively (Albitar et al., 2020).

c. Current Situation

During the second wave, just before the introduction of MCO, the reproductive number, R_0 recorded was about 3.5. MOH, through the implementation of MCO, which was followed by CMCO and RMC0, managed to bring down the R value to the lowest reading of 0.3 in early August 2020. However, the R value rose again to 2.3 during the 3rd wave. It led to the introduction of CMCO at the majority of the states in Malaysia, and EMCO at the selected localities and districts, mainly in Sabah and few areas in Kedah, Selangor and Negeri Sembilan (Figure 18). The action taken had successfully brought down the R value to 1.07 (MOH, 2020a).

SEIR MODEL: COVID-19 DAILY OBSERVED AND FORECAST CASES MALAYSIA (12 SEPT - 31 DEC 2020)

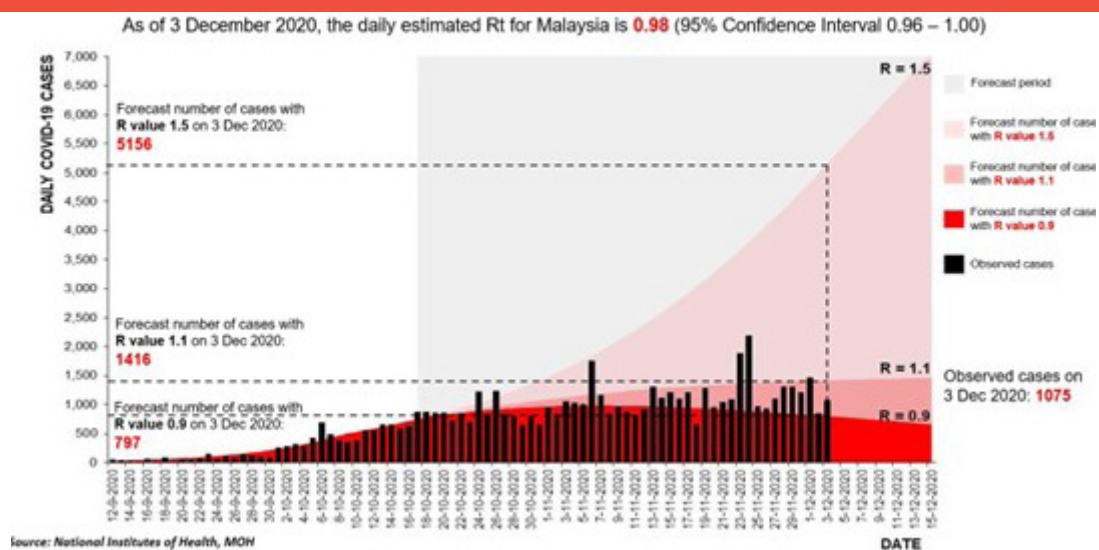


Figure 18: R_t for COVID-19 in Malaysia

As of 28th November 2020, Malaysia had 63,176 COVID-19 positive cases with 350 deaths (0.56% from the overall cases). Overall, 51,314 recoveries were recorded (81.2% of total cases) with 11,508 active cases. 118 cases were treated in ICU and 43 cases required oxygen support. 355 clusters were documented so far, with 180 clusters are still active. Sabah continues to be the highest number of cumulative COVID-19 positive cases of all states in Malaysia with the majority of the active clusters currently from this state (MOH, 2020a).

Nevertheless, as the travel restriction banned was uplifted, Malaysia started to record a significant rise in the number of new daily COVID-19 positive cases in December 2020. As of 13th January 2021, the R value of COVID-19 infection in Malaysia was 1.16. Malaysia had 144,518 cumulative COVID-19 positive cases with 563 deaths (0.39% from the overall cases). Overall, 111,578 recoveries were recorded (77.2% of total cases) with 32,377 active cases. 197 cases were treated in the ICU and 79 cases required oxygen support. 616 clusters were documented so far, with 270 clusters are still active. Sabah continues to be the highest number of cumulative COVID-19 positive cases of all states in Malaysia with the majority of the active clusters are currently from this state (MOH, 2020a). Almost half of the COVID-19 positive cases admitted to the hospital in Malaysia were asymptomatic and categorised into Stage I (50.2%). 31.6% were presented with Stage II (symptomatic without pneumonia). 17.2% were diagnosed with pneumonia and were categorised into Stage III (without hypoxia) and Stage IV (with hypoxia). Only 1.1% of the total number of COVID-19 positive cases were categorised into Stage IV (critically ill). Stage I-III were classified as mild while Stage III-IV as severe disease (Sim et al., 2020).

Public Health Measures and Their Effectiveness

Public health interventions had proven to be the most effective measures to control the spread of COVID-19 infection since there were no definitive treatments and vaccines available at that time (Ganasegeran et al., 2020).

a. Movement Control Order (MCO)

During the initial phase of the outbreak, the MOH strategy is to contain the outbreak. Health screenings were conducted at all entry points to Malaysia to identify and isolate positive COVID-19 cases from spreading locally. While this was deemed to be effective in controlling the first wave, sudden surged of positive cases that led to the second wave, had triggered the Malaysian government to implement the MCO on 18th March 2020. The MCO was enforced under the Prevention and Control of Infectious Disease Act 1988 and the Police Act 1967 (Shah et al., 2020).

During the MCO phase, all mass movements, sports, socio-cultural or religious activities were prohibited. Schools, universities and non-essential public and private were also closed. Travel banned, borders restrictions and compulsory quarantine for those coming back from overseas were also implemented. Together with the MCO, the EMCO or a full lockdown were also enacted in the areas that were considered as 'hotspot' with positive cases of more than 40 (Ganasegeran et al., 2020).

The three-month MCO had successfully brought down the number of daily new positive COVID-19 cases to a single digit, reducing the infectivity rate and controlled the development of the new cluster.

In balancing the effectiveness of MCO and its impact, especially towards the business activity, the MCO was then replaced with the CMCO and later the RMCO, that allows the re-opening of major economic activities, education, and socio-cultural events, however with strict SOPs and guidelines (Ganasegeran et al., 2020).

b. Early Detection and Prompt Treatment

In Malaysia, the primary strategy is to "trace, test and treat" (Ganasegeran et al., 2020). Currently, all positive COVID-19 cases of any stages were admitted to the gazetted COVID-19 hospitals. Once positive cases were identified, a thorough contact tracing was conducted. Those who had close contact with the positive cases were considered as PUI. They were tested for COVID-19 and were admitted to the hospital for treatment if the results turned out to be positive. Close contacts to PUI were considered as "person under surveillance (PUS)" and need to quarantine themselves under the Home Surveillance Order for at least 14 days. If the PUI they contacted were negative, they could return to work as usual, but if the PUI were positive, they were ordered to do a screening test for COVID-19 and were considered as the PUI.

This approach allows a rapid containment and prevents local spread amongst the community. It also helps for early treatments and intervention, especially to those with a higher risk of developing severe disease. This might have contributed to the low CFR of 1.2% in the country, comparable with Singapore and the Republic of Korea (Ganasegeran et al., 2020) which is lower than the world's average (Figure 19).

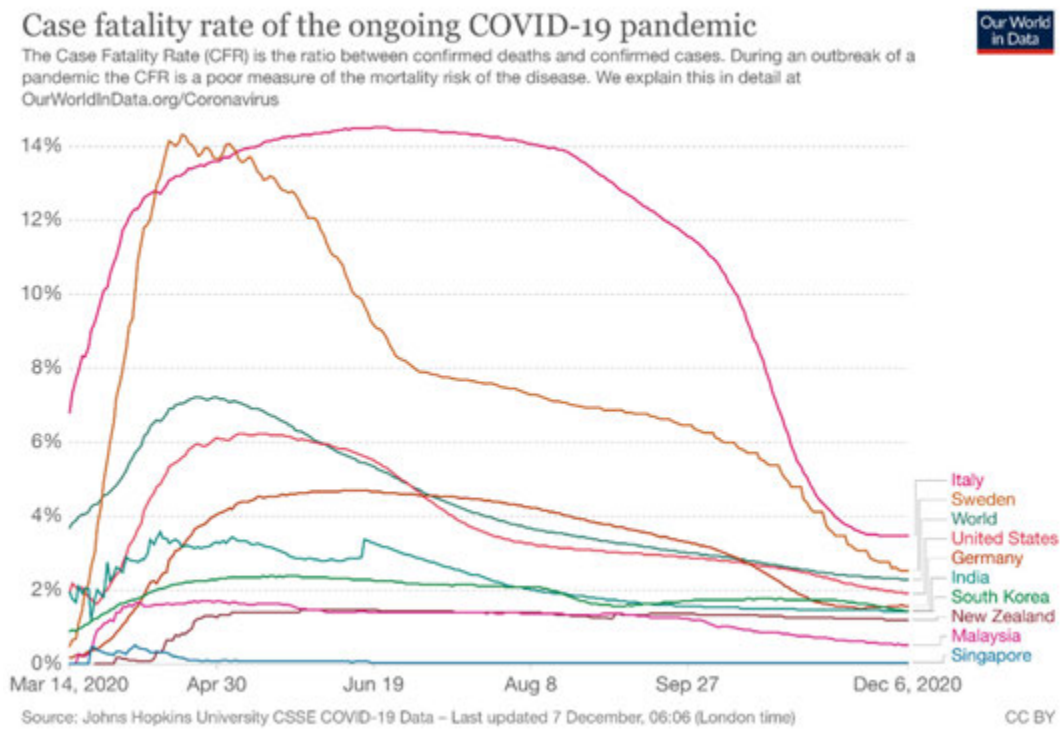


Figure 19: The CFR for COVID-19 as of 7th December 2020

c. MySejahtera to Help Contact Tracing

Prior to the introduction of the MySejahtera mobile application, the contact tracing process was very tedious and time-consuming (BERNAMA, 2020). Although there were a lot of controversies related to the privacy and data security initially raised during its introduction, overall, it has been very helpful in allowing for rapid detection of hotspot area. As for now, it was made compulsory for all to check-in to the applications or written their name with temperature taken prior to entering any premises. In failing to do so, they will be subjected to a minimum fine of RM1,000 (MOH, 2020a).

d. Standard Operating Procedures (SOPs) and Guidelines

Since the MCO, Malaysian had been introduced with lots of SOPs and guidelines to control the outbreak. These include physical distancing, hand hygiene and wearing a face mask. The WHO propagate the concept of 3Cs (Crowded places, Confined spaces, Close conversation) that need to be avoided, and the practice of 3Ws (Wash hands, Wear face masks, Warn against risks, symptoms, prevention, and treatment) (Ganasegeran et al., 2020). All premises and workplaces were also required to follow specific SOPs made by the MOH. Nevertheless, even with strict SOPs enforced, they were still few clusters recorded that originated from workplaces, factories, business premises, construction sites, detention centres, prisons, shopping malls and education centres. The question lies on whether the SOPs were not effective and should be reviewed or it was due to the non-compliance to the SOPs by the respective individuals and groups.

e. Controversial Decisions

During the early phase of RMCQ, Malaysia was on the right track to win the battle against the COVID-19 pandemic. However, few decisions made resulted in the sudden rise of new positive cases and clusters. The first decision was regarding the home quarantine for those coming back from overseas. Initially, persons that return from overseas need to be quarantined at the dedicated quarantine centre. Started on 10th June 2020, they were allowed to quarantine at home. This decision was deemed as too early and resulted in the rises of new clusters in Kedah (MOH, 2020a).

Another controversial decision that created dissatisfaction and uneasiness amongst the Malaysian was the Sabah state election. The third wave of the outbreak was associated with the decision to allow Sabah state election to be held. The idea of conducting a state election while Sabah was handling a few clusters originating from the detention centres was proven to be a wrong move. Although warnings were issued by the public health experts, the state election was continued. It was further worsened by the failure of implementing compulsory quarantine for those coming back from Sabah, immediately after the election process. The decision to quarantine those returning from Sabah was only started on 27th September 2020 and was considered as too late by some experts (Noor, 2020).

Modelling and Future Outbreak Forecasting

To manage the outbreak, accurate information is crucial. In the UK, a special independent organisation was established to advise the government using scientific evidence.

Following the current transmission rate, it is expected that the number of new daily COVID-19 positive cases will be increased up to approximately 5000 new cases per day. To manage the outbreak, accurate information is crucial. Few studies had been conducted to forecast COVID-19 cases and trends in Malaysia. These include the Auto-Regressive Integrated Moving Average (ARIMA) to forecast daily cases (Edre et al., 2020; Singh et al., 2020) and susceptible, exposed, infections, and recovered (SEIR) model to predict epidemic peak and effective epidemic control (Alsayed et al., 2020; Gill et al., 2020). While the results from the studies showed a good model fit, those were not without the limitations. Most of the prediction and modelling were based on the information retrieved by using publicly available data during the first and second wave of the outbreak. As COVID-19 itself is a dynamic disease, future forecasting requires accurate and quality data, with more dimensions and use time series model to improve the accuracy of COVID-19 outbreaks prediction. Data sharing from the responsible authority is crucial for the modelling and future outbreak forecasting.

However, information related to the impact of COVID-19 pandemic towards healthcare system was scarce. Not much reported data were available at the moment, especially those related to the situation in Malaysia. Most of the information came from the official website and social media of relevant agencies, such as MOH and NSC. Accordingly, the next section was prepared with the main objective of understanding the real burden or impact of COVID-19 pandemic on the healthcare system in Malaysia.

Impact of the COVID-19 Pandemic on Healthcare System in Malaysia

Challenges to Current Healthcare System during Pandemic

a. Capacity to Manage Crisis

In coping with the pandemic crisis, a coordinated response should be implemented focusing on maintenance of situational awareness, public health messaging, reduction of transmission, and care for and treatment of the ill. Successful contingency planning and response require surge capacity—the ability to scale up the delivery of health interventions proportionately for the severity of the event, the pathogen, and the population at risk (Madhav et al., 2017).

The pandemic displayed the ability of the MOH to respond to a crisis, and its promptness was proven in mobilising beds for COVID-19 patients.

Respondent 1: "I am creating 7,800 beds for Pusat Kuarantin dan Rawatan COVID-19 Berisiko Rendah, why?, because we do not want to jeopardise our COVID-19 patient and you know during the third wave suddenly because of saringan pekerja asing, all the employers are doing the saringan voluntarily, suddenly cases went up and patients are waiting outside, what did I do?"

b. Budget Allocation for COVID-19 Management

It was reported that the government had allocated RM31.9 billion for the MOH under Budget 2021, marking a marginal 4.3% increase from 2020's RM30.6 billion budget amid the COVID-19 pandemic. Of the total RM322.5 billion Budget 2021 — including the RM17 billion COVID-19 Fund allocated under a separate law, the Temporary Measures for Reducing the Impact of Coronavirus Disease 2019 (COVID-19) Act 2020 — MOH received 9.9% of the 2021 federal budget, marking a slightly smaller share of the budget as compared to MOH's share in the 2020 budget.

The-then Pakatan Harapan government previously allocated MOH RM30.6 billion, or 10.3% of the overall RM297 billion Budget 2020. The current Perikatan Nasional government only increased MOH's allocation by 4.3% for 2021 from 2020, continuing a trend of increasingly smaller raises since the 2019 budget.

It is to be noted that Budget 2020 saw an increase of 6.6% for MOH from 2019, whereas MOH's allocation in Budget 2019 was raised by 7.8% from 2018. The RM17 billion allocation for the COVID-19 fund in 2020 will be channelled to the *Kita Prihatin* economic stimulus package, additional assistance for the well-being of Malaysians, and to serve the needs of frontliners and purchase of vaccines supply.

MOH's RM27.2 billion operating expenditure for 2021, which goes towards running the ministry, marked a slight decline from RM27.9 billion estimated for 2020. Cuts were made to services and supplies (from RM10.9 billion in 2020 to RM9.6 billion in 2021), assets (RM 76.4 million to RM74.1 million), grants and fixed charges (RM511.7

million in 2020 to RM481.5 million in 2021). Emoluments saw an increase from RM16.5 billion in 2020 to RM17.1 billion in 2021. Drugs and medications fall under services and supplies.

MOH's development expenditure almost doubled from RM2.7 billion in 2020 to RM4.7 billion for 2021. The budget for services and supplies multiplied by over eight times from RM318.1 million in 2020 to RM2.7 billion in 2021. Assets were cut from a budget of RM2.3 billion in 2020 to about RM2 billion in 2021. Grants and fixed charges were reduced from RM62.9 million in 2020 to RM59.9 million in 2021.

The government's total expenditure of RM322.5 billion for 2021 was the largest in history. Of that, the government has allocated RM236.5 billion for operating expenses, RM69 billion for development expenditure, and RM17 billion under the COVID-19 Fund. A separate RM2 billion has been allocated for the Contingency Reserve Advance Warrant. The 2021 fiscal deficit is projected at 5.4% of the gross domestic product (GDP) (CodeBlue, 2020a).

The additional budget allocation to cope with measures to provide the additional healthcare services and supporting measures were not mentioned by the respondents, but the allocation towards other support services was not forthcoming.

Respondent 2: "As mentioned by Respondent 1, the challenges that we are facing is about additional budget."

c. Implications to Healthcare System Resources

On the mobility of healthcare resources, Chan et al. (2020) concluded that societies with low levels of healthcare confidence initially exhibit a faster response with respect to staying home (Chan et al., 2020). However, this reaction plateaus sooner, and after the plateau, it declines with greater magnitude than the response from societies with high healthcare confidence, as was observed locally following the first MCO in March 2020. On the other hand, regions with higher confidence in the healthcare system are more likely to reduce mobility once the government mandates that its citizens are not allowed to leave home except for essential trips, as compared to those with lower healthcare system confidence. The authors summarised that regions with high trust in the government but low confidence in the healthcare system dramatically reduce their mobility, suggesting a correlation for trust in the state with respect to behavioural responses during a crisis (Kawachi et al., 1993). The fluid local political scenario and measures to kickstart the economy may have contributed to the surge of cases of COVID-19.

The general consensus of the respondents was unanimous in their opinion about the surge of the workload and heavy responsibility shouldered by the MOH during the pandemic.

Respondent 1: "we have opened up almost additional 20,000 beds nationwide. Latest one at the MAEPS hospital with 10,000 beds. With said capacity of human resources. Besides that, our existing hospitals, we have taken out almost 5,000 beds to treat COVID-19 patients. We deprive basically 5,000 beds from non-COVID-19 patients. This is during the third wave....."

Respondent 3: "When the government says that they need to start giving vaccine, I think our service and delivery will be further burdened because of that."

When questioned on the preparedness or any contingency measures were planned to ensure the continuity of essential services during and post pandemic period, the respondents were unable to provide information as this was beyond their area of jurisdiction. However, the respondents mentioned that the workload of the primary care teams were already burdened with provision of essential prevention and treatment services for communicable and non-communicable diseases, including immunisations.

Respondent 4: "I think kena tengok keadaan klinik tu sebelum COVID-19 begin, even the best of times, without COVID-19, the increasing burden for the NCDs, how they make the bulk of how patients are coming into our health clinic, and 75% of patients with diabetes had [can] potential secure many primary care facilities so, even in the best of times we were already overstretched in providing quality care" ...Many of our healthcare workers are affected by COVID-19 from the community and have to be isolated and treated. So we lost our human resources."

Respondent 5: "We know that the burden with the NCD is still ever present and yet they also have to reorganise themselves to actually cope with the COVID-19 load in the testing."

One of the respondents also highlighted that the non-communicational diseases, especially mental health related issues including domestic violence and abuse had also increased due to COVID-19.

Respondent 2: "The impact of COVID-19 on our Malaysians got perasaan takut and need help because we received calls from those who have problems with keganasan rumah tangga because they stay longer hours in their small houses, small flats and we receive complains about husband and wives who have problems in their daily life. Also their children who cannot go to the playgrounds and schools so they have a lot of this kesan kepada jiwa that they come to us for counselling. We also got information that KKM opened up a talian for counselling and the increase of numbers, especially children below 18 have increased about 40%. These are some situations that we have to look into. Are there need for more counsellors or pegawai pelindung?"

d. Issues with Communication

The role of media and the announcement on crisis to the public – fairly transparent, one way and authoritative but clear. However, inter-agencies communication to facilitate collaboration is still an issue.

The pandemic highlighted the need for improved communication between government agencies even more, and that efforts should be made to promote collaborative efforts to ensure success in delivery of services. The matter of bureaucracy causing delays in execution of procedures was raised by the respondents.

Respondent 4: "...the bureaucracy of Malaysian government, the ministries and agencies."

Respondent 2: "it is not about the bureaucracy, it is about the procedure. Sometimes when we do procedures, people outside there do not understand, so I think that the more we sit down and try to communicate with each other, we can make things easier. In our discussion, this is a new thing, political width is very important because they direction to us. I think communication is very important, to understand each other is the key point."

Respondent 1: "Normal operating procedure cannot be used in crisis or something crucial. C is for crisis and disaster, we already bought the consignment, but we cannot bring it back because the procedure kata tak boleh kerana apa, the line all over the world stop. We told the PM, we are Malaysia, we can't. This is no procedure for crisis, this is not accepted. So, the PM agreed and said, bring back the consignment and return the ventilators to Malaysia. We need it urgently, so I agree with you. O is the operating procedure while thinking outside the box. C is crisis, all that."

e. Inter-agency Cooperation

Several respondents from different ministries confirmed that inter-agency cooperation was evident from the onset of the pandemic, although the challenges to initiate cooperation and facilitate the roles would have benefited with better communication and less bureaucracy.

Respondent 6: "I don't think that there are any constraints. I would context it as a challenge. I think on our part is, we are quite challenged by the situation times the number of patients or number of suspected patients in quarantine centres itself is too many for us to handle at once. ...We have no problem in terms of offering our corporation, try as much as possible to all of the agencies, Jabatan Kebajikan Masyarakat, Jabatan Pembangunan Wanita, even LPPKN looking at family matters, JSM looking into the numbers and how we can further strategise to help our kumpulan sasar better, so that's my response."

Respondent 2: "We also have to streamline our policies and communication line is very important within inter agencies, data sharing is another area that we have to collaborate."

A respondent from Ministry of Defence (MINDEF) mentioned about their contribution during the pandemic, apart from setting up a hospital onsite for quarantine of mild COVID-19 patients, they also assisted in helping to ease the MOH burden by treating non COVID-19 cases.

Respondent 7: "Despite being a small (organisation), we play an objective supporting role together with the Ministry of Health. Supporting the Ministry of Health in many areas. In particular, mostly in the term of makeshift of big setup because that is where our technical expertise is. We have helped in the MAEPS in makeshift treatment centres and we have helped to deploy personnel all over Malaysia."

f. Lack of Cooperation from the Public

On the compliance of people to SOP, the initial stage of the MCO generally showed a good compliance and it appeared to control the spread in the disease (MINDEF, 2020). However, when entering the RMC0 in August 2020, the lifted restrictions caused a steady increase in the COVID-19 cases, and the surge continues to rise to four digits by the end of 2020. This has resulted in the MCO being reinstated in most of the states in the country and this has accelerated the decision for immunisation (Noh, 2021).

The respondent from MINDEF voiced concerns about the strong anti-vaccination groups who have been campaigning to the public to reject any immunisation programmes offered by MOH, based on a survey conducted by their Ministry.

Respondent 7: "With vaccination, we are also worried because when we come up with surveys whether you are willing to take the vaccine or not, we received a lot of anti-vaccination response going on. Either openly or submissively, we are having that now and many negative aspects of COVID and many vaccinations."

g. Disruption to Other Healthcare Services

The Director General of MOH during a press conference stated at that time (April 2nd 2020) that there was no disruption of healthcare services provided by the 146 hospitals (operating as usual) as only seven hospitals were designated for treating COVID-19 cases (Salleh and Amrie, 2020). During the same period, the Association of Private Hospitals Malaysia (APHM) had offered their assistance to MOH to manage COVID-19 patients should the need arise. Apart from availability of 900 beds in private hospitals nationwide, pro bono consultations by specialists and lending out ventilators for use at MOH facilities were offered. Complimentary support was also offered by Medical Practitioners Association of Malaysia who offered COVID-19 screening services to be carried out by private General Practitioners and sending positive cases to designated government hospitals (Fong, 2020).

The WHO advocates that to avert indirect morbidity and mortality and prevent acute exacerbations of chronic conditions when services are disrupted, countries should identify context-relevant essential health services that will be prioritised for continuation of services during the acute phase of the COVID-19 pandemic. Temporary suspension of services will lead to a backlog of people needing care. Interrupted preventive programmes, including screening, are likely to require catch-up campaigns, such as for missed vaccinations. Complications and morbidity associated with care-seeking, such as severe exacerbations of noncommunicable diseases (NCD) or advanced infections are areas of concern (WHO, 2020d).

Two of the respondents acknowledged the fact that there was a need to improve the capacity of the MOH, especially with regards to disruption of other healthcare services during the pandemic. As for the magnitude and impact of the pandemic on these programmes, this is relatively unknown at this point in time.

Respondent 1: "How about non-COVID-19 patients, we cannot jeopardise treatment to non-COVID-19 patients based on what happened in other countries.."

Respondent 4: "So now you have COVID-19, so SOPs are in place to ensure the safety and health of our healthcare providers but unfortunately because of those SOPs it puts an additional burden to the services being delivered by from the screening primary care."....."Vaccination, HPV, school programmes, I would expect that to be affected not sure to what extent because they are trying to do it vaccination outside of schools..."

Respondent 4: "We did see some disruption in terms of processes in terms of screening for complications like fundus examination for example, but these are localised to the total localities again COVID-19 is not affecting Malaysia uniformly throughout the country, obviously we know this right. Certain states are less affected. OK referrals that has not been disrupted generally speaking by (but) again this is just my conversation with some of the clinicians we do not really have to research our data collection to back me up."

h. Illegal Immigrants and Foreign workers: Health Threats to Security Personnel, Inequality, Mistreatment, and Misbehaviour

Malaysia is the largest importer of labour in Asia, sourcing its workers in various employment sectors from a total of 15 countries. Despite the large presence in the Malaysian economy, the policies and laws regulating immigration have been flawed and subject to frequent revisions (Devadason and Meng, 2014). The pandemic has revealed the outcome of poor social and living conditions which contributed to the spread of COVID-19 amongst the migrant labour population (Habibu, 2020).

According to one of the respondents, Malaysia is also facing a threat from the movement of illegal immigrants who are already infected with COVID-19 from nearby jurisdictions into the country. They came to Malaysia with the knowledge that immigrants are provided with free treatments for COVID-19. Due to this scenario, security personnel who are not aware that they are in contact with infected immigrants are also exposed to the viral infection.

Respondent 7: "We are having quite a significant number of positive cases amongst us because they are dealing with illegal immigrants. Quite a majority of the illegal immigrants are purposely coming to Malaysia to get free treatment for COVID-19 and they don't know that they are infected with COVID-19. These are serious issues that collected in Sabah and some areas along the course of Johor. They heard from the newspapers, that we are treating the illegal immigrants well."

Also, the risk of transmission is rather high amongst the security personnel given the fact that they are housed in accommodation, which is in a close proximity with each other. This will not only jeopardies the health and safety of the personnel but also the mobilisation and availability of security force in the country. For instance, one of the respondents shared that there were two clusters involving Malaysian navy ships, which has resulted in the entire submarine to be immobilised to contain transmission of virus. The respondent also expressed a strong concern about the safety of those living in quarters or barracks, which will also put family members of the personnel at risk of infection.

Respondent 7: "The close proximity measure of our personnel, we are living in camps. Living quarters are very close, so one single case can render the whole security force useless. For example, we had 2 clusters involving navy ships. The company in the submarine was immobilised because of that. Everybody had to be quarantined and it affected our security."

Another respondent shared his view on the importance of addressing the inequality faced by illegal immigrants in Malaysia. It was argued that the condition where the illegal immigrants are currently in makes it rather unfair to put the blame on them for transmission of virus within the community. It was pointed out that the pandemic has only amplified the poor condition of the detention centres in the country, and this should be addressed in order to reduce the rate of transmission amongst immigrants.

Respondent 4: "We do know that in Malaysia there is already inequality in equities and what COVID-19 has done it has amplified that, dulu-dulu it was out of sight and out of mind you know...Pendatang tanpa izin, migrant workers legal or illegal, we just turn a blind eye. So what COVID-19 has done is that it has amplified... we keep thinking that the migrant workers yang degil yang tak nak dengar cakap is just like saying orang obese tak nak dengar cakap jaga makan or tak nak exercise, it is not as simple as that. It is their circumstances that has made it impossible for them to do what you are asking them to do, as highlighted by colleagues from MINDEF... This is affected by the circumstances and the environment of the vulnerable population... unlikely for us to reduce the COVID-19 burden...I sedih jugak dengar kan the condition of our detainees dekat Malaysia in the detention centres. So even in that situation, we can see the spread..."

Another respondent also shared the same sentiment on the circumstances and the environment of foreign workers in this country, particularly their accommodation. It was stressed that the foreign workers are not properly housed. They are living under bad conditions of cramped space, which makes them vulnerable to infection and rapid virus transmission due to close contact with each other. One can also argue that the current pandemic has also amplified this unfortunate situation as to how foreign workers are being treated by employers in Malaysia. Their living condition can be seen as an enabling or contributing factor that increase the transmissibility of the COVID-19.

Respondent 1: "Similarly for the employers like Cluster Teratai. When you have the opportunity, you can go to their house, how do they live, 30-40 people in a house. 20 people sleep and another 20 go to work. Although while working they are following SOP but when they sleep, they get infected by each other."

This reveals that some employers are not providing their foreign workers with a proper accommodation and amenities as required by the Act 446 on Workers' Minimum Standards of Housing and Amenities. It was argued that this issue is not within the ambit of MOH's jurisdiction, and it should be looked into by the Ministry of Human Resources (MOHR). The abovementioned law provides legal force for any relevant legal actions required as stipulated in the statute to address the overcrowding, particularly during the pandemic to control the spread of infectious disease.

Respondent 1: "No.3, foreign workers, 1.5 million, is it under MOH? It is not under MOH, what are the role of Kementerian Sumber Manusia, and look at Act 446, why can't we take action? What are the role of CIDB on foreign workers and all that..."

Nonetheless, the same respondent also highlighted one of the challenges faced by the government in providing care for foreign workers. There were reports of misbehaviour involving foreign workers. Some of them vandalised properties of the hospital and hotel where they were temporarily housed.

Respondent 1: "These foreign workers from other countries, you can see what happened in IIKKM and ask them all the mattresses are all torn, in Hospital (Rehabilitasi) Cheras, damage in the toilets because this is a very delicate hospital, but we have no choice to bring them. Now we move them out...so when they stay at the hotel, they koyakkan, kencing dan sebagainya."

Opportunities to Improve the Healthcare System

Currently, Malaysia is battling with the third wave of the COVID-19 outbreak. The daily new positive cases reached four digits. While the situation in Sabah is still worrying, the increasing number of new cases in Klang Valley and Negeri Sembilan had created a new challenge to the MOH, especially when it involved mainly the foreign and illegal workers. The nature of their living arrangements, population density, health status and compliance to SOPs had resulted in the development of new clusters with higher positivity rate.

Another challenge that should be addressed during and after the pandemic is to balance between the health and economic impact. Although the numbers of daily new cases were higher as compared to the second wave, the Malaysian government had decided not to introduce another nationwide MCO. This step was taken to ensure that the economic activities were not affected and to prevent people from losing their job as what had been observed during the MCO phase. The CMCO that was enacted currently at few states might not be as effective as MCO to prevent the local spread, but it was deemed as the best options to balance between the health needs and economic survival.

Community empowerment and trust in managing the outbreak should be considered as it is more sustainable over time. The public must be educated on the new living norm, which includes attention to personal hygiene, wearing face mask and avoidance of mass gathering. During the second wave, the Malaysian government received full support from the public to fight the spread of COVID-19. Nevertheless, few controversies, bias decision, and special treatment received by some politicians had hampered the trust given by the public. Without the trust and cooperation from the community, any decision made by the government would be difficult to be followed.

The government must also establish an independent advisory committee using scientific and statistical evidence in making the decision and predictions. COVID-19 is still not over yet, but it may not be the last outbreak we need to face. We need to devise sustainable public health measures using accurate information which include community empowerment in confronting the current and future health crisis.

The MOH is clearly overburdened in terms of providing care for COVID-19, human resource, and logistic arrangements during the pandemic. Current measures employed appears unsustainable as the number of cases continue to surge, despite the public health measures in place. On the hospital administration side, increasing or mobilising additional hospital beds for COVID-19 patients with the current human resource strength will not be a sustainable measure for long if the transmission continues at its current rate.

For the community-based care, the magnitude, and effects of the disruption of essential services at primary care is relatively unknown at the time of writing. No data has been shared or published from MOH, albeit for some small research groups who have had the opportunity to access data from the various divisions providing specific NCD service. The lack of data sharing initiatives is obvious within MOH itself as well as with other ministries.

The pandemic has magnified the gaps in which the MOH as well as other relevant Ministries need to revamp and transform the local healthcare delivery to further optimise the quality of healthcare in this country. Efforts to collaborate with the private healthcare services should be explored to help with disrupted healthcare services, i.e., NCD, immunisation programmes, rehabilitation, antenatal and surgical services resulting from the pandemic.

These issues further emphasise the need for healthcare system transformation, i.e., to improve on human resource, optimisation of existing resources to ensure sustainable healthcare financing.

a. Human Resource

Human resource related issues became more obvious during pandemic situations. It highlighted contingency measures and poor preparedness to cope with heavy workload. The human resource strength at MOH has been highlighted in the past few years – in terms of surplus of medical graduates which has resulted in reduction of permanent posts available for those who completed the compulsory housemanship training. The pandemic situation has only highlighted that there will be a relative or perhaps even permanent shortage of healthcare workers during and after pandemic conditions; not only amongst medical officers, but also allied healthcare support, i.e., psychologists, counsellors, or health inspectors. Despite the nation having both the public and private healthcare systems, the public will tend to migrate more to the public healthcare services for both medical and economic reasons.

Respondent 1: “we do not have enough of healthcare workers and another thing MAEP Hospital is going to have 5,000 beds and going to increase to 10,000 which will be really congested managing category 1 and 2 patients.”

Respondent 8: “We believe that we should use this not only for effective COVID-19 treatment but also for other purposes. Upgrading our facilities, more contract workers, making more permanent work, more equipment, stuff like that.”

Respondent 3: “COVID-19 will bring in back in terms of the population will now revert back to government facilities. I think in the near future, the Ministry of Health (MOH) has to look into accommodating more in terms of patients for both outpatients and inpatients.”

Respondent 4: “Mental health needs more attention while we have a proof but 200 plus contract for counsellors solutions to distribute throughout the country because we can convert that into a permanent post but 200 tak cukup. We need to collect more data available on the utilisation of these services and their longevity, accessibility for counsellors. That is one aspect of mental health.”

One of the respondents highlighted an important issue in terms of providing mental health support services - which should also include ensuring mechanisms to support the healthcare workers who are similarly affected by the challenging workload and circumstances.

Respondent 9: “I think one part that we need to look after for the post-COVID-19 responses is to look at their welfare and well-being of the frontliners personnel because it also covers on their needs for childcare, mental health. We conducted a little survey on the mental health and preparedness of frontliners during COVID-19. We had about 800 responses. It was mentioned that the frontliners have shown a very bad, the stress, the worriedness and the depression. However, it contrasted to their preparedness as they were showing high levels of responsiveness to face the COVID-19 itself. We have to focus on the healthcare and all, we should also look into this welfare and well-being of the workers”

b. Technology Driven Healthcare

In general, three of the respondents agreed that healthcare technology or digital health measures would be beneficial in pandemic situations. However, the success of digital healthcare transformation would depend on the behaviour of the population, i.e., with the end users embracing the technology as the new norm for delivery of ‘personalised’ and ‘COVID-19-proof’ healthcare.

Respondent 7: "From the technology point of view, we realise that for a more COVID-19 proof healthcare system in a way. We still have an influx of patients in huge numbers in all the hospitals coming for follow ups some chronic diseases, for example. Quite a majority of them, they just come for their medications and they will take their blood results or any investigation or reviews. Which does not necessarily mean that they have to be physically present there, something to think about to reduce the number of patients by having the use of technology, application for example for review or follow- up. Maybe have one to two face-to-face follow- up a year. That would help to reduce the burden of the overall operational cost for our healthcare centres."

Respondent 4: "So we do know that Malaysians are low health literacy and there are studies to show that Malaysian have no IT literacy as well. I imagine would be more amongst the older age groups, amongst the lower social economic class who are the more vulnerable groups. People who would benefit the most from digital healthcare intervention. The other thing why this is important is because as compared to other technologies before, in regards to this current digital healthcare utilisation, both the healthcare provider to be adapt and also their clients, the patients, the population to be adapted to using it as well."

c. Public-Private Partnerships - Strategies to Outsource for Screening/Testing for COVID-19

It was announced in March 2021 on decanting of non-COVID-19 cases from public hospitals to some of the private hospitals, as well to the university hospitals that are not involved in managing COVID-19 cases.

The advent of the pandemic and its impact on the healthcare system has resulted in a tremendous strain on the public healthcare system. The current situation draws attention to the opportunities to share the burden with the private healthcare sector, in particular to help in ensuring care provision for non-COVID-19 cases, specifically for NCD care.

Respondent 1: "We also worked together with other GPs to help us and we also thinking that some of the NCDs can be referred to Klinik Kesihatan. Klinik Kesihatan now has workload increasingIf we wish to utilise GP, we need to prepare another paper to the Ministry of Finance. What was done by medical programmes, by hospitals, we get papers to present to the Cabinet. So that we can prove to the Cabinet that we can outsource research from hospitals but similarly it can be done by providing papers to the Cabinet by outsourcing with the GPs from NCD."

Respondent 3: "...our services are always running to cater both for COVID-19 and non-COVID-19 patients. Also looking specifically into outsourcing activity from private and public partnerships.."

Impact of COVID-19 on the Socio-economic Situation in Malaysia and the Role of Various Stakeholders in Managing them

The COVID-19 pandemic has resulted in a significant burden on the healthcare system and other sectors globally. The spread of the disease has affected people's lives around the globe in an extraordinary way, threatening health, disrupting economic activity, loss of job and loss of income and resulted in a poor quality of life as well as overall well-being, including physical and mental health.

The pandemic has significantly restrained global economic activities that caused negative economic impacts to the society. It has also caused direct economic implications to patients due to high healthcare expenditure for disease management, as well as an indirect financial burden due to premature deaths, workplace absenteeism and reduction in work productivity. Economic shock took off soon after the initial outbreak of the pandemic. International trade had slowed down and financial markets plunged as early as February 2020. Labour markets were further affected by the implementation of lockdowns, which resulted in a dramatic rise in unemployment and under-employment.

"The United Nations Framework for Immediate Socio-Economic Response to the COVID-19 Crisis warns that the pandemic of COVID-19 is much more than a health crisis: it is at the heart of communities and economies" (WHO, 2020g). In order to inform and tailor the responses of governments and partners to recover from the crisis and ensure that no one is left behind in this effort, it is important to evaluate the effect of the COVID-19 crisis on populations, economies and vulnerable groups.

To date, several reports and reviews to determine the impact of COVID-19 on socioeconomic situation in Malaysia have been conducted by many agencies. Nevertheless, a thorough discussion between stakeholders and non-governmental agencies in Malaysia pertaining to this issue is still limited. Therefore, this study aimed to review the published and available literature on socioeconomic impacts of COVID-19 and to conduct focus group discussions to understand the magnitude of impacts of COVID-19 in Malaysia. This information is significantly beneficial in understanding the pandemic-related socioeconomic issues, gaps, and needs of communities during this pandemic. Findings from this study could provide evidence on the importance of local action and strategies to help address the short-term and long-term negative consequences of the coronavirus (COVID-19) outbreak. Plan of action on mitigating the health and economic impacts of the COVID-19 pandemic is essential to ensure the survival and well-being of the people.

In this section, three key sectors have been identified to be amongst those that have been significantly affected by the pandemic, namely SMEs, education, and tourism. Managing the aftermath of the pandemic requires a multi-sectoral approach to address the battling of COVID-19, preserving the welfare of the people and supporting the continuity of businesses.

Small and Medium-Sized Enterprises (SMEs)

Evidence on the COVID-19 crisis impacts on SMEs from business surveys indicates severe disruptions and concerns amongst small businesses. SMEs make up 99% of the 920,624 business establishments in Malaysia. In 2018, SMEs employed 66.2% of the workforce in Malaysia, contributing RM522.1 billion, or 38.3%, to the Malaysian GDP. They are classified into three categories: micro, small, and medium, defined by industry, sales turnover, and the number of employees. Micro-enterprises make up 76.5% of Malaysian SMEs. In contrast, medium-sized enterprises comprise only 2.3% of SMEs. Any business and economic challenges will inevitably affect these business sectors in various ways. This section shall report the impacts of the pandemic on SMEs in Malaysia based on desktop reviews of available data published by the government agencies and business associations, as well as academic journals. It is followed by a gap analysis of strategies that had been put in place and some recommendations on the role of stakeholders other than the healthcare sector in planning for the recovery phase of the pandemic.

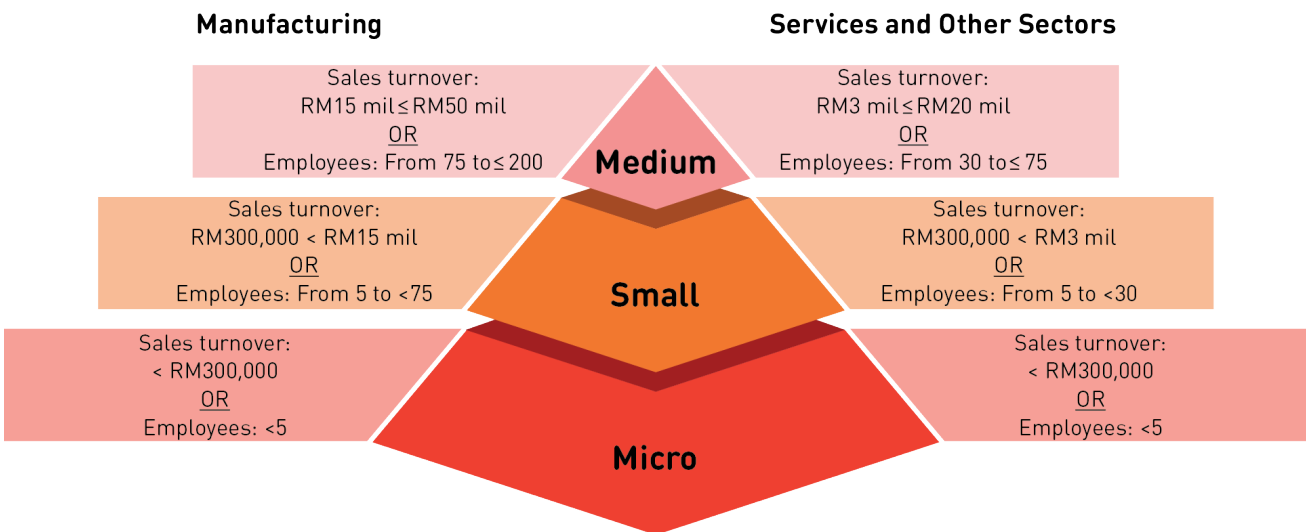
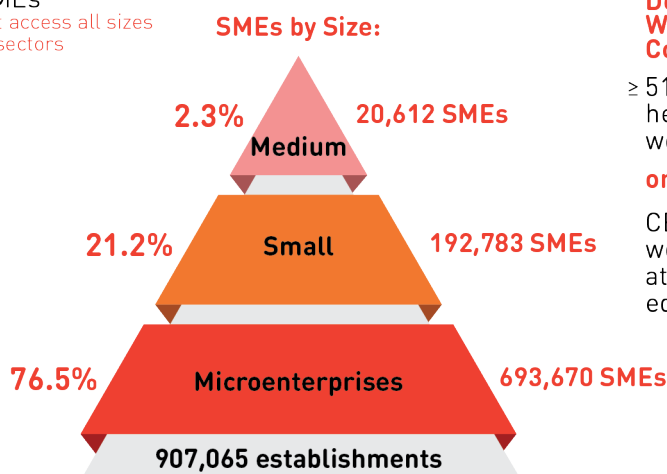


Figure 20: Breakdown of SME Categories in Malaysia

SMEs are the backbone of the economy

98.5% business establishments in Malaysia are SMEs
cut access all sizes & sectors



20.6% SMEs are women owned

Definition of Women-owned Company
≥ 51% of the equity held by a woman / women
or
CEO / MD is a woman that owns at least 10% of the equity

SMEs by Sector:

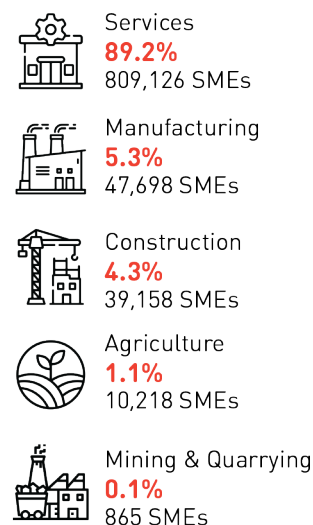


Figure 21: SMEs distribution by size, employees, and sectors in Malaysia
Adapted from (Hong, 2020)

a. Impacts of the Pandemic on SMEs

All types of business face the challenge of needing to react and adapt to the impacts of the COVID-19 pandemic, but it is recognised that SMEs of different sizes face different challenges. The differentiation of various respondents must be made in various surveys. Larger SMEs may have millions in cash reserves to sustain their payroll, making their experience during the COVID-19 pandemic a different one. Although micro-SMEs may not have high overheads, they still have financial commitments in terms of employee salaries and rent totalling between RM3,000 – RM5,000 per month. While several larger SMEs have reported that they may not last beyond two months, the micro-SMEs may struggle even briefer durations due to the lack of savings. Alternatively, micro-SMEs are more adaptable as they can change their business model very quickly due to their smaller size. On the other hand, SMEs with a high number of employees will struggle to sustain overheads and apply changes in business direction.

The biggest impact of the MCO on all business sectors is the threat of business closure; more than 30,000 SMEs have “closed shop” since the implementation of the first MCO in March 2020 until November 2020. According to the Entrepreneur Development and Cooperatives Minister, a total of 9,675 SMEs had been reported to cease operations during the first phase of the MCO from March 18th to June 9th, and 22,794 during the RMCO phase from June to September 2020. The highest figure was recorded in August with 17,800 SMEs ending operations with the majority being micro-SMEs which made up 79.5% of the closures during the MCO and 70.8% during the RMCO.

A local study involving six selected SMEs’ owners using a qualitative approach to investigate the impact of the pandemic on their businesses and found that the first MCO had impacted SMEs on two aspects, namely operational and financial problems (Omar et al., 2020). Operational problems refer to operations and supply chain disruption, as well as foresighting future business direction, while financial problems refer to cash flow imbalance, access to stimulus package and risk of bankruptcy. Meanwhile an online survey amongst 97 service-based SMEs found similar concerns of financial impacts during the same phase which were mainly reduction in sales and cash flow (Annuar, 2020; Marie, 2020).

In another survey, most sectors saw their workforce and financial commitments being impacted most significantly by the COVID-19 pandemic (Lim, 2020). Breaking down the impacts on different sectors saw slightly different trends in their responses. For instance, the manufacturing, food and beverage, retail and logistic sectors are primarily impacted on their financial commitments while the entertainment and tourism, advanced manufacturing are primarily impacted by their workforce. The education sector was greatly impacted by cancellations of events and enrolments, while for retail and logistics sector, they were most impacted by supply chain disruptions. Expected loss of revenues was anticipated by sectors that had the strongest regulations and enforcement imposed during the MCO, such as entertainment and tourism, followed by manufacturing, and food and beverage sectors. This survey respondents were represented by about 70% of small and medium-sized businesses.

Ernst and Young in their online survey of business impact due to the pandemic evaluated key challenges identified by business owners across five areas: Financial impact, customer, technology, supply chain and people (Ernst & Young Malaysia, 2020). Financial issues cited by SMEs include cashflow, liquidity, delays in receivables and declines in revenue. Customer issues include the fall in demand, while work from home connectivity poses a challenge in communicating with customers. In addition to that, delays in fulfilment and delivery of supply are also a major challenge, followed by delays in completing tasks and projects due to workforce problems.

Furthermore, a survey by Department of Statistics, Malaysia (DOSM) conducted on 23rd - 31st March 2020 and covering 168,182 respondents reported reduction of income for employees in various sectors: the hardest hit was reported by the agriculture sector (70%) and the services mainly the food services (86%), arts and entertainment (75%), and accommodation (70%). Almost 70% of all sectors reported no sales/ income during the MCO. As the pandemic disrupted both the supply and demand of the global economy, companies find themselves stretched to the limits by maintaining supply chains and stimulating consumer demand. Like previously mentioned studies, the areas of business reported to be most affected were also sales, cashflow and supply chains. The respondents of the DOSM survey had less than 20% respondents from the medium and large-sizes businesses while the rest were micro and small-sized businesses (DOSM, 2020).

With regards to the manufacturing sector, two surveys were conducted by the Federation of Malaysian Manufacturers. The first covered 1,120 manufacturers, while the second survey represented 419 companies (FMM, 2020). The main challenge faced by this sector is due to its non-essential status for most cases, and the nature of work which is not suitable to be done remotely from home leading to stoppages of most of its business activities. Furthermore, manufacturing sector was hit both by the supply and demand sides. In this situation, retrenchment of employees seems inevitable. Finally, another sector which is also not spared from a significant economic impact of the pandemic is the agriculture sector, whereby almost 90% of agricultural establishments are SMEs and out of this, 40% are micro-enterprises. Workers in this sector are mostly low-income earners and considered as non-standard workers; they are therefore at a greater risk of being retrenched or being asked to take unpaid leave (Shaharudin, 2020). The declining bulk demand from the hospitality and tourism sectors and the disruption of the global supply chain is bound to cause even more negative impacts on the agriculture sector.

b. Gap Analysis

Though there are plentiful economic assistances provided by the government, there have been concerns whether they are reaching those most in need; the appropriateness of the conditions and criteria for receiving support; the speediness in delivery and adequacy of the amounts or waivers that are specified; whether the distributional effects can be considered fair and effective; and the longer-term implications for recovery. With the various stimulus packages provided to assist vulnerable businesses and communities, the medium-term and long-term economic impact remains a concern for businesses, as unemployment rates reached decade-long highs towards the end of 2020. Other than those who have or may lose their jobs, there are existing vulnerable populations that will be impacted significantly by economic crisis, such as the elderly, the B40 households, the urban poor, and the migrants.

The following are some concerns raised regarding the financial assistance provided by the government for SMEs:

1. Under the scheme dubbed 'i-Lestari', Employees Provident Fund (EPF) contributors will be allowed to withdraw a portion of their savings from Account 2, up to RM500 per month for 12 months for a total of RM6,000. A significant proportion of EPF contributors will not be able to benefit from the scheme. Assuming that Account 2 represents about 30% of total savings of an individual, it has been estimated that up to 40% of total contributors have less than RM6,000 in their Account 2; in fact, those in the bottom 10% do not even have RM500 in their Account 2. The poor and most needy are not likely to have loans from financial institutions nor to have EPF savings. Furthermore, there are serious longer-term implications since withdrawing funds now means depleting what they will have for retirement or old age or even for productive purposes, such as education. A third and major concern is that i-Lestari is limited to only those registered and contributing to EPF, namely employees working in the formal sector, meaning that the large numbers of the self-employed, those in the gig economy and those in informal or non-standard jobs will not be able to participate in i-Lestari.
2. There is the important issue of equity and fairness. The current provisions are biased against the self-employed who are actually the most severely affected by the MCO yet have essentially fallen between the cracks of the Stimulus Package as they are in the informal sector. Unlike formal sector employees, the self-employed cannot benefit from the i-Lestari provision, Bantuan Prihatin Nasional (BPN) and from direct fiscal injections through the Employment Retention Programme (ERP), Employment Insurance System (EIS) and Wage Subsidy Programme (WSP). And since the self-employed likely would not have registered as businesses, they also would not qualify for support from the SME package.

3. The Prihatin stimulus package offers no support for foreign workers, documented or otherwise. The WSP explicitly excludes migrant workers and expatriates. In fact, MOHR advised, “if a lay-off is inevitable, foreign employees should be terminated first”. Yet, the migrant workers and refugees are certainly amongst the most vulnerable in terms of both the health risks and the loss of livelihoods. Furthermore, the migrant workers and refugees are being stigmatised as carriers of the virus and are being raided and detained and denied jobs; and there are growing calls to deport the Rohingya refugees who are seen as absorbing the country’s increasingly scarce resources.
4. The RM10 billion of Prihatin SME stimulus package has been much needed. But microenterprises are not registered with the Social Security Organisation (SOCSO) or the Companies Commission of Malaysia (CCM) – therefore, in the informal economy, do not qualify for assistance. Own-account work and unpaid family work have been officially classified as vulnerable employment, and it is acknowledged that the most vulnerable workers are in the informal economy. Informal workers often have poor access to healthcare services and have no income replacement in case of sickness or lockdown. Many have no possibility to work remotely from home. But staying home means losing their jobs, and without income, they will face shortage of food supplies.
5. E-commerce had varying effects on different types of SMEs. While the MCO has accelerated the uptake of e-commerce adoption, some SMEs have reported lesser earnings, such as those in F&B, as they no longer were able to capitalise on higher profit margins from beverage and dessert sales. The opposite effect is true for other businesses that were able to capitalise on positive earnings due to increased exposure when they established an online presence.
6. Delays due to bureaucratic processes. SMEs have misgivings towards the complicated processes required by the various government agencies to obtain financial relief due to a lack of explanation of the processes required, leading to delays.
7. Policy gaps affecting e-commerce processes. During the MCO, some SMEs were keen to carry out e-commerce activities as it was listed as an essential service by the federal government. However, SMEs were prevented from carrying out the necessary ordering processes as personnel were not allowed to access warehouses which then prevented the necessary processes of sorting, packing, and dispatch necessary in completing an order. Hence, the intention in recognising e-commerce as an essential service did not synchronise with its execution.

ISCED	Level of Education	Enrolment (2016)	Enrolment (2017)	Enrolment (2018)
0	Pre-School	943,022	988,393	999,557
1	Primary	3,101,007	3,084,630	3,084,630
2	Lower Secondary	1,391,757	1,379,597	1,348,161
3	Upper Secondary	1,367,896	1,365,042	1,244,809
4	Post Secondary	-	-	-
5	Short Cycle Tertiary	468,382	440,816	458,065
6	Bachelors Degree	674,598	677,178	685,571
7	Master	149,895	89,216	98,052
8	Ph.D	43,675	41,717	43,188

Figure 22: UIS Indicators – (Malaysia) Enrolment by Level of Education – Enrolment by International Standard Classification of Education (ISCED) Level
(Source: UNESCO Institute for Statistics)

As reported by the Institute for Management Development (IMD), 2018, total public expenditure on education in Malaysia was recorded as 4.9% and 4.5% GDP in year 2017 and 2018, respectively. According to the Ministry of Education Malaysia, there are a total of 10,208 schools in Malaysia in 2019, with 6,152 pre-schools, 7,772 primary schools and 2,436 secondary schools. Besides, Malaysia has 477 private higher education institutions, of which 53 are private universities and 36 are private university colleges. Malaysia is also home to 10 foreign university branch campuses, which serves the purpose of turning Malaysia into a regional higher education hub.

Based on the above statistics, it is noted that the education sector is one of the major sectors in the country. On March 2020, Malaysia had declared MCO as the control measure of COVID-19 pandemic. All the industries and sectors were closed except for the essential sectors. Over this period, all schools including higher educational institutions (HEIs) were closed and all the teaching and learning activities has been moved online. The students continued their study via online platforms, such as google classroom, zoom, MS Team, etc. after the first phase of MCO, CMCO and RMC0 were announced in May and June 2020. During the CMCO and RMC0, the education sectors reopened with SOP. However, the enrolment of international students was still restricted.

A cross-sectional study by means of a convenient sampling method was conducted amongst 401 students by using a self-administered online questionnaire. It was found that 272 (67.8%) of the respondents had a less negative impact of MCO, while 129 (32.3%) of the respondents had a more negative impact of MCO. The MCO negatively impacted, more, those with less family income. The study findings concluded that most of the participants had a fair level of knowledge, attitude, and a lesser level of good practice towards the prevention of COVID-19 (Abdalqader et al., 2020).

During this MCO period, there are many challenges and restrictions faced by the education sector in Malaysia as summarised below:

a. Guideline from Ministries

In the early stage of MCO, there is a long delay in guidelines from the Ministry of Education on SOP. This has caused many educators' (teachers, academics in tertiary education, etc.) inability to plan the teaching and learning activities effectively. Besides, it also impacted on the operation of the education sector, especially higher education institutes (IHL). In addition, in some situations, there are conflicting announcements from different ministries, which caused confusion to the students as well as to the educators.

b. Internet Connectivity and Infrastructure

During the MCO period, all learning and teaching activities were moved online. Therefore, stability and connectivity of the internet is one of the important infrastructures to support the education sector. Due to the accessibility of internet requirement, telecommunications companies (Celcom, Digi, Maxis and U Mobile) provided 1GB of free high-speed Internet daily during the enforcement of the MCO, starting 1st April 2020. However, due to the coverage of internet still limited in certain areas (especially Sabah and Sarawak), this caused some students unable to follow the classes online accordingly. In addition, although free quota was provided by the telecommunication companies, the data limitation caused students (especially from tertiary education) limited access to certain types of materials that they could download.

c. Online Teaching and Learning

As most of the educators are switching from the traditional face-to-face teaching to online in a very short time, many educators are not well prepared. The adoption of online teaching method ranged from excellent to non-starters in different schools and IHL. Therefore, the quality of learning experience was affected. Online classes might be able to replace face-to-face classes for certain disciplines but not suitable for all courses. In addition, due to the quick change in a short period, most assessments were affected. Students are also unable to access the laboratory and workshop, which impacted the students' technical skills. Also, students had difficulties in adjusting to a new learning paradigm, whereby they could not just raise their hands, ask a question in class and get immediate feedback, but had to do more 'background' reading before each class and engage in online discussions. On the other hand, in IHL, all assessments have moved from physical examination to online assessment. However, a proper online evaluation has not yet being explored. The accreditation bodies were not able to provide the proper guidelines in handling online assessment. Therefore, the efficiency and accountability of online testing and assessment are in doubt, in which students assume and treat the alternative online assessments as being 'easier'. Another issue was the difference in time zones, as students who has gone back to their home countries must attend virtual classes based on Malaysian time.

In March 2020, those students residing in hostels, dormitories and rented properties were not allowed to leave the premises to return to their hometown or homeland during MCO, this has created psychological stress and fear amongst students.

Furthermore, support personnel, especially IT Department, have been working overtime to assist large numbers of academics in 'getting to grips' with the technology since the engagement of MCO.

d. Deferment of National Assessment

Due to the change of teaching and learning mode, the government had resorted to the postponement or cancellation of public examinations. The Ministry of Education had declared to postpone national examination (such as SPM, STPM, etc.) to February and March 2021. In addition, the Senior and Junior UEC examination was also postponed to December 2020. With such deferment, it has caused the impact on the student's enrolment in tertiary education, especially private institutions. Some students were also opting for a gap year due to the uncertainties in enrolment. This may cause shortages of human capital for the nation post COVID-19.

e. Reduction of International Students

With the closure of the national border, the enrolment of international students in our education sector has dropped significantly. According to the Malaysian Association of Private Colleges and Universities (MAPCU), new foreign student enrolment has dropped to 7,000 in 2020 from 16,500 in 2019. This has impacted significantly on the income of the tertiary education providers, which led to the closure of private institutions. Private institutions are under financial pressure, especially with the decline of local freshmen of up to 60%. In 2021, it will be more challenging as SPM has been postponed and on top of that, there are no new international students coming in. A study shows that 97% of universities and university colleges will make losses and 51% would become insolvent because of the MCO (Yunus, 2020). According to DOSM, a total of RM13.4 billion revenue was generated for Health, Education and Arts, Entertainment & Recreation segment in the fourth quarter of 2020 with 3.1% decrease as compared to the third quarter of 2020. The decrease was mainly contributed by Education (-RM0.3 billion; -7.0%). With such reduction of revenue generation, one-fifth of the 440 private higher education institutions nationwide were at risk of closure this year. It is known that some universities and colleges were already laying off their workers, while others had imposed significant pay cuts as the enrolments dropped tremendously. Amongst the main factors that contributed to the failure included incompetent top-level management and lack of contingency plans.

Tuition fees for online programmes are also becoming cheaper, which further squeezes profits. For instance, the standard fee for an MBA programme was about RM36,000, but it is now down to RM10,000 with e-learning. It is expected that competition in online learning is going to be massive amongst higher-learning institutions.

f. Delay in Research Progress and Postgraduate Supervision

Due to the laboratory and research facility closure, many research projects conducted by postgraduate students (MSc, PhD, and Postdoctoral) have been postponed. This has led to delay in research progress and output, and subsequently impacted research performance, including delay in publications and postgraduate student graduation. Deferment in student graduation also impacted their future job prospect and opportunities.

During the pandemic, several postgraduate students applied for a semester deferment, which inadvertently postponed their graduation time. However, several students did register and continue to study from home, but they were experiencing difficulty in accessing laboratory facilities, and resulting in paying the tuition fees to the university without much productivity in research. Similarly, some supervisors are paying their postgraduate students and Research Assistant (RA) during MCO without any research output from their students.

Several postgraduate students did not show up or even lost contact with their supervisors during MCO, and some may even drop out. Undoubtedly, the lack of supervision upon this group of students has contributed to the issue of low-quality graduates following the pandemic. Furthermore, several international postgraduate students and visiting scholars were unable to return to Malaysia to continue their studies and research due to the national border closure.

Responses and Actions to the Challenges

a. Transformation of Face-to-Face Teaching to Online Teaching

In response to the MCO, all classes have moved to online teaching. This is to ensure the students are still continuing their studies when they are staying at home. However, the duration of the classes was revised based on the individual school management. Meanwhile, all lectures were also conducted via online platforms in most public and private IHL. Some of the experiments were redesigned to be offered as virtual experiments via simulation and software. For final year projects, most of them were offered as computational experiments instead of experimental projects. In the later stage of CMCO and RMC0, some IHL were offering hybrid modes of teaching that combined face-to-face teaching and online classes.

b. Formation of the Crisis Management Team

In order to address the changes of SOP effectively, most IHL have formed a crisis management team headed by the university management team. Such teams were able to provide scenario planning and adapt the ministry guidelines in the respective IHL effectively. Immediate actions could be taken according to the uncertainties of the situation. Constant updates on procedures and SOPs were communicated to all IHL communities.

c. Flexible Working Mode

Since the starting of MCO, most of the educators had been working from home to continue supporting the teaching and learning activities. Most of them picked up the skills of online teaching and engagement with students. The physical interaction can be reduced via working from home and eventually reduce the risk of contact with the virus. Occasionally, some work may require the staffs to be at the office due to limited and secured access that were not possible to be conducted remotely. Therefore, the ministry had released SOP for the education providers to access the office based on a rotation basis and capacity limitation.

d. Staff and Student’s Well-being

Due to COVID-19, many sectors were affected significantly. Thus, many families were facing a financial crisis and mental health issues. In order to address the financial burden, many private schools and IHL were offering fee reductions, late payment, instalment plan, etc. Besides, the education providers were also offering counselling services to all their staffs and students. For those students who were not allowed to return to their hometown, authorities should provide food and other necessities adequately for those students who reside in campus and ensure everything is under control.

Effect of COVID-19 on Tourism

In 2019, the tourism industry had contributed RM240.2 billion or 15.9 % of Malaysia’s GDP. Global coronavirus pandemic (COVID-19) has crippled the tourism industry worldwide. Whatever status tourism has in one country, and how promising the tourism industry development has been, it came to an abrupt end as the impact of COVID-19 brought the sector to a standstill (Brouder, 2020).

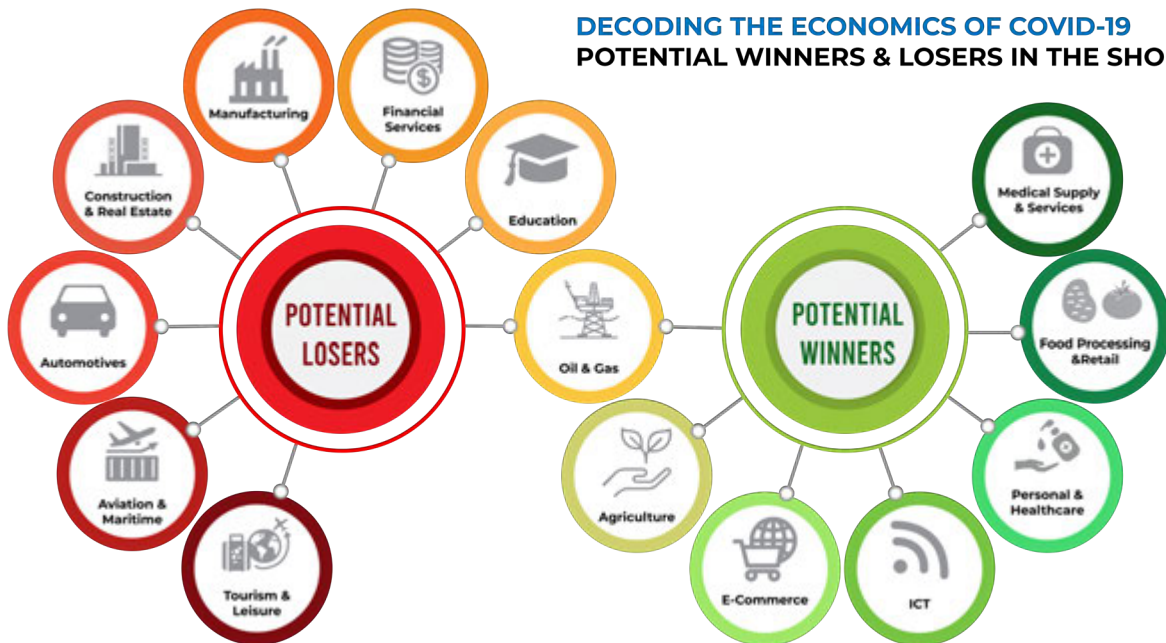


Figure 23: Potential Losers and Winners during and after the COVID-19 pandemic

Figure 23 above shows the list of potential losers and winners during and after COVID-19 pandemic. Tourism and Leisure industry is greatly affected by this pandemic, whereas medical supply and services is positively affected by the pandemic.

The tourism sector is currently one of the hardest-hit by the outbreak of COVID-19, with impacts on both the travel supply and demand. This represents an added downside risk in the context of a weaker world economy, geopolitical, social and trade tensions, as well as uneven performance amongst major outbound travel markets. The potential economic impact are:

- As of today, World Tourism Organisation (UNWTO) estimates that in 2020 global international tourist arrivals could decline between 20% - 30%, down from an estimated growth of 3% to 4% forecast in early January 2020.
- This could translate into a loss of USD30 to USD50 billion in spending by international visitors (international tourism receipts).
- Estimates for other world regions are currently premature in view of the rapidly evolving situation.
- UNWTO underscores that any estimate must be treated with caution due to the volatile and uncertain evolution of the outbreak which might lead to further revisions.

Considering the evolving nature of the situation, it is too early to estimate the full impact of the COVID-19 on international tourism. For its initial assessment, UNWTO takes the SARS scenario of 2003 as a benchmark, factoring in the size and dynamics of global travel and current disruptions, and the geographic spread of COVID-19.



Figure 24: 2020 Forecast for International Tourism Receipts

Meanwhile, Figure 24 above shows the impact of COVID-19 pandemic to the International Tourism Receipts. UNWTO estimated that around USD300 to USD450 billion are lost for tourism industry globally.

Areas Affected

Malaysia closed its borders to foreigners in March 2020, except for business purposes, as one of the measures to curb the spread of COVID-19. It was regarded as one of successful measures that helped to contain COVID-19 cases to under 100,000 with only 439 deaths. However, tourism industry was a direct collateral impact of the policy. Malaysia targeted 30 million tourists following its Visit Malaysia Year Campaign, a targeted 7% increase from 28 million in 2019. Instead, Malaysia suffered a 78.6% drop in tourist arrivals between January and September 2020 as COVID-19 forced lockdown and both the domestic and international travel restrictions. In 2020, Malaysia estimated to have lost more than RM100 billion due to the pandemic.

Tourism inevitably involve local communities as the industry is linked to many economics that are either part of the industry or support the activities. The surge in cases in the community at large though had been blamed on elections, politicians, and close-knit community clusters, such as “tabligh” and “pondok”, is also linked to the behaviour and ‘could not care less’ attitude of the citizens. Malaysians really need to look at themselves in the mirror as to the parts they play in causing new spikes of cases with their inconsiderate travelling and movement that causes community spread, especially the famous ‘balik kampung’, knowing very well that they had been staying, working, and involved in various activities in red zones or high-risk localities. MCO 2.0 delays whatever counter measures planned to re-open general tourism.

The impact of COVID-19 pandemic on tourism industry affected airlines and hotel businesses or vice-versa. All airlines in Malaysia, namely Air Asia, Malindo Air and MAS (that includes Firefly) were severely affected. The projected loss of local hotel sector in Malaysia in the first half of 2020 which directly attributable to COVID-19 was RM3.3 billion (Foo et al., 2020).

Current Measures

a. Government

Malaysia, on Wednesday 23rd December 2020, launched a 10-year plan to restart the tourism sector. The plan focused on strengthening competitiveness, encouraging sustainable and inclusive tourism, and planning for future disasters. The plan includes reviving Malaysian brand as ecotourism hub with a commitment towards balancing development and conservation of natural environment and heritage.

Meanwhile, the Malaysian government, in realising how badly hit is the industry, introduced a stimulus package to help ease the cash flow of Malaysia's tourism stakeholders and industry players. These include tax incentives, loan restructuring and bank repayment postponement. Short term measures to curb rampant job termination by employers, such as RM600 per month subsidy for each retained employee for up to 3 months, and other one-off schemes initially helped both the players and stakeholders as well as tourism frontliners. However, the positive effects waned off as the pandemic continues.

b. Green Bubbles Plan

After shutting its doors to travellers, Malaysia needs to reopen borders if it wishes to revive the severely hit tourism industry. However, the most difficult part in reopening borders to international and domestic tourism is not the campaign or efforts to bring in tourists, but to stop COVID-19 cases from re-entering the community, the act of balance to ensure that the country is safe if the 'Green Bubbles' travel plan is activated. In fact, Malaysia and the governments worldwide must really need to closely study and decide whether restarting economic activities from tourism worth the risk to the rest of local economy. For some countries, it is justified since tourism is not just an economy but a major force that drives the local economy. For many others, shutting down mass market tourism is necessary to minimise COVID-19 risk and allow the community to function safely and safeguard the rest of the economy. Malaysia, that lies in the middle of this economic characteristic scale, may have to delay the 'Green Bubbles' policy until a safety net is decided.

The importation of risk should be analysed in depth when considering which countries can be included in Travel Bubbles agreement and this include:

1. Assessing the level of risk of arriving passengers being infected or infectious from those particular countries.
2. Determining an effective method to prevent or minimise the risk of virus spread to the local communities.
3. The possibility of spill over infections into the community, aiming for a perfect zero spill over of course, but if it does occur, how much of the spill over would be tolerable.

c. Medical Tourism

Perhaps something similar to the Green Bubbles Plan, or maybe part of the Green Bubbles Plan, is medical tourism. Malaysia is ranked 1st in South-east Asia for medical tourism for the last two consecutive years with 900,000 and 1.3 million medical tourists for the year 2018 and 2019, respectively. Just before the current 2nd Movement Control Order (MCO 2.0), Malaysian Healthcare Travel Council, the governing body for medical tourism, proposed a green zone entry for patients from 6 countries that include Australia, Brunei, Japan, New Zealand, Singapore and South Korea. The move, which was based on Malaysia relative success in managing and controlling the spread of COVID-19, was hoped to act as a precursor to general tourism travel bubble. However, current surge in cases, both in Malaysia and other countries may delay the reopening of medical tourism as the risk is considered too high to be acceptable. Until now, only 'high-yield' patients are allowed to come in with strict SOP. Even then, anger and criticism had been voiced through social media by the public and certain authorities.

d. Managing Risk

Should the Malaysian government decide to allow tourism a restart, there must be a clear SOP on risk management specific for COVID-19 and tourism. It has to be done through multifarious strategies, which is important given that COVID-19 has progressed into a complex pandemic, ranging from individual measures to national and international protocols. In these instances, the following will have to be taken into account:

1. How trustworthy would individuals be to follow strict SOPs, and how to ensure that?
2. Government processes of testing protocols, pre-arrival and arrival guidance, quarantine and other measures balanced with risk inconvenience and cost to travellers.
3. The test: there is no perfect test. A negative test is no guarantee of no infection, and thus still a possibility of risk of virus spread exist. What if travellers are tested positive on arrival?
4. What works in one country may not be so in another for various factors, such as cultural, social, economics, etc.

Association between Socio-economic Status and Health Outcomes

Literature has reported that the pandemic resulted in significant negative implications to the society, especially to the socially disadvantaged and underserved populations (Kantamneni, 2020; McNeely et al., 2020; Singu et al., 2020). The low socio-economic status has been shown to have a major influence upon health outcomes in various ways for many infectious diseases, including COVID-19 infection. Several studies have found a positive correlation between the incidence of COVID-19 and low socio-economic status. Hawkins et al. (2020) reported that community with low education levels were strongly related with higher rates of incidence and fatality of COVID-19 (Hawkins et al., 2020). Baena-Diez (2020) also found that, the incidence of COVID-19 was significantly higher amongst people in the low-income group (Baena-Díez et al., 2020). Several factors had contributed to the negative consequences of COVID-19 pandemic amongst the disadvantaged groups, such as low education level, impoverishment, poor access to healthcare, limited access to clean water and small crowded housing environment. These findings highlighted that, beyond healthcare for people with the disease, socio-economic factors should be considered when implementing public healthcare strategies to ameliorate the disparities for the whole population, particularly amongst people with low socio-economic status.

Factors contributing to poor socio-economic status are linked and interconnected with each other and further worsen the health outcomes, particularly in this pandemic. The socially disadvantaged populations are usually those with high rate of unemployment, lower education level, stay in locality with lack of conducive living environment and limited access to facilities (McNeely et al., 2020; Aleman et al., 2020; Fodjo et al., 2020; Khan et al., 2021; Martins et al., 2020; Clarke, 2020). Majority of these people are staying in poor housing condition, which could be contributing to high exposure of infection and susceptible to poor health outcomes (Ahmad et al., 2020; Patel et al., 2020). Poor-quality housing is associated with overcrowding in which social distancing is difficult to be implemented. It was found that households living in overcrowded housing has a risk factor for respiratory tract infections (Nkosi et al., 2019; Rao and Chou, 2019; Weaver et al., 2009), as seen in Singapore, whereby the initial spike of the infection was due to the clusters in the labour dormitories amongst foreign workers (Leng and Saravanamuttu, 2020). Other than overcrowding, inadequate access to clean water supply is also a risk factor to poor adherence to regular hand washing as one of the non-pharmaceutical interventions in controlling COVID-19 virus spread (Kumwenda, 2019; Otto et al., 2020). Many people experience only partial access or regular shutoff of piped water, making frequent hand-washing difficult or impossible.

All the factors that contribute to the poor socio-economic status make the community more prone and highly susceptible to COVID-19, which highlight the issues of healthcare inequality. The socio-economic factors that increase the gaps of inequality are directly related to the adverse health outcomes of vulnerable populations during this COVID-19 pandemic. Structural inequality is a critical determinant of disease incidence and amplifies the negative socio-economic consequence.

Impact of COVID-19 on Socio-economic Situation of the Society

The International Labour Organisation (ILO) estimates the economic crisis of the COVID-19 pandemic could result in the loss of 25 million jobs globally (ILO, 2020). The expectation of a decreased employment will increase in the rate of unemployment and work insecurity and eventually leads to losses in the wages of employees and a consequent decline in the consumption of products and services (ILO, 2020). This literature findings were supported with the FGD outputs where one of the main socio-economic impacts due to COVID-19 highlighted was people losing their job due to the MCO. Most businesses and service industries were affected significantly by the MCO. The most affected families were those whom the husband is the only breadwinner of the family and those who work with daily wages. It was noted that people were out of the job as early as in March 2020, especially amongst self-employed workers, and remained unemployed until June to July 2020.

The impacts of job loss during this pandemic were more substantial amongst the low-income household, especially those who are working with small and medium-sized enterprises. It was estimated that 73% of the enterprises reported to have reduction in their revenues in 2020 (Nair et al., 2020). The findings were also highlighted by the representative from SME Corp. during the focus group discussion. According to their study and analysis, SMEs were amongst the industries that were significantly affected due to this pandemic. During the first MCO, a national survey found that 95.3% of business had a significant drop in sales, whereby the sales were reduced by more than 70%. The main reasons for the drop in sales included disruption in company cash flow, reduced demand, supply chain disruption and several legal issues. Apart from that, the implementation of MCO further exaggerated the situation as some of the businesses had to stop their operations either temporarily or permanently, which resulted in huge losses to the company. The abrupt and stringent regulations implemented by the government during the first MCO in response to the pandemic has also left the enterprises inadequate preparation time to sustain their businesses. As a result, many of the companies had to retrench their workers, as they did not have adequate cash flow to run their businesses.

According to the SME Corp. during the focus group discussion, almost 60% of the businesses did not have any sales and experienced lower sales because they still had to pay salaries for their employees, pay for their business-related loans, rental, and utility, as well as to purchase raw material. Through the study conducted by SME Corp., almost 90% of the businesses could only survive up to 5 months with the cash in hand. During the focus group discussion, representative from SOCSO also highlighted that, based on their data, almost 100,000 individuals lost their jobs as the pandemic hit the country and active job seekers had increased to more than 300,000 in Malaysia.

As a result of the unemployment, many individuals, especially those in B40 group did not have sufficient food to eat and did not get access to daily necessities. The worst impact scenario seen as many of this economically vulnerable people had inadequate daily necessities and food to eat, which was emphasised by many of the representatives in the focus group discussion. As an emergency response to the pandemic, many NGOs initiated food pack distribution programmes, especially on the earlier part of the pandemic. Nevertheless, the assistance given by the NGOs, such as food basket programme and monetary assistance which estimated to be RM90 per family could only help them to last for two weeks.

The effect of the socio-economic gaps on COVID-19 pandemic is clearly seen in Malaysia. Although the costs of treatment-related to COVID-19 is provided free of charge by the government of Malaysia, the financial implications related to the pandemic is still apparent, particularly amongst B40 and M40 groups as many people in these groups lose their source of income during this pandemic period. It was reported that, the job losses in the country have increased by 42% in the first quarter of 2020 and it was estimated that approximately 2 million individuals from B40 and M40 groups had loss their job and income due to this pandemic (Sharudin, 2020; MalayMail, 2020; Lim, 2020). The loss of income is mainly due to the high retrenchment rate from the disruption in the supply and demand chains in many businesses and sectors on top of the implementation of the national MCO which reduced purchases by the local consumer and international trades. The high rates of workers retrenchment and the impact of loss of income were also highlighted by all representatives during both focus group discussions.

On top of the economic repercussions experienced due to the job loss, the low socio-economic individuals are also the most vulnerable groups in this pandemic as physical distancing and practising good hygiene, including washing hands with clean water are difficult to practice due to their poor living conditions (Lim, 2020). Most of the underprivileged individuals are staying in cramped houses with poor sanitation, poor amenities, and improper facilities, such as in People's Housing Projects. The difficulties of complying with the SOPs have been set to be the main obstacle to curb the transmission of COVID-19, especially in the areas if any of the residents get infected (Khalidi, 2020).

The spread of COVID-19 in Sabah is one of the examples of how socio-economic factors contributed to poorer health outcomes. Those people living with poor conditions had difficulties to access healthcare facilities due to the obstructive geographical structure, such as hilly, improper road tract, coastal and rural area, also contact tracing is more challenging (Azzeri et al., 2020). To date, there are still many active clusters of COVID-19 in Sabah and the healthcare system is struggling to provide effective healthcare interventions to minimise the spread of the disease. On top of that, compliance with the SOP is challenging as the majority of the people are daily-earner and had to go out to find food for survival. Studies have shown that workers with no possibility for home-based teleworking, which many of them are unskilled labour, were likely to have high-risk exposure during the pandemic as they are forced to go out to work (Baena-Díez et al., 2020; Pell et al., 2016).

Objectively, to move towards a universal healthcare coverage, however access to healthcare facilities is still limited, healthcare awareness is still lacking and understanding of healthcare amongst the vulnerable and rural population, especially those in the low socio-economic status are still unsatisfactory. The COVID-19 pandemic has given a lot of wisdom that there is still much needed to improve in ensuring that everyone can enjoy the universal healthcare coverage and minimise the healthcare gaps in Malaysia to achieve health equity and social justice to all Malaysians.

Roles of NGOs to minimise the Impact of COVID-19 on the Socio-economic Situation of the Society

Other than numerous initiatives by the government to alleviate the socio-economic implications of COVID-19 in Malaysia, the NGOs play a big role to complement the efforts and strategies. Based on the focus group discussion, it was found that amongst the initial responses by NGOs were the food basket programme and the monetary assistance programme. On top of that, the NGOs also conducted initiatives to empower people not depending on the food pack distribution programmes only to survive. The mid-term initiatives to empower the communities conducted by the NGOs during the COVID-19 pandemic in Malaysia included social entrepreneurship programme, whereby it facilitated single mothers and OKU individuals to sew and prepare some amounts of PPE for frontliners while they were given livelihood benefits and could contribute to control the pandemic at the same time.

Apart from that, the NGOs complemented the government efforts by conducting a targeted screening programme for refugees and migrants in Malaysia through government-NGOs collaborations. Also, many NGOs were approached by MOH to find and recruit volunteers as frontliners and to produce more PPE. The NGOs also facilitated returnees, especially Malaysian to return home by initiating some funds for them.

Various group of people were mentally and psychologically affected due to the pandemic, whereby they were placed under quarantine, working from home, and study via online education. The NGOs also assisted to alleviate the mental health implications, including giving emotional support for parents to handle teenagers for their online learning system. Also, the NGOs provided free counselling sessions with counsellors and other volunteers through phone calls.

From the perspective of SME Corp., the organisation had provided data to the government and suggested for various stimulus packages, such as Prihatin and Penjana initiatives to minimise the socio-economic impacts. Also, SME Corp. had proposed to the government to encourage SMEs to boost their digitalisation efforts to improve its business during this pandemic. From the perspective of SOCSO, the organisation plays bigger roles by providing economic supports to employer and employee and facilitating COVID-19 screening amongst employees. The economic supports include enhanced employment system, wage subsidy programme and employee retention programme to support companies and employers who had to implement unpaid leaves. Those who were asked to take unpaid leave were given cash benefit of RM600 per month. SOCSO also provided programmes that could help the business to avoid retrenchment of workers and provided a platform for employer to hire Malaysian workers. The government had provided RM200 billion through SOCSO for screening purposes.

Roles of R&D in Managing the Current COVID-19 Pandemic and Beyond

The unprecedented COVID-19 pandemic has created unprecedented changes in all aspects of life. However, on a brighter note, the pandemic has also presented unique research opportunities. Research activities have been a critical tool in ensuring a sustainable recovery of any country and the resilience of our healthcare system. In the current healthcare and well-being context, the science-driven solutions, including a safer and faster scientific understanding of the virus, as well as the development of vaccines, treatments, diagnostics, health data, product approvals, procurements, innovations, and development of clinical guidelines have become more apparent.

The number of cases and deaths worldwide have increased exponentially that required urgent and rapid responses and attentions from the local healthcare agencies and authorities. Close collaborations between governmental, private, and non-governmental agencies in health, education, technology, human resource, monetary are indeed required to prioritise key research areas, hence the gaps could be effectively identified. The current and future research are important to explore and understand the effects and impacts of the nation's responses on COVID-19 outbreak for the past one year on health and non-health outcomes.

The publications on COVID-19 have exceeded 30,000 as of July 2020 and the research will definitely continue to flourish as the pandemic has not been well contained and controlled at the global level (Wang and Hong, 2020). The knowledges from the scientific research on COVID-19 are demanded in order to develop effective strategies on intervention programmes, assisting the policymakers in developing relevant policy. The evaluation study on the previous and current intervention programmes are pertinent to reduce uncertainty of the interventions and maximise the resources. The outcomes of intervention programmes shall be the indicators for the scaling-up and scaling-down for better planning and investment allocations (Berardi et al., 2020).

In addition to that, De Giusti (2020) in the latest policy report, stated that the COVID-19 pandemic has also negatively impacted the education systems (De Giusti, 2020). The education sector has been primarily affected during this crisis, as all the educational institutions are forced to shut down following the implementation

of Movement Control Order (MCO) suggested by World Health Organisation (2020). It has affected almost 1.6 billion learners from over 190 countries due to the school closures. Interestingly, the onset of the COVID-19 pandemic has resulted in an instant change in the teaching methodology and approach. One of the significant changes is the implementation of online learning method with the aims at enabling students to continue their studies. However, some students have been reported to be left behind because they are facing problems to attend the online learning classroom due to the large gaps in technology access problem in certain areas in the country (Kuhfeld et al., 2020; Soland et al., 2020). Correspondingly, other studies conducted by Gonzalez et al. (2020) concluded that COVID-19 confinement changed the students' learning strategies (Gonzalez et al., 2020). Therefore, in order to support the education system during the crisis, the role of research in managing the current era of the COVID-19 pandemic is significant to be identified, thus alternatives and solutions could be subsequently proposed.

Moreover, education is also regarded as an intervention and essential channel for knowledge delivery for the prevention of disease. With the absence of effective vaccines, the healthcare knowledge and awareness included in the proper education become more important and cannot be neglected to ensure the effectiveness of infection prevention and management (Gray et al., 2020). However, due to school closure, the educational sector has been facing problem to deliver the knowledge to students effectively including preventive measures and understanding of the disease. Apart from the inclusion of healthcare knowledge and awareness in the educational programme, it is also important for research development to educate and inform the publics about illegal products with proper knowledge. Even though much research has been conducted on the educational section during the COVID-19 pandemic. However, scanty studies had focused on the roles of educational research in managing the COVID-19 pandemic in the future; for instances, to develop proper education programme, such as post-pandemic educational programme toolkit for human health and infection prevention (Aliyyah et al., 2020; Barnes, 2020). Therefore, the role of education and the development of effective teaching method and necessary public health knowledge for the present and future should be emphasised more seriously.

In this position paper, after consultations with a group of experts, it is proposed that the research can be conducted in many ways to assist the government agencies, policymakers, national healthcare services, education sectors and funder in the current pandemic situation, and beyond.

There are several major themes of opportunities for research in healthcare. Barnes (2020) proposed eight non-mutually exclusive areas of research (8Es) that provide the most fruitful opportunities: employment and work, education and e-learning, e-health and security, e-commerce and consumption, enterprise and economy, entertainment and well-being, environment, and equality as shown in Figure 25 (Barnes, 2020).

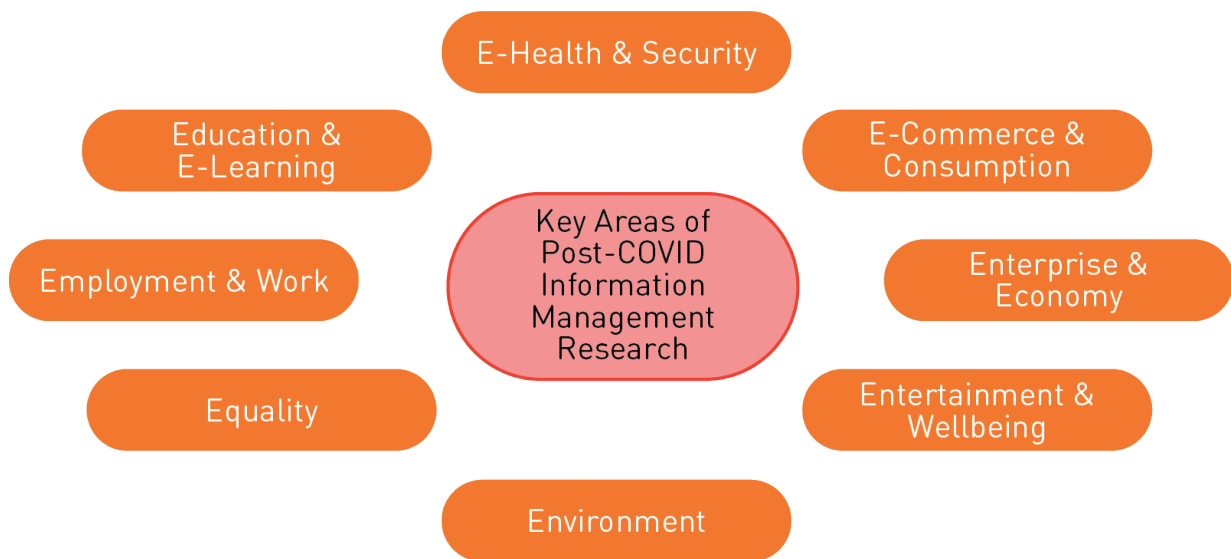


Figure 25: The 8Es of post-COVID-19 Information Management Research

According to Barnes (2020), a key area of e-health in need of further research is the development and implementation of a cost-effective telemedicine on a massive scale. This is because the implementation of lockdown in many countries has created the problem of clinical consultations and procedures backlog. Therefore, reengineering process of the existing healthcare service delivery is needed to allow the primary care providers and hospitals to operate efficiently to cater for future healthcare traffic and cope with spatially dispersed populations. This is not a far-fetched idea as it has been shown that even COVID-19 can be remotely diagnosed at the primary care level (Greenhalgh et al., 2020). Indeed, a new digital outlook provides an unprecedented platform for change. Robots, sensors, AI, blockchain and broadband networks provide components for a comprehensive personal healthcare monitoring and management (Rahman et al., 2019).

Venkatesh (2020) suggested that research should look into matters which include job loss, coping, support, home life changes, changes in children's activities, changes to social life, role of technology, COVID-19 constraints to research in general and data collection. These research themes can be further applied in various focus groups of the population, such as underprivileged populations, women vs. men, workers in healthcare, the elderly, and at-risk groups (Venkatesh, 2020).

There were four most studied main topics on the COVID-19 research until July 2020 according to Wang and Hong (2020). The topics were epidemiology and public health interventions, virus infection and immunity, clinical symptoms, diagnosis and drug treatments, and clinical studies as shown in Figure 26 (Wang and Hong, 2020). The study on drug treatments were found to be inadequate and suggested a more interdisciplinary, multi-institutional, and global research collaborations on the topic.

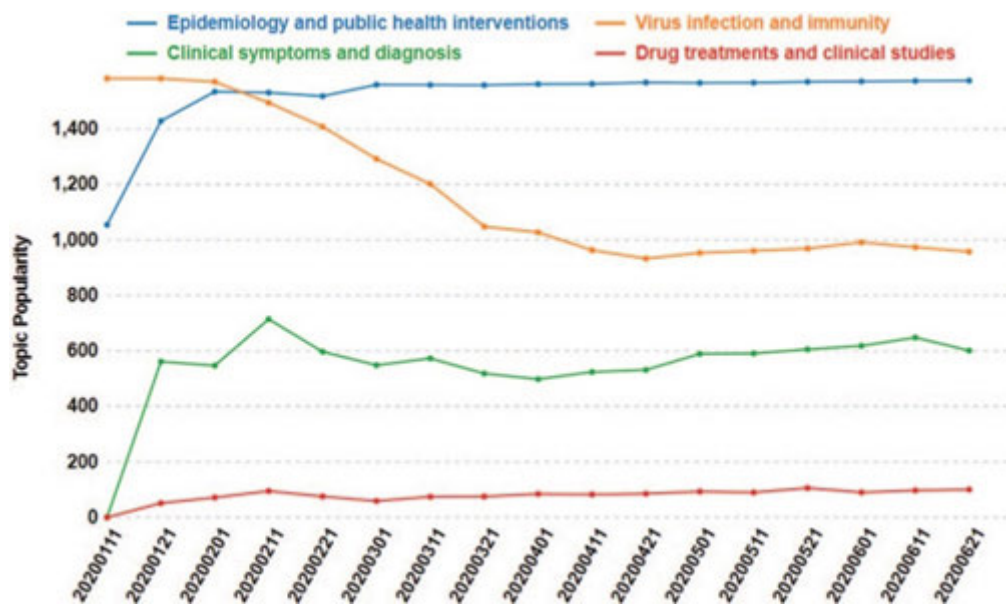
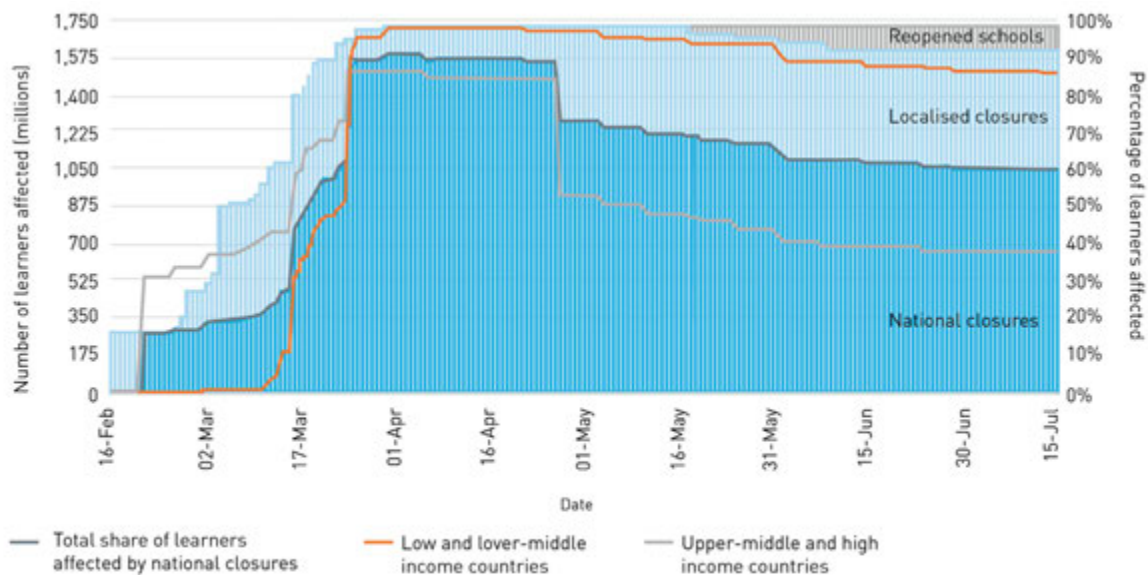


Figure 26: Trend of research topic of COVID-19

The role of education, especially of the young population is often overlooked. As the evidence shown in Figure 27, it can be noticed that students were negatively affected by the COVID-19 pandemic due to the school closures (De Giusti, 2020). Although the educational institutions have shifted to online learning platforms, the challenges are still there, in fact becoming more intricate. The problems consist of dropout issue, lack of infrastructure, teaching effectiveness and learning environments, et cetera. The pandemic had disrupted their education, health, and well-being. In addition, students were found to be struggling with negative effects caused during the pandemic crisis, especially during online learning (Chandra, 2020). There are a few distinguished differences between online learning platforms and physical classroom. Hence, understanding on how to assist and support the children in coping with the pandemic will be a critical task not only for educators but also parents. Therefore, it is vital to understand the complexity of managing children of varying ages from various family backgrounds when it comes to enforcing discipline and helping them continue to learn and socialise (Venkatesh, 2020).



Source: <https://en.unesco.org/covid19/educationresponse> and authors' calculations

Figure 27: Number of Children Affected by School Closures Globally
Adapted from (De Giusti, 2020)

On a different note, Adam and Walls (2020) pointed out that the governments suggested different PPE and hygiene recommendations to ensure the minimal risk of infection during the COVID-19 (Adams and Walls, 2020). This consists of wearing face mask and gloves, washing hands, keeping social distance, et cetera. In conjunction with this, the education on healthcare and awareness are vital so that the public, including students are well-informed on the rules, guidelines, and recommendations. Hence, continuous education in healthcare is a key element in managing the COVID-19 pandemic. It is then urged to work with different stakeholders, such as healthcare departments, schools, government offices and others to design more effective educational programmes and other resources to address the importance of continuous education on healthcare needs (Vadurro, 2018).

The Public Private Partnership (PPPS) is one of the main research areas to gain the interest and readiness of the private healthcare setting in assisting the public setting to manage current and future COVID-19 infection. A study conducted in India found that private sectors were willing to participate and provided services on screening, testing, patient care, support for equipment and clinical trials of newer drugs, as well as repurposed medicines, vaccines, or newer diagnostic tests (Davalbhakta et al., 2020). The introduction of PPPS in Malaysian setting requires comprehensive and extensive study to explore and understand the feasibility of the services in the context of implementation, payment, monitoring, and legal aspect.

The utilisation of ICT in healthcare has been widely used in developed and developing countries. The principle of the introduction and implementation of ICT is to provide continuity of healthcare services, for example the use of telemedicine to remote areas with poor accessibility to the healthcare centre. In the face of the current COVID-19 pandemic, the ICT usage is essential to sustain and continue the healthcare support to the communities and to reduce exposure to COVID-19 infection. Telemedicine enables the integration of resources, information sharing, and eventually supporting healthcare providers (Song et al., 2020). There are many studies concluded that telemedicine is one of the best approaches to manage COVID-19 and non-COVID-19 cases. However, to sustain telemedicine in developing countries, a comprehensive study needed to be carried out to explore and identify the barriers and challenges that it may pose.

In terms of the educational aspect, one of the challenges is the changes of learning concept. Because of the safety concern, online learning class has been adopted to replace the physical classroom. From the experts' observation, not all educators and students are ready to adapt to this new teaching mode. In particular, the mindset is not prepared, yet the new teaching techniques and digital skills are essential for them to master in a short time. The primary and secondary students have faced the greatest challenge in online classes. Additionally, the problem on the reliability of assessment and evaluation methods are another concern pointed out by the expert. Besides that, during COVID-19 pandemic, a variety of new and innovative teaching methods have been implemented in the educational institutions; nevertheless, there are limited evidence about the usefulness of these new teaching techniques. The questions are whether the students have acquired the knowledge, are the lesson outcomes met successfully, what will happen if they change back to the physical classroom and can

they adapt to another new learning environment. Moreover, another challenge is the limited education about healthcare and precautions. In Malaysia, a good educational programme or platform to deliver the healthcare education to students and publics in managing the infection during COVID-19 seemed to be lacking. Therefore, researchers are urged to continue study to explicitly address these challenges in educational aspect for the present and future.

The expert on education has raised a few critical issues which would be beneficial to be explored further. She mentioned on the importance of looking into the relationship between the brain and learning experience, especially during this pandemic era where all classes are being conducted online. One of the challenges that come in package with online classes that has been exclusively put forward was the inadequacy of infrastructure and 'infostructure' (as in the technical infrastructure supporting an information system). Questions on the skills of educators were also included. The educators may have the necessary skills, but do they have the right set of skills when it comes to teaching online? Thus, a few areas must be carefully addressed, such as the method of teaching, the differences between assessment and evaluation methods as well as the instructors' readiness. On the receiving end, the students herein, issue on changes in motivation and their readiness towards online learning has also been a concern, especially amongst primary and secondary school students. Another expert has corroborated the issues and in fact highlighted that the online teaching limitations could be even more pronounced in clinical teaching.

An expert and also a practising medical doctor himself, with vast experience in the field expressed his concern on public-private partnership initiatives. He opined that human resources have not been fully utilised by the government, saying that at least 6,000 General Practitioner (GPs) have been neglected from being recruited as part of government COVID-19 taskforce. A senior professor from a public university agreed on the importance of public-private partnership, stating that all facilities (public and private) should have been made accessible during this pandemic so that the process in diagnosis and treatment could be sped up. There should not be any barrier between these two entities. The implementation of telemedicine had been specifically mentioned to be widely adopted in Malaysia, especially during the pandemic where the usual physical consultation has been significantly limited.

The role of Malaysia at international level in any efforts initiated has been put in question and perhaps, Malaysia can be more active in partaking in any COVID-19 related initiatives, internationally. Other than the existing research activities carried out by some research institutes and universities, new areas of research could also be explored in a greater detail, namely zoonosis, viruses from bats and wildlife, i.e., pangolins as the latter have been reported to be the intermediate host of COVID-19.

Apart from the aforementioned research area, the experts believed that a rapid, accurate and affordable diagnostic kit should be developed, consequently time, energy and manpower could be significantly saved and reduced. Research on genotype and phenotype must be paid attention too. The focus of the discussion also had been directed towards redesigning hospital to make it more accommodating during pandemic and non-pandemic setting. Data management system and facile accessibility to the availability of the data have been one of the most crucial parts during the pandemic, as experts consensually agreed. Bureaucracy and territory should have been abolished and procedure should have become less rigid, hence researchers could help the government and its related agencies in combating against the invisible viruses. MOH and any responsible agencies in charge of the data should be more open and transparent in sharing the relevant data with pertinent researchers.

The experts strongly urge for immunology, virology, and vaccine development to be seriously looked into as these will help the government and society to be better prepared should the pandemic recur. A solid framework of research should be initiated in facilitating any research projects, especially during trying times. The COVID-19 pandemic has been witnessed to affect healthcare, social and economics, equally. Therefore, it was deemed vital for socio-economics research to be carried out to shed the light on how the community can survive despite being posed with a huge magnitude of difficulties.

One of the healthcare agencies has conducted an epidemiological and population study viz preventive practice amongst population, knowledge of population on COVID-19, as well as zero-prevalence study. A task force has also been established at the university's hospital to study the compliance of SOP amongst healthcare workers. It was believed as important for the healthcare workers to display good examples so that they could be emulated by society, thereafter.

The experts have also been asked on the strength, weakness, opportunities, and threat of the current research setting in Malaysia. Sustainable funding was pointed out to be the hindrance of the most research project in our

nation. Therefore, it is hoped that this could be further improved to ensure growth and maturity of any cycle of the project which could be progressively sustained. Capacity building, i.e., the competency training for the researchers has also been mentioned as one of the challenges that need immediate action plan as there has been a high turnover of researchers at some research institutes. A CDC-like entity needs to be established, enabling the researchers to transcend from one ministry to another without any hassle. Data ownership was once again stated as one of the problems faced by researchers and a serious plan must be conducted to ensure that research could be more progressive and transparent. Researchers were deemed to have been lacking a certain set of skills, for example in interpreting and analysing data.

Malaysia needs to be prepared for current and even more so for future pandemic. GPs should be given more opportunity to be involved in the task force fighting against the pandemic. Data on 'who does what' should be established, accordingly no researchers will invent the same wheel. While it may be quite sensitive, it is crucial to highlight that any decisions on health-related issues concerning the public to be kept away from being politicised.

On a much brighter note, Malaysia has been blessed with a few great things that have emerged to kick in. This is evidenced from the establishment of a zoonotic task force as well as the vaccine development roadmap.

Scope 3

Application of Artificial Intelligence (AI) and Big Data Analytics (BDA) for Infectious Disease Researches

Artificial Intelligence and Big Data Analytics

Artificial Intelligence (AI) is a branch of computer science that aims to develop machines that can imitate humans' abilities and intelligence. AI has been proven to be an excellent method for handling the COVID-19 pandemic, predicting the next epidemic, pattern of an attack and prognosis (Bragazzi et al., 2020; Hu et al., 2020; Panwar et al., 2020; Wang et al., 2020). Big data analytics (BDA) examines large amounts of data to uncover hidden patterns, correlations and other insights that cannot be easily accessed, handled, or analysed by conventional data processing systems. It defines the huge scale of data as well as includes fast data processing capacity, innovative technology, and data handling approaches (Krumholz, 2014). BDA has shown promising capabilities to serve a wide variety of medical and healthcare roles, including support for clinical decision making, epidemic tracking and population healthcare management (Liang and Kelemen, 2016).

COVID-19 initiatives using Artificial Intelligence and Big Data Analytics in Malaysia

Through this literature review, COVID-19 initiatives using AI and BDA in Malaysia can be divided into four categories, which are: (1) Modelling; (2) Dashboard; (3) Contact tracing; and (4) Diagnostics.

a. Modelling

There were 13 modelling projects identified in this study. The modelling projects deal with applying epidemiological models fitted to daily cases published by MOH. Most of the research used data fitting as methods to model and predict the growth of the epidemic. The compartmental models in epidemiology, such as Susceptible-Infectious-Recovered (SIR) or SEIR were the most used models for these projects. However, there were few studies which use deep learning and time series forecasting (e.g., the ARIMA model) to achieve the same purpose. These projects claimed their usefulness in simulating and predicting the spread, the growth, and the peak of the disease, as well as the effectiveness of mitigating measures, such as the MCO. What is unknown is whether the findings were actually used by the decision makers in making their decisions for managing the pandemic. Another issue with these projects is that they mainly rely on the publicly available data where data quality might be compromised due to noise and incompleteness.

b. Dashboard

Five dashboard projects were identified. The projects were initiatives by both the public and private sectors in tracking the outbreak and providing statistical information, often with visualisation for readability purposes. Notable mentions included the Coronatracker.com and Global COVID Index (GCI). The Coronatracker.com, inspired by the John Hopkins University (JHU) COVID-19 dashboard, is a community-based project involving over 460 volunteers worldwide, including data scientists, medical professionals, UI/UX designers, full-stack developers, and the public. It is an online platform that provides the latest and reliable news development, statistics, and analysis on COVID-19. The project used SEIR predictive modelling and a dataset from JHU.

GCI, on the other hand, was developed by PEMANDU Associates in collaboration with MOSTI, with recommendations and endorsement by the WHO, to create a fair performance measurement of countries worldwide battling with COVID-19. The GCI pulled and analysed data from verified sources of 180 WHO Member

States into a single source daily, with the aim to help “governments, businesses and the public cut through the noise to make informed decisions in a post-COVID-19 world”.

Two similar projects were identified, Outbreak.my and Malaysia COVID-19 Updates. There is not much information about the project available from the Outbreak.my website, or its copyright holder, Evozi, which appeared to be a software company as gleaned from the limited resources about the company on the Internet. Malaysia COVID-19 Updates is a collaboration between UiTM and Fusionex, a local data technology provider specialising in analytics, big data, machine learning and AI. The fifth dashboard project is COVID-19 Malaysia and Prediction, jointly developed by UTM, UNISZA and USM. As of 15th February, the data shown on the website was last updated on 11th July 2020.

One of the main motivations of these projects is to provide insights into massive and unstructured data while making the dashboards publicly available and hence promoting transparency. However, the credibility of the dashboards may be questionable if information, such as data sources, methodologies (including AI or BDA techniques adopted) and products owners are not available. Another challenge faced by these projects is maintenance and sustainability (financial and technological), as COVID-19 will last for quite some time.

c. Contact Tracing

Contact tracing is used to record and log the movement of people within the business and non-business premises. This is for the purpose of tracing the individuals that an infected person may have been in contact with. Implementations are commonly through the mobile apps. Some systems may warn users when they are in proximity to infected individuals.

There are two main functionalities covered by the contact tracing projects. Firstly, is the premises check-in, while another is proximity tracking. Before the Malaysian government mandated the use of the MySejahtera application for all businesses nationwide on 3rd August 2020, several contact tracing applications have been developed and used by the state governments and private companies. These include Selangkah, Qmunity, Sabah Trace, Masuk.la and UM Touch for premises check-in; and MyTrace, CovidTrace, PgCare, Jejak Johor for proximity tracking. Some of these applications have ceased operation, with MySejahtera and MyTrace being the main applications covering both functionalities. Ideally, both functionalities should be integrated into a single application to make it convenient for the end-users, or the data collected from both applications be integrated for efficient contact tracing. Nevertheless, as of 15th February 2021, on the Play Store, the marketplace for the main mobile platform Android, MySejahtera has accumulated more than 10 million downloads, while MyTrace only has more than 100,000 downloads. This signifies a gap coverage between the two functionalities for the Malaysian users, which raises a further question about the effectiveness of contact tracing applications in Malaysia.

Moreover, the effectiveness of such systems was unknown. The efficacy of the data collected by the applications supporting the enforcers in identifying close contacts to a new positive case, as well as the efficacy in identifying such close contacts through the data collected, are not available too. In general, the BDA technologies behind the developed systems are also inaccessible to the public. Key issues, such as security and privacy of these contact tracing applications need a thorough investigation and scrutiny as these applications deal with personal data and information.

d. Diagnostics

At the time of writing, there are two published papers by researchers from local universities which applied variations of Deep Learning algorithms to X-ray images to predict whether a person is infected with COVID-19 or otherwise. However, the datasets are not from Malaysian cases but from a globally published dataset. The research also claimed to be a potential replacement for COVID-19 test kits for screening, which raises the question of the idea feasibility. For instance, the availability, cost, and strict requirements of using and operating an X-ray or computed tomography (CT) machine for mass screening as compared to a RT-PCR test have not been considered and discussed in these papers.

From the news and social media, three commercial diagnostics applications were identified which local stakeholders, such as hospitals or MOH have adopted or planned to adopt. Nevertheless, the context of use was not available from the news. In addition, whether the applications have been clinically validated and approved by the authorities for use in the clinical context is also unknown.

e. Others

Several COVID-19 projects identified that were not related to AI or BDA, or the relevance to AI or BDA was not obvious, or unknown. These included the e-Covid19 platform used by MOH to streamline data reporting, Gerak Malaysia used by PDRM to track and record detailed movement information during the MCO (discontinued on 31st July 2020), IPTPulang used by MOHE for managing university students returning to their hometown during MCO (discontinued), COVID-19 Symptoms Monitoring System (CoSMoS) developed by Universiti Malaya researchers and used in Universiti Malaya Medical Centre (UMMC) for monitoring COVID-19 patients, PUI/PUS. In addition, there were experts' review, critical analysis, and opinion on the social-economy aspects of COVID-19. There were also 63 COVID-19 related projects reported by universities, out of which 13 involved AI and BDA applications. However, as these were mainly projects awarded research grants recently by respective universities and other funding agencies, not much information was available for further analysis.

In general, there are not many publicly available initiatives related to AI and BDA applications in COVID-19. This may be due to factors, such as: (1) It takes time to publish, and the pandemic only started in early 2020. Therefore, the available publications are those mainly researches performed in the early stage of the outbreak; (2) Private initiatives or those which have commercial values are not made publicly available due to confidentiality and security concerns. The only publicly available datasets are the daily cases and statistics released by the MOH. Datasets such as X-rays and CT-scans from Malaysian hospitals are also unavailable.

Issues and Challenges on AI and BDA Applications

COVID-19 had changed the conventional way of doing things all over the world and Malaysia is not an exception. The first COVID-19 cases in Malaysia involved three tourists from China on the 25th of January 2020. The disease subsequently spread across the nation (Mahmud and Lim, 2020).

The disruption caused by COVID-19 has triggered the development of several AI/BDA applications and research which involve modelling (analytics and prediction) of the pandemic, dashboard, contact tracing and diagnosis of the disease to mitigate its impact on the country. Several challenges associated with the AI/DBA applications in relation to the COVID-19 pandemic were identified and classified accordingly in this section, as summarised in Figure 28.

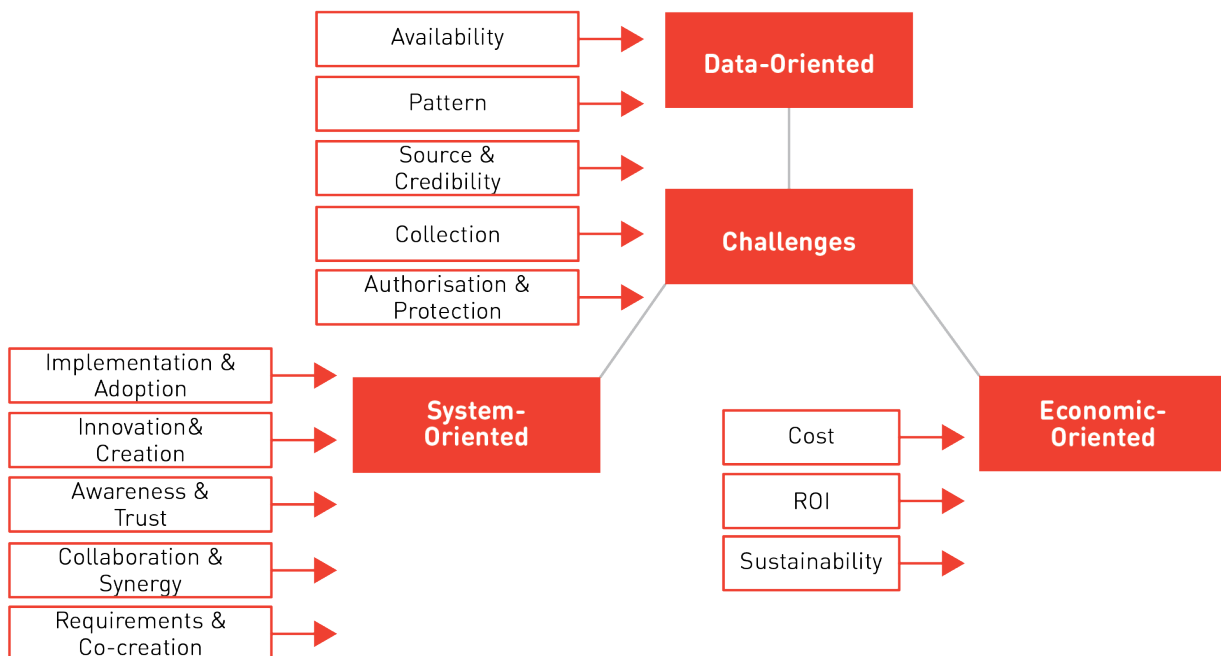


Figure 28: AI and BDA Issues and Challenges

Data-oriented Challenge

Data is an integral part of any AI/BDA based systems. All predicted results or findings are data-driven, and as such, the precision and accuracy of these findings are dependent on the dataset used. Thus, the availability, credibility and reliability of the dataset are of paramount importance. It is evidently clear that limitations of the AI/BDA associated predictions and forecast lie mainly in the data used (Alsayed et al., 2020; Mahmud and Lim, 2020; Ariffin et al., 2020; Hamzah et al., 2020; Law et al., 2020; Mohd and Sulayman, 2020; Qazi et al., 2020). In this study, these data-oriented challenges are classified into five classes, namely: data availability, data pattern, data collection procedure, data source and credibility, and data authorisation and protection.

a. Data Availability Challenge

The absence of an adequate COVID-19 dataset is a major challenge affecting AI/BDA applications in many ways. The vast majority of AI/BDA research and applications rely on publicly available datasets, which are currently extremely limited, incomplete, or even contains noises. Furthermore, most researchers' survey claimed that these publicly available data are grossly insufficient to develop, train and run a reliable system. Young developers and researchers participating in the COVID-19 research involving AI/BDA claimed insufficient data as a challenge, as they cannot afford subscriptions to privately owned datasets due to financial constraints.

Another concern is that, even if the data is available, but the size of the dataset is inadequate, the results and predictions may be unreliable. This is because Machine Learning techniques require huge amounts of data for training, testing and validating in order to produce a reliable model. In other words, apart from the data availability challenges, the availability of datasets of adequate size is also considered a big threat to the success of AI/BDA applications for COVID-19 and similar crisis in Malaysia.

Another data availability challenge is its acquisition on a real-time basis in the event of the COVID-19 pandemic. This study reveals that developers and researchers mostly used the available data the same day it was released (Mahmud and Lim, 2020; Hamzah et al., 2020). This indicates that there is limited time for an in-depth analysis to be conducted on the data, let alone of having sufficient data in this regard. These are believed to affect the reliability of any kind of results offered by AI/BDA applications. This scenario often entails more difficulty due to constraints from other factors, such as delay in symptom appearance because of the virus incubation period and delay in confirmation of positive cases resulting from limitations in detection and testing capacity, among others.

The data availability challenge is also related to the availability of data about efforts in addressing COVID-19 issues. This study, for instance, faced difficulty in collecting relevant data about AI/BDA applications for COVID-19. Thus, making especially scientific research and data of COVID-19 available and accessible is also a challenge in data availability.

b. Data Pattern Challenge

The pattern of data affects other data-oriented parameters and predictions of AI/BDA models. In the case of the Malaysian COVID-19 pandemic, the parameters observed by this study include the recovery period, in which the death or discharged dates are considered in relation to the actual date the illness begins. Other data-oriented parameters comprise records on the medical capability to handle the pandemic, such as laboratories, ventilators, healthcare centres, number of beds, the medical staff involved, event centres, house of worships (Mosques, Churches, etc.) (Ariffin et al., 2020). It is noted that these data parameters are not given much consideration when extracting or generating a dataset for effective COVID-19 AI/BDA modelling, even though they define the real scenario of data generated. In addition, the idea of correlating Malaysian data parameters, trends, and patterns to that of other countries is observed to be given less attention and considered as a challenge in projecting potential cases in Malaysia by AI/BDA models (Salim et al., 2020).

c. Data Collection Challenge

The data were collected mostly through the daily press conference by the Malaysian Director General of Health, in which patients' personal data remained anonymous. However, in view of the allegation that this procedure adopted by MOH is not sufficient to track both active and potential victims of the COVID-19 pandemic, it is evident that the procedure can lead to unreliable datasets which may eventually negatively affect the results of the AI/BDA applications (Ariffin et al., 2020).

On the other hand, there were redundant or overlapping efforts in addressing COVID-19 issues with AI and BDA applications. For example, there were several similar dashboard and modelling projects, which implies the possibility of spending redundant efforts on data collection and analysis.

d. Data Source and Credibility Challenge

Considering the natural urgency in handling the pandemic, a lot of data outlets were looked into by AI/BDA researchers in order to achieve real-time and up-to-date results. This reason compelled the AI developers and researchers to utilise any data related to Malaysian COVID-19 cases from data sources that are within and outside Malaysia. The sources provide reports about the COVID-19 confirmed cases, deaths and recoveries for countries affected by the pandemic, including Malaysia. In one of the efforts, the researchers obtained verified data from JHU, WHO as well as Ding Xiang Yuan, which is a renowned data outlet managed by the Chinese authorities to develop AI/BDA systems (Hamzah et al., 2020; Salim et al., 2020). Some studies, such as in used daily datasets were generated by MOH for modelling their proposed systems (Gill et al., 2020; Ariffin et al., 2020). Alsayed et al. (2020) utilised dataset from Worldometer and the Novel Coronavirus Visual Dashboard for their proposed statistical machine learning algorithms. Current study reveals that most of these data sources are characterised by being slow, non-real-time, infrequent updates, unreliable or associated with discrepancies, backlog, dependent as some datasets are influenced by the political inclination of the source country, while some sources have insufficient data and unclean data. The credibility of data used becomes a risk to these projects.

On the other hand, interpretation of the data and construction of data model is dependent on domain experts. How the data were interpreted, and a model was constructed may introduce biases in the output. Unfortunately, detailed information about how the data were obtained, preprocessed, and processed were mostly absent.

e. Data Authorisation and Protection Challenge

The notion of securing clearance from relevant authorities for health-related data during pandemic grossly affects the development and slows down the rate at which AI/BDA applications are produced to mitigate the impact of COVID-19. AI/BDA researchers and developers expressed concern over the unnecessary protocols provided by authorities, as well as the slow process in handling the requests placed, which hinders the ideas of mitigating the impact of the pandemic using AI/BDA applications. It is found that in some cases, researchers need to secure a permission from the Malaysian Director General of Health before publishing their findings concerning the COVID-19 pandemic (Ariffin et al., 2020). This creates unnecessary bureaucracy and could demoralise the efforts of Malaysian researchers in COVID-19.

For authorities to responsibly grant AI/BDA researchers and developers swift access to necessary data is crucial. Similarly, for AI/BDA researchers and developers to commit to securely protecting the data collected is equally important, as the data used may contain confidential information, including the patients' details. In fact, data authorisation and protection are two sides of the same coin.

System-Oriented Challenge

In a pandemic of such magnitude, creating AI/BDA systems with the ability to provide timely and perhaps real-time information to the public as well as authorities and other stakeholders is of paramount importance. This study has identified some system-oriented challenges faced in achieving such objectives.

a. Implementation and adoption challenge

A system like CoronaTracker has the ability to assist the government authorities with quick and effective means of disseminating verified information, such as periodic updates on the current situation, promotes sustainable personal hygiene measures to common people using a scientific-oriented data prediction, analysis and valid news outlets (Hamzah et al., 2020). However, most people do not subscribe to the system and do not adhere to the personal hygiene campaign as they do not take the AI/BDA systems' effect seriously due to ignorance, as well as resistance to the novel AI/BDA-based technological changes introduced to them. Therefore, how to effectively implement the AI/BDA projects in the real world to engage most stakeholders by providing as-needed, just-in-time, and actionable-upon information is the most crucial system-oriented challenge.

b. Innovation and creativity challenge

Currently, there are limited AI/BDA systems with a diverse and dynamic ability to address the COVID-19 pandemic, even though it is believed that AI/BDA approaches are the most effective means of tackling the pandemic in Malaysia if carefully explored (Tang et al., 2020). In terms of novelty, some AI/BDA applications are considered weak in handling the pandemic in Malaysia because of failure to blend, synchronise and link the model with the prominent social media outlets, such as Facebook, Twitter, TikTok, WeChat, Instagram, etc., creatively, and automatically. This blended and synchronised approach is believed to show more impact on the AI/BDA models in creating meaningful awareness to Malaysians, hence, it could play an effective role considering the popularity of these social media.

c. Awareness and trust challenge

Reliable evidence-driven approach from a justifiable experiment to demonstrate that the AI/BDA systems' concepts are practically feasible and capable of mitigating COVID-19 is lacking in most cases in Malaysia. Since AI/BDA are new technological concepts, people are continuously underestimating and questioning its capability of playing a role in alleviating medical related issues, such as COVID-19. In other words, there is limited knowledge and understanding of AI/BDA concepts and capabilities in mitigating the COVID-19 pandemic by Malaysian.

d. Collaboration and synergy challenge

The public and private institutions do not have a clear framework for IT interventions. As such, there is a lack of focus and guidelines on the areas needed to be handled by the government agencies. Identifying focus areas and guidelines in terms of support, guide, and government priorities could maximise the efforts of the IT communities towards achieving desired and timely outcomes. On the other hand, the private sectors carry out projections and investments without legitimacy as well as feasible consultations with government and IT communities, may result in recording catastrophic loss through repeating or introducing applications that might have already been developed by other parties. In other words, the public, private and developer's partnership (PPDP) collaborative communication is lacking in the event of commencing AI/BDA projects in Malaysia.

e. Requirements and co-creation challenge

There is a lack of precision in specifying user requirements in AI/BDA projects. To have a useful system to assist relevant stakeholders in the event of COVID-19 pandemic, user requirements must be clearly articulated, specified, and then translated into application systems. The AI/BDA projects investigated in this paper lack involvement from the relevant stakeholders. It is obvious that most projects did not encompass a bottom-up approach which is essential in providing precision healthcare and decision making in handling the pandemic. This, in turn, reflects the need for IT experts, healthcare authorities and other stakeholders, including the patients, to work closely and collaboratively for the AI/BDA experts to understand the nature of the disease, and for the healthcare experts to understand how AI/BDA systems operate. If both parties (and other relevant stakeholders) continue to work independently, AI/BDA projects involving infectious diseases, in particular, COVID-19, would not be comprehensive.

Economic-Oriented Challenge

It is envisaged that AI-based companies, firms, and developers are not making reasonable profits which, in turn, affects the rate of AI-based systems production, causing a decline during the pandemic. It is also evident that the government itself is affected financially by the pandemic. Furthermore, all relevant NGOs may also be suffering financially, as almost all economic sectors are not fully operational due to the pandemic.

Now, it is evidently clear that the COVID-19 pandemic has a significant damaging effect on the Malaysian as well as the global economy at large (Cheng, 2020; Hasanat et al., 2020; Ratnasingam et al., 2020; Usman et al., 2020). Locally, the main economic issue identified in this study is the little investment and financial assistance given to utilise AI/BDA techniques in the Malaysian healthcare sector. This is particularly due to the return on investment (ROI) of AI/BDA applications that may not be encouraging in the short-to-medium term, especially in countries lacking economies of scale like Malaysia. Four financial questions that any AI/BDA applications cannot avoid are:

1. How much funding is needed?
2. Who will fund the project?
3. For how long the funding will sustain?
4. What are the returns on investment of the projects?

AI/BDA applications, like most IT solutions, require highly skilled interdisciplinary professionals and expertise. The training, acquiring, and retaining these professionals and expertise are facing stiff global competition. AI/BDA applications also require intensive computational resources. In addition, AI/BDA applications face high risks of failure due to the 4V dimensions of big data – volume, variety, velocity, veracity. Thus, ensuring financial feasibility and sustainability of AI/BDA projects is the economic aspect that must not be ignored, instead of focusing only on the technological aspect of these projects.



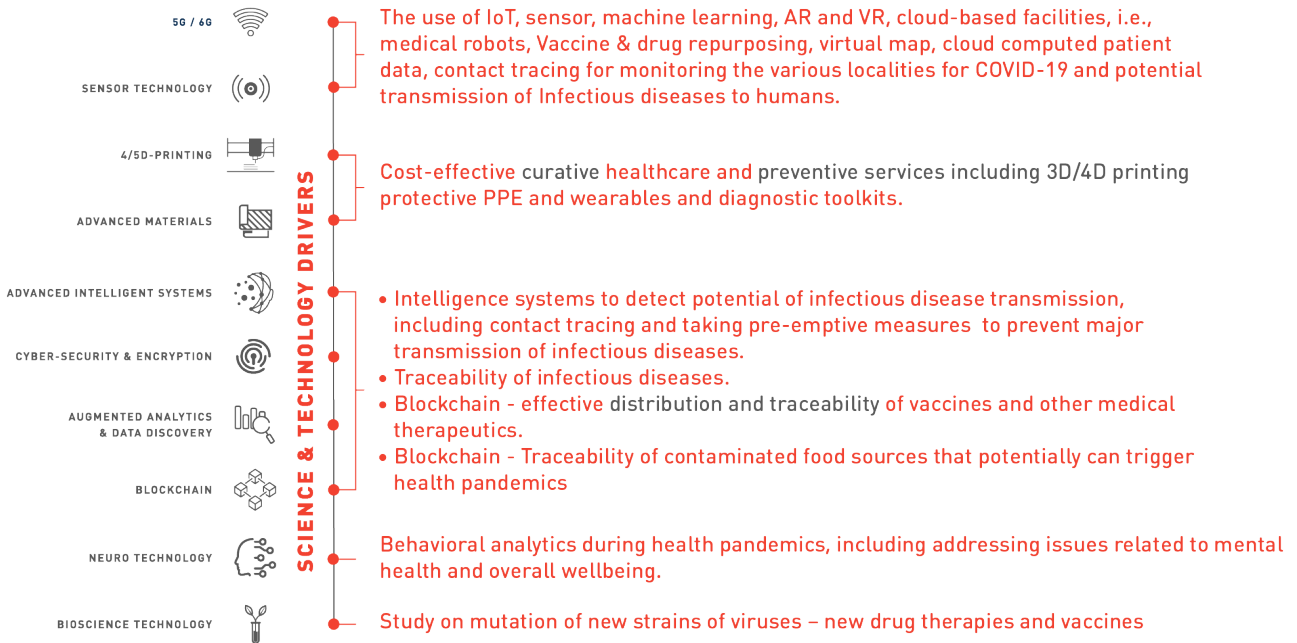
**APPLICATION OF
THE 10-10 MYSTIE
FRAMEWORK
DURING THE
COVID-19 PANDEMIC**

APPLICATION OF THE 10-10 MYSTIE FRAMEWORK DURING THE COVID-19 PANDEMIC

3 socio-economic drivers have been chosen based on the COVID-19 position paper prepared by the subgroups as these are the main highlighted issues. The drivers are:

- Education
- Business Financial Services
- Medical and Health Services

For each socio-economic driver chosen, the catch-up (current) technologies deemed relevant were picked and S&T drivers were subsequently mapped accordingly.



Application of the 10-10 MySTIE Framework in Education Sector During the COVID-19 Pandemic

Application of the 10-10 MySTIE Framework to the Education Socio-economic Driver during the COVID-19 Pandemic

Catch-up (Current) Technologies

- Student safety monitoring through 5G-connected IoT sensors and social media data analytics for bullying prediction (1, 2, 5, 7)
- Blockchain technology for verification of digital academic certifications (1, 6, 8)
- IoT sensors for cloud-based school facilities management systems (1, 2, 5, 6, 7)
- Machine learning technologies to offer personalised curricular content and early prediction of failing students (5, 7)
- Machine learning-based grading machine for student work assessments and personalised learning feedback (5, 6, 7)
- Remote laboratory monitoring and experiments through IoT-connected sensors and automatable equipment (2, 3, 4, 7)
- Virtual reality simulations for engaging and immersive interactive education (1, 2)

Leap-frogging Technologies (Next-Generation Research & Application)

- Encrypted tracking of student bio- and neuro-metrics for early identification of mental health stress (1, 2, 4, 7, 9)
- Virtual reality 3D/4D/5D-design and printing for rapid prototyping in engineering and creative arts (1, 2, 4)
- AI-led teaching with blockchain powered self-guided and modular curriculum (5, 6, 7, 8)
- Intuitive heads-up display in a virtual reality classroom with seamless access to information and advanced analytics (1, 2, 5, 7)

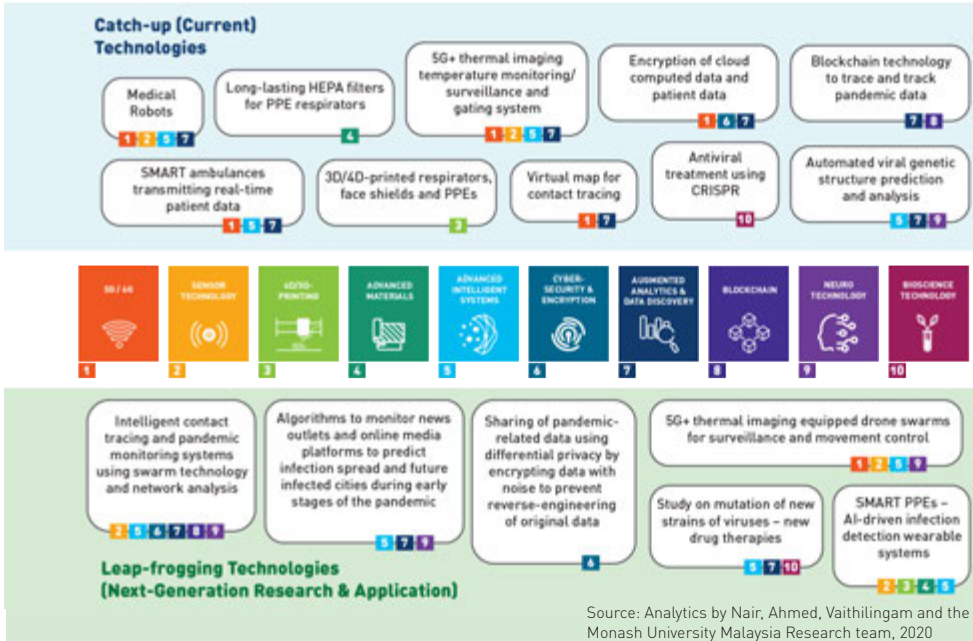
How can education innovations be integrated with other sectors?

- Smart Technology & Systems (Next Generation Engineering and Manufacturing)**
The use of IoT, sensor, machine learning, AR and VR, cloud-based facilities for student safety monitoring and high-risk students profiling, and block chain technology for verification of certification, assessment and grading. (1, 2, 5, 6, 7, 8)
- Medical & Healthcare**
VR simulation for medical and health interactive education. Monitor health risk of students. AR and VR – Telemedicine. training the students (1, 2, 5, 6, 7)
- Business & Financial Services**
IoT, machine learning, cloud-based facilities, online transaction, (1, 2, 4, 5, 6, 7)

Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

Application Of The 10-10 MyStie Framework In Medical And Healthcare During The COVID-19 Pandemic

Application of the 10-10 MySTIE Framework to the Medical and Healthcare Socio-economic Driver during the COVID-19 Pandemic



Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can medical and healthcare innovations be integrated with other sectors?

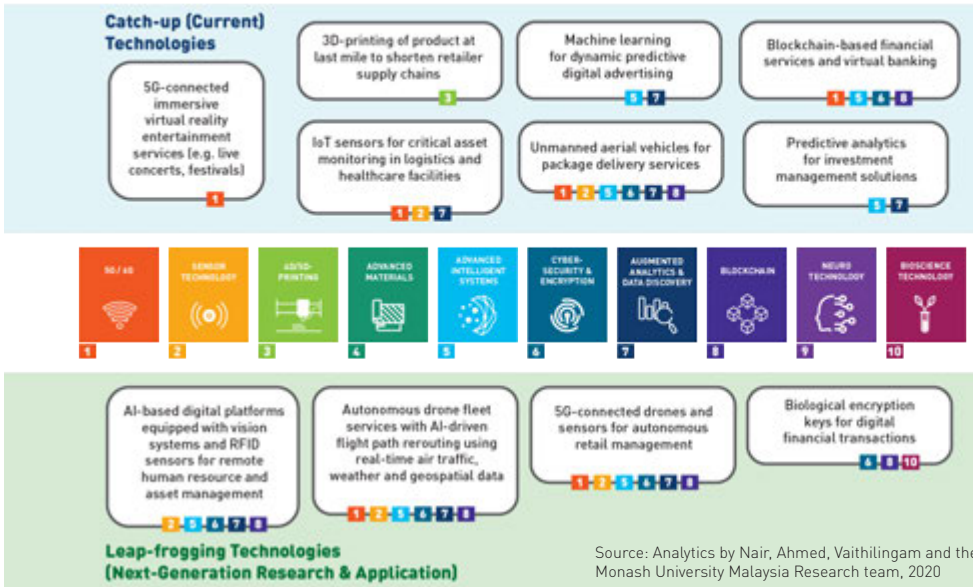
Smart Technology & Systems (Next Generation Engineering and Manufacturing)
 Medical robots, 3D/4D printing PPE, Vaccine & drug repurposing, virtual map, cloud computed patient data, contact tracing. Medical robots to be used in the area of vaccination and testing.

Business & Financial Services
 Medical robots, 3D/4D printing, HEPA & PPE, Vaccine & drug repurposing.

Water and Food Security
 Blockchain - Traceability of contaminated food sources that potentially can trigger health pandemics.

Application of the 10-10 MySTIE Framework in Business and Financial Services During the COVID-19 Pandemic

Application of the 10-10 My STIE Framework to the Business and Financial Services Socio-economic Driver during the COVID-19 Pandemic



Source: Analytics by Nair, Ahmed, Vaithilingam and the Monash University Malaysia Research team, 2020

How can business and financial services innovations be integrated with other sectors?

Smart Technology & Systems (Next-Generation Engineering & Manufacturing)
 The use of IoT, sensor, machine learning, AR and VR, cloud-based facilities to reduce the number of labors in labor intensive industries.

Medical & Healthcare
 The use of AR, VR and machine learning for the monitoring logistic healthcare facilities.

Water and Food Security
 Blockchain - Traceability of contaminated food sources that potentially can trigger health pandemics. Cold chain process to preserve food integrity.

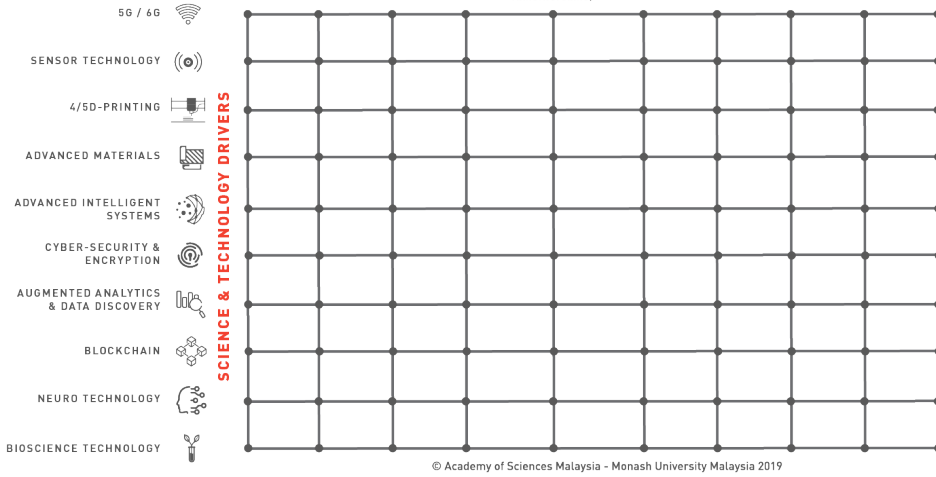
Socioeconomic Impact of a Vibrant, Agile and Responsive Healthcare System

Sound, agile and responsive healthcare ecosystem will have significant positive spillover impacts on other socioeconomic drivers.

- Improve healthcare (prevention of pandemics)
- Disruption of economic activities
- Spawn new value-added industries and services



MALAYSIAN SOCIO-ECONOMIC DRIVERS



© Academy of Sciences Malaysia - Monash University Malaysia 2019

Healthcare Ecosystem will spawn new sectors - increasing revenue streams and enhancing Return on Value (ROV) for the Rakyat

Analytics by Nair, Ahmed, and the team from Sunway University, 2021

8i Ecosystem Analysis - Gaps & Way Forward

8i	GAPS	WAY FORWARD
Infrastructure	<ul style="list-style-type: none"> • The private and public healthcare system are not properly coordinated. • The research facilities, labs, many of the hospitals, clinics and other healthcare facilities do not have advanced technology to undertake contact tracing, especially in the rural and remote areas – significant lag in undertaking contact tracing. • The bigger challenge for many of these facilities is the adoption of technology to pre-empt the spread of infections. • Many industries are labour intensive and are prone to potential work stoppages that impact their economic sustainability. 	<ul style="list-style-type: none"> • Use the best STI (10-10 MySTIE) to link all the natural and physical ecosystems & facilities – create a network system to monitor and take pre-emptive measures to address infectious diseases. • Strengthen the coordination between private and public healthcare system. • Speed Up the Industry 4.0 Transformation in manufacturing and labour-intensive industry. Review the policy on unskilled foreign workers to reduce health security risk. Reduce dependency on foreign workforce (transition into automation).
Infostructure	<ul style="list-style-type: none"> • The digital infrastructure in many of the localities are rather patchy, especially in the rural areas. While contact tracing is less complicated in rural areas, it affects health literacy and community empowerment. Requires change in education with better infostructure and accessibility to rural/ B40. • Lack of interoperability and data sharing across systems impedes health information exchange. 	<ul style="list-style-type: none"> • Enhance internet accessibility and connectivity to cover all areas including rural areas. • Establish a one-stop portal for all players on expertise, R&D programmes, industry, institutions, incentives and support systems for managing infectious diseases, health pandemics and the healthcare sector. • Ensure the supply chain uses the best technology (10-10MySTIE) across the country, especially in rural areas - for this digital connectivity using 4G/5G is critical. • Employ FAIR (Findability, Accessibility, Interoperability, and Reuse) framework for data sharing and management. • Bridge data silos using big data integration. • Capitalise interoperable telemedicine solutions for integrated health service delivery.

8i	GAPS	WAY FORWARD
Intellectual Capital	<ul style="list-style-type: none"> • Lack of talent due to high turnover of researchers. • Lack of specialised and multidisciplinary skills to lead fundamental breakthroughs and translational impact, including developing viable ways to manage COVID-19 and other health pandemics, especially in the use of advanced digital technology and data analytics tools. • Lack of talent also impedes firms from making the technology transformation to be less labour intensive and prevent disruption in the supply chain due to the health pandemic. • Underutilisation of private healthcare personnel and over burdening of public healthcare personnel. 	<ul style="list-style-type: none"> • Invest in talent with specialised skills to lead solutions to address infectious diseases – medical specialist, biologist, engineers, entrepreneurs, digital technologist (block chain), financiers, data scientist and others to improve the quality of life and create a vibrant healthcare industry. • Incentivise as a strategy of attracting and retaining researchers/ healthcare personnel.
Integrity	<ul style="list-style-type: none"> • Governance systems to manage COVID-19 are experiencing major challenges due to outdated regulations, over-lapping responsibilities, turf-wars and lack of knowledge sharing culture. • Low ICT use (digital governance systems) and lack of talent poses risks in managing infectious diseases and health pandemics (lack integrated of systems) into the future. • The need to standardise the implementation of guidelines and SOPs to avoid double standard in policy implementation and politicisation of health issue. 	<ul style="list-style-type: none"> • Invest in Healthcare Digital Governance System that ensure adherence to global best practices on the management of infrastructure and the healthcare services (both the upstream and downstream sectors related to COVID-19 and other infectious diseases). • Put in place clear guidelines and regulations to ensure smooth development and functioning of the infectious disease healthcare ecosystem. • Develop pandemic act that will serve as the basis for decision making. • Strengthen systems for infodemic management in health emergencies.
Incentives	<ul style="list-style-type: none"> • The need for sustainable fiscal and non-fiscal incentives to develop and use local technology in the management of infectious diseases has considerable scope for improvement. • The use of new technology varies across different agencies, localities and sectors of the economy. • There is a lack of aligned and holistic R&D funding & financial support for local R&D to address COVID-19 and other health pandemics. • The financial support system is fragmented – lack of local technology players and innovators to create a viable vaccines and medical therapeutics. Over-reliance on foreign technology players. 	<ul style="list-style-type: none"> • Sustainable fiscal and non-fiscal incentives to intensify R&D and commercialisation in the infectious diseases area. • These include establishing a national centre of excellence that nurture multi-stakeholder partnership between research institutions, universities, local industries and community organisations to lead the development of new medical therapeutics, medical devices and other support systems.
Institution	<ul style="list-style-type: none"> • Often there is duplication of services and this dissipates the efficacy of the limited resources. • Many of the institutions are not tech-savvy in managing infectious diseases, health pandemics, public perceptions and individual behaviour – lack of integrated and seamless sharing of information. Hence, many are slow in addressing infectious disease transmission. Need to retrain talents to become more tech savvy. • Lack of “Integrator Organisations” that build foster trust and collaboration amongst key players in the infectious disease prevention and management. 	<ul style="list-style-type: none"> • Streamline the institutions (federal, state, local government) and regulations that manage the healthcare system to ensure that they are at the fore-front of STI development, including gathering intelligence on hotspots for infectious diseases and health pandemics. • Establish “Integrator institutions” that foster strong “Quintic -Helix”. • Centralised management could improve efficiency and reliability. However, proper decentralisation and real empowerment of the community should be in place when local responsiveness and flexibility are required. • Pre-emptive role of institutions in environmental protection and sustainable development towards preventing disease and creating health-supportive environments.

8i	GAPS	WAY FORWARD
Interaction	<ul style="list-style-type: none"> • Lack of awareness amongst people and migrant workforce on best practices on COVID-19 prevention. • Cooperation amongst key stakeholders (government agencies, universities and industries) is patchy. Many of the agencies operate in silos and engage in turf-wars. There is limited movement of researchers from one agency to another. • Very low knowledge sharing culture and minimal sharing of research information leading to scarcity of data. • Different interpretation of guidelines and enforcement from different agencies leading to confusion. This impacts the spread of infection and disruption of education and economic activities. • Lack of investment in building strong knowledge networks, leading to unfocussed effort on knowledge & low technology transfer. • There are many challenges to address the COVID-19 pandemic and its spillover impact on socioeconomic activities due to fragmented information and knowledge flow from the healthcare sector. 	<ul style="list-style-type: none"> • Put in place a collaborative platform for all stakeholders to work collectively to nurture a sustainable healthcare ecosystem for the management of infectious diseases and ensure that the spill-over impact to other socioeconomic sectors are mitigated and managed very well. • Example: Strengthen “Quintic-Helix” (Government, Industry, Research & Learning Institutions, Community Organisations and Citizen Scientists / Grassroot Innovators). • Establish a system/act for data sharing i.e, MAMPU is currently in the process of drafting the new data sharing act. Such act should allow the ease of obtaining data without compromising data security. • Establish Independent Scientific Advisory Group of Expert (SAGE) during Public Health Emergencies.
Infrastructure	<ul style="list-style-type: none"> • The private and public healthcare system are not properly coordinated. • The research facilities, labs, many of the hospitals, clinics and other healthcare facilities do not have advanced technology to undertake contact tracing, especially in the rural and remote areas - significant lag in undertaking contact tracing. • The bigger challenge for many of these facilities is the adoption of technology to pre-empt the spread of infections. • Many industries are labour intensive and are prone to potential work stoppages that impact their economic sustainability 	<ul style="list-style-type: none"> • Use the best STI (10-10 MySTIE) to link all the natural and physical ecosystems & facilities - create a network system to monitor and take pre-emptive measures to address infectious diseases. • Strengthen the coordination between private and public healthcare system. • Speed Up the Industry 4.0 Transformation in manufacturing and labour-intensive industry. Review the policy on unskilled foreign workers to reduce health security risk. Reduce dependency on foreign workforce (transition into automation).
Infostructure	<ul style="list-style-type: none"> • The digital infrastructure in many of the localities are rather patchy, especially in the rural areas. While contact tracing is less complicated in rural areas, it affects health literacy and community empowerment. • Requires change in education with better infostructure and accessibility to rural/ B40. • Lack of interoperability and data sharing across systems impedes health information exchange. 	<ul style="list-style-type: none"> • Enhance internet accessibility and connectivity to cover all areas including rural areas. • Establish a one-stop portal for all players on expertise, R&D programmess, industry , institutions, incentives and support systems for managing infectious diseases, health pandemics and the healthcare sector. • Ensure the supply chain uses the best technology (10-10MySTIE) across the country, especially in rural areas - for this digital connectivity using 4G/5G is critical. • Employ FAIR (Findability, Accessibility, Interoperability, and Reuse) framework for data sharing and management. • Bridge data silos using big data integration. • Capitalise interoperable telemedicine solutions for intergrated health service delivery.
Internationalisation	<ul style="list-style-type: none"> • Limited collaboration with international partners, resulting in limited data sharing at global level (except WHO), which will impede the rapid development of new systems and protocols. • There has been on-going vaccine development and zoonotic research. However, it requires strategies incorporating internal and external (global) organizations to strengthen the on-going effort. • Local firms are highly dependent on foreign players for STI – there is a “lock-in” culture in the management of COVID-19 and infectious diseases. 	<ul style="list-style-type: none"> • Build strong knowledge networks and partnerships with leading global centers of excellence, industry players and researchers in COVID-19 and health pandemic management. • Malaysia should endeavour to be part of the leading global knowledge network in the region. • Malaysian institution must contribute to new knowledge in the field and foster strong knowledge & technology transfer to the local and regional research institutes, firms and organisations. • Ensure competitive incentives (both fiscal and non-fiscal incentives) are in place to encourage leading foreign pharmaceutical firms and research institutes to use Malaysia as a ‘test-bed’ for developing new medical therapies, innovations and vaccines for regional economies.

Intellectual Capital

- Lack of talent due to high turnover of researchers.
- Lack of specialised and multidisciplinary skills to lead fundamental breakthroughs and translational impact, including developing viable ways to manage COVID-19 and other health pandemics, especially in the use of advanced digital technology and data analytics tools.
- Lack of talent also impedes firms from making the technology transformation to be less labour intensive and prevent disruption in the supply chain due to the health pandemic.
- Underutilisation of private healthcare personnel and over burdening of public healthcare personnel.
- Invest in talent with specialised skills to lead solutions to address infectious diseases - medical specialist, biologist, engineers, entrepreneurs, digital technologist (block chain), financiers, data scientist and others to improve the quality of life and create a vibrant healthcare industry.
- Incentivise as a strategy of attracting and retaining researchers/healthcare personnel.

Integrity

- Governance systems to manage COVID-19 are experiencing major challenges due to outdated regulations, over-lapping responsibilities, turf-wars and lack of knowledge sharing culture.
- Low ICT use (digital governance systems) and lack of talent poses risks in managing infectious diseases and health pandemics (lack integrated of systems) into the future.
- The need to standardize the implementation of guidelines and SOPs to avoid double standard in policy implementation and politicisation of health issue.
- Invest in Healthcare Digital Governance System that ensure adherence to global best practices on the management of infrastructure and the healthcare services (both the upstream and downstream sectors related to COVID-19 and other infectious diseases).
- Put in place clear guidelines and regulations to ensure smooth development and functioning of the infectious disease healthcare ecosystem.
- Develop pandemic act that will serve as the basis for decision making.
- Strengthen systems for infodemic management in health emergencies.

Incentives

- The need for sustainable fiscal and non-fiscal incentives to develop and use local technology in the management of infectious diseases had considerable scope for improvement.
- The use of new technology varies across different agencies, localities and sectors of the economy.
- There is a lack of aligned and holistic R&D funding & financial support for local R&D to address COVID-19 and other health pandemics.
- The financial support system is fragmented - lack of local technology players and innovators to create a viable vaccines and medical therapeutics. Over-reliance on foreign technology players.
- Sustainable fiscal and non-fiscal incentives to intensify R&D and commercialisation in the infectious diseases area.
- These include establishing a national center of excellence that nurture multi-stakeholder partnership between research institutions, universities, local industries and community organisations to lead the development of new medical therapeutics, medical devices and other support systems.

Institution

- Often there is duplication of services and this dissipates the efficacy of the limited resources.
- Many of the institutions are not tech-savy in managing infectious diseases, health pandemics, public perceptions and individual behaviour - lack of integrated and seamless sharing of information. Hence, many are slow in addressing infectious diseases transmission. Need to retrain talents to become more tech savy.
- Lack of "Integrator Organisations" that build foster trust and collaboration amongst key players in the infectious diseases prevention and management.
- Streamline the institutions (federal, state, local government) and regulations that manage the healthcare system to ensure that they are at the fore-front of STI development, including gathering intelligence on hotspots for infectious diseases and health pandemics.
- Establish "Integrator institutions" that foster strong "Quintic-Helix".
- Centralised management could improve efficiency and reliability. However, proper decentralisation and real empowerment of the community should be in place when local responsiveness and flexibility are required.
- Pre-emptive role of institutions in environmental protection and sustainable development towards preventing disease and creating health-supportive environments.

Interaction

- Lack of awareness amongst people and migrant workforce on best practices on COVID-19 prevention.
- Cooperation amongst key stakeholders (government agencies, universities and industries) is patchy. Many of the agencies operate in silos and engage in turf-wars. There is limited movement of researchers from one agency to another.
- Very low knowledge sharing culture and minimal sharing of research information leading to scarcity of data.
- Different interpretation of guideline and enforcement from different agencies leading to confusion.
- This impacts the spread of infection and disruption of education and economic activities.
- Lack of investment in building strong knowledge networks, leading to unfocussed effort on knowledge & low technology transfer.
- There are many challenges to address the COVID-19 pandemic and its spillover impact on socioeconomic activities due to fragmented information and knowledge flow from the healthcare sector.
- Put in place a collaborative platform for all stakeholders to work collectively to nurture a sustainable healthcare ecosystem for the management of infectious diseases and ensure that the spill-over impact to other socioeconomic sectors are mitigated and managed very well.
- Example: Strengthen "Quintic-Helix" (Government, Industry, Research & Learning Institutions, Community Organisations and Citizen Scientists/ Grassroot Innovators).
- Establish a system/act for data sharing i.e. MAMPU is currently in the process of drafting the new data sharing act. Such act should allow the ease of obtaining data without compromising data security.
- Establish Independent Scientific Advisory Group of Expert (SAGE) during Public Health Emergencies.

Internationalisation

- Limited collaboration with international partners, resulting in limited data sharing at global level (except WHO), which will impede the rapid development of new systems and protocols.
 - There has been on-going vaccine development and zoonotic research. However, it requires strategies incorporating internal and external (global) organisations to strengthen the on-going effort.
 - Local firms are highly independent on foreign players for STI - there is a "lock-in" culture in the management of COVID-19 and infectious diseases.
 - Build strong knowledge networks and partnerships with leading global centres of excellence, industry players and researchers in COVID-19 and health pandemic management.
 - Malaysia should endeavour to be part of the leading global knowledge network in the region.
 - Malaysian institution must contribute to new knowledge in the field and foster strong knowledge & technology transfer to the local and regional research institutes, firms and organisations.
 - Ensure competitive incentives (both fiscal and non-fiscal incentives) are in place to encourage leading foreign pharmaceutical firms and research institutes to use Malaysia as a 'test-bed' for developing new medical therapies, innovations and vaccines for regional economies.
-

RECOMMENDATIONS



SCOPE 1

Malaysia Infectious Disease Outbreak Preparedness and Response

Preparation and Development of MySED III

Based on the JEE assessment, Malaysia had achieved high level of IHR (2005) core competencies on preparedness and response to public health emergency. This high level of competency has contributed to an excellent initial containment response to the pandemic. In developing MySED III, Malaysia needs to continue building on these strengths towards sustainable disease outbreak and pandemic preparedness capacity. The overarching recommendations of the JEE team were as follows (WHO, 2020c):

- Continue to invest in strengthening of health security systems, guided by MySED II, further reviewing system readiness through high-level functional exercises and after-action reviews, and addressing identified gaps, particularly for large-scale events, such as an influenza pandemic.
- Further enhanced coordination, stewardship and accountability of all relevant sectors across Malaysia for full implementation of IHR (2005). This includes strengthening coordination and collaboration between the human and animal sectors across relevant technical areas.
- Develop nationwide strategies to further optimise workforce in all relevant sectors to advance implementation of IHR.
- Strengthen effective engagement of the private sector in health security systems, including surveillance, case management, risk communication, and other preparedness and response activities.
- Continue to share the considerable experience in health security within the region and globally, including the expertise in emergency operations, surveillance, laboratory, field epidemiology training, risk communication and capabilities in dealing with chemical and radiation events.

Establish National Policy and Guideline on National Mobilisation of Resources During Public Health Emergency

The Malaysian healthcare system comprises public healthcare services funded by taxation and run by the government and private healthcare services funded by out-of-pocket payment and private medical insurance. The current severe pandemic revealed the huge challenges in national mobilisation and utilisation of resources for effective response. When the public healthcare system is overwhelmed as seen during the third wave, attempts to mobilise and utilise private healthcare resources is not as straight forward as some might have thought. There are challenges with various clinical governance, medico-legal, and financial implications. Lack of strategic planning preparedness regarding this situation is also partly to be blamed and last-minute decisions could lead to chaotic and dangerous situations for the patients. It is strongly recommended for clear policies and guidelines to be developed for national mobilisation of resources during emergencies as part of the preparedness plan. Moreover, the enforcement of the emergency law to compel private healthcare providers to provide COVID-19 related services without addressing the underlying legal, governance and financial issues could be disastrous. Therefore, consultation with the industry, and possibly legislation, may be needed to ensure that medical insurance cover the costs needed for screening, testing, treatment, and rehabilitation of insured individuals who are in need of healthcare services related to disease outbreaks. The existence of preparedness strategies and guidelines in this regard could also potentially prevent such disasters and allow for maximal utilisation of national resources.

Integrate Public and Private Healthcare Through Healthcare System Reform

During the recent public health emergency, some decisions made during the MCO had severely affected delivery of services which included limiting the number of services offered, number of appointments and even postponement of elective procedures. Although no evidence had yet to surface from scientific studies, such restrictions may further aggravate existing accessibility and equity divide between urban and rural population and between the rich and the poor. The public services have not kept in pace with the population growth in urban areas. As a long-term strategy, the government must seriously address the current unsustainable independent dual system of public and private services and must have the political will to decide for a comprehensive healthcare reform. Integration of public and private healthcare system will not only address the widening gap in healthcare equity but also lead to optimal utilisation of resources and further improvement of our responses to serious public health emergencies.

Review the Existing Pharmaceutical Antiviral Stockpiling Practice

The past efforts of pharmaceutical stockpiling have been focusing on influenza pandemic. With the emerging of the latest non-influenza pandemic, the questions on what and when to stockpile arise. Stockpiling on broad-spectrum antivirals and multi-purpose medications for symptomatic treatment is worth looking into as well. Broad spectrum antivirals, e.g., Remdesivir had received FDA approval in October 2020 for use in COVID-19 patient. Although it was shown to reduce recovery time in hospitalised adults, its usage probably remains limited and its benefit towards survival is still under trial. Besides, WHO recommends against the use of Remdesivir in hospitalised patients, regardless of disease severity. There is also currently no evidence on other outcomes, such as its effect on mortality, need for mechanical ventilation, and time to clinical improvement. It may be practical to keep it under the watch list and more research is warranted as WHO suggests continued enrolment in trials to provide higher certainty of evidence for specific groups of patients (USFDA, 2020; Beigel et al., 2020). To complement stockpiles, pre-emptive arrangements could be made with suppliers of pharmaceutical agents which have short shelf lives, should large quantities be needed urgently.

Consider Stockpiling of Other High on Demand Pharmaceuticals

Apart from specific anti-viral drug, non-specific supportive treatment could also be on high demand during pandemic and can result in shortages. Corticosteroids, e.g., dexamethasone has been shown to be effective in severe cases of COVID-19 by decreasing the risk of death. It works mainly by suppressing cytokine storm in severely ill patients and reducing the length of time on ventilator. As steroids are cheap and widely available, perhaps the concern of stockpiling may be minimal at this point and moderate stockpiling may be practical (RECOVERY, 2020; Angus et al., 2020; Dequin et al., 2020; Tomazini et al., 2020).

Sustainable Funding for Stockpiling of Essential Drugs and Items

Stockpiling on drugs will incur high costs, especially costs associated with long-term storage. Hence, financing the stockpile may be a major issue resulting in budgetary constraint and spending on uncertainty. Besides, evidence used to decide antiviral stockpiling size did not consider potential co-circulation of other pathogens, hence the issue of unused stockpile should not be considered as a wastage. Educating central funding agency (Treasury) on this concept is important and process should be built into the government's Treasury Instruction. This is to avoid controversy when unused stockpiles which can run into millions of ringgits, need to be disposed, for example; for exceeding expiry date.

Enhance the Field Epidemiologist Training Programme in the Ministry of Health

Malaysia must have a strong team of well-trained personnel to lead in epidemiology, outbreak investigation and public health response. Malaysia must continue to invest in the training in this area through the Field Epidemiology Training programme (FETP). FETP, pioneered by Centre for Disease Control, Atlanta, USA is a well-established and globally recognised programme. MOH Malaysia has its own version, the Epidemic Intelligence Programme (EIP). It is a structured 2-year postgraduate programme for public health specialist (with Master of Public Health) in advanced skill in epidemiology, outbreak investigation and public health intervention. It is on-the-job training programme, just like the clinical specialists who are trained at workplace in the hospitals. Field Epidemiologists are trained at their workplace, i.e., health offices and in the field. The EIP started in 2002 with a mandate from the Malaysian Cabinet to strengthen disease control following the Nipah virus outbreak in 2008/2009. However, it has yet to be accredited by the Training Programmes in Epidemiology and Public Health Intervention Network (TEPHINET) which is a recognised international accreditation body in this field. It has been observed that EIP has suffered from changing policy direction. It was originally under the Disease Control Division, MOH. Formalising it under the Public Health Programme as a functional Unit under the Surveillance Section of Disease Control Division with dedicated annual operating budget is strongly advocated. Malaysia has a rich history and experience in managing disease outbreak. Expertise developed may be lost from retirement and mechanism should be in place to engage them as Fellows of the EIP programme, as well as those experts in the academia.

Epidemiologists should also be exposed to new technologies relevant for public health laboratories (e.g., the concept of genotyping of viral variants of concern) to improve their understanding of the laboratory support for their work.

Establish Independent Scientific Advisory Group of Expert (SAGE) during the Public Health Emergencies

Severe disease outbreak and pandemic is a national disaster. It requires national effort by tapping into available national resources wherever they are. When dealing with a severe outbreak or pandemic caused by new or novel agent, not much is known about the disease during the early phase. Thus, the more critical for the government to be advised by an independent group of experts so that the intervention is based on good science. As part of the preparedness strategy, a mechanism should be put in place for the establishment of an independent Scientific Advisory Group of Experts (SAGE) at a very early phase of the outbreak. This is the practice in many developed countries, including the UK, to provide guidance to the government on appropriate response based on data and science. This would help the country harness the expertise from across the country, which in turn, would benefit the nation.

Infectious Disease Outbreak Management – Go Back to the Basics

In the management of infectious disease control, every effort must be made to ensure that the fundamentals of infectious outbreak management be implemented. There are similar fundamental principles of outbreak management, be it a small or a major outbreak, or a local event or a pandemic. Critical comments on the management of the current pandemic by experts outside MOH (which culminated in the open letter to the Prime Minister) should be taken into consideration for the good of the nation. As argued earlier, limited access to diagnosis severely compromised the first principle of early detection and early isolation/treatment. Problems related to the “Find-Test-Trace-Isolate” strategy and the surveillance system have allowed increasing number of isolated cases in the community to grow and spread. Inefficiency and costly screening procedures, especially amongst migrant workers, compromise the compliance and completeness of such activity. During the first and second wave, we did very well in terms of rate of testing. However, during the third wave (MCO2.0), the weekly test positivity rate has always exceeded the WHO recommended level of 5%, indicating that we have not done sufficiently in testing (Figure 29). Further empowerment of the community is also needed to help in the outbreak management. The SOPs to which the public must comply were viewed as inconsistent across businesses and even across states (e.g., religious activity, pubs versus restaurant). Additionally, there was apparent double standards in the enforcement of the SOPs. All of these compromises the public perception of legitimacy of public health intervention and enforcement principles, which are the basics of infectious disease control.

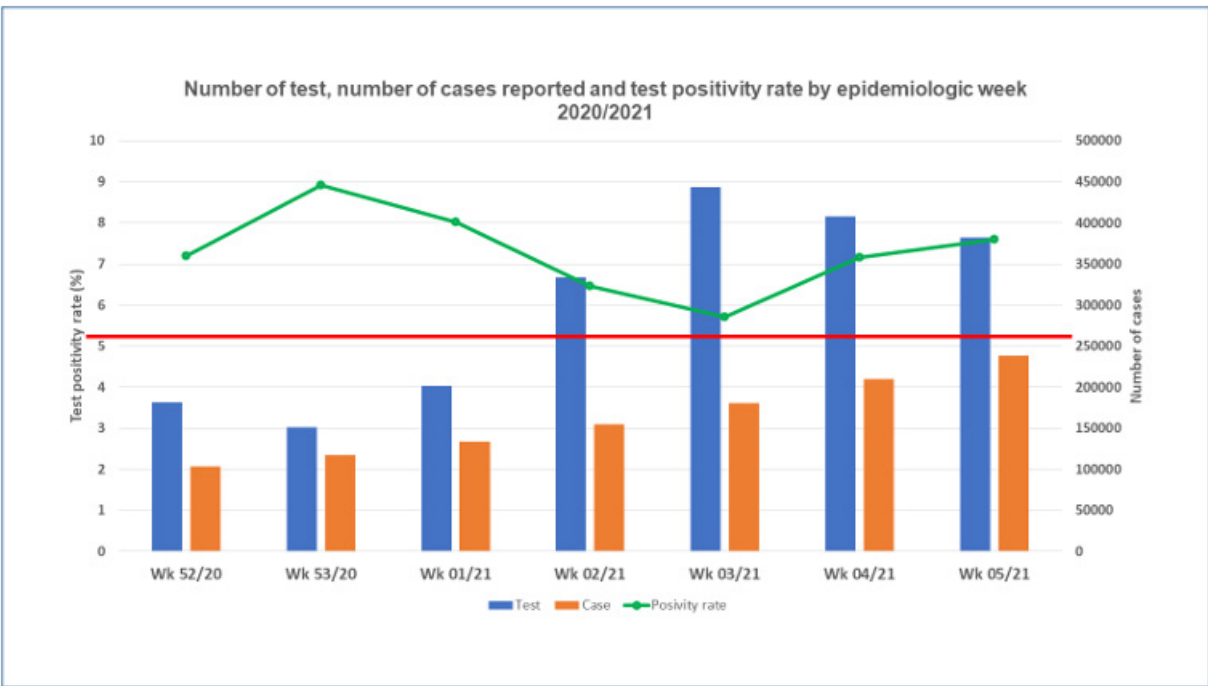


Figure 29: Number of COVID-19 cases by Epidemiologic week in relation to test sample positivity rate (SPR). The red horizontal line represents the WHO proposed target for population testing. SPR above 5% indicates insufficient testing

Enhance the Field Epidemiologist Training Programme in the Ministry of Health

In public health emergency, speed and accuracy is the essence of a decisive decision and response. Maximise the utilisation of digital technology in digitalising public health response, such as in public health investigation and risk assessment, case detection and contact tracing, and in public health intervention. The government should also consider collaborating with telecommunication companies in case investigation and contact tracing. There are issues surrounding ethics and confidentiality, but this could be addressed by the establishment of a comprehensive national ethical framework in outbreak investigation and response in striking the balance between the individual's right and public good. Specific experts could be identified to be given access to granular data so that the use of data for the public good could be enhanced.

Enhancing and Strengthening the Public Health Frontliner for Outbreak Investigation and Response

The real healthcare frontliner in infectious disease outbreak is the public health personnel doing the case investigation, case detection, contact tracing, control activities in the field, mobilising and engaging the community and enforcing the SOP and rules and regulation. Therefore, it is only sensible that when an outbreak occurs, the first to be strengthened should be the public health frontliner. No matter how equipped and how good the ICU facilities and how many specialists and workforce we have in the hospitals as the last line of defence, the country is still vulnerable if the public health frontliners are overwhelmed. The news that one third of all deaths during COVID-19 third wave occurred before they could reach the hospitals should make us relook into our public health capacity and efficiency (Tong, 2020).

Improve National Laboratory Capacity and Response to Major Outbreak

Diagnostic laboratories are indispensable as part of the frontline measure in outbreak detection and reporting. A comprehensive and structured network of emergency diagnostic laboratories should be established at all times. It should build upon the existing initiative under the National Advisory Committee for Laboratory Services, MOH. Amongst others the following are recommended:

- Further enhance the current network of NPHL, public and private university laboratories, and private commercial laboratories. Not only the number but attention must be given to the distribution of these laboratories to ensure equal access to the service. There must be a system to determine the capacity required and need to be provided by all these laboratories for national service. Under national emergency, the testing capacity should not be based on voluntary number by the institution but by assignment of specified number of tests to be carried out. For example, during the current pandemic, the ability of a small private university with only one PCR machine to offer a relatively large number of tests could be used as a benchmark of the expected number of tests which could be performed by the external labs. A system of national inventory of critical assets, human resource, and expertise should be maintained and updated annually
- NPHL should also invest in laboratory automation in all area of work process to improve efficiency and enhance capacity, including the use of robotics for high throughput performance.
- Regular training should be provided and coordinated by MOH in joint efforts with other stakeholders to train up outbreak-ready staff. The element of outbreak response could be better strengthened in all biosafety and biosecurity programmes. The training should be targeted for all personnel at the selected laboratories as part of overall national laboratory capacity building and preparedness.
- Continued improvement and upgrading of the Public Health Laboratory Information System (SIMKA), capitalising on new cutting edge information technology and include the ability to cater for rapid data entry of test subjects at point of sample collection, integration with high throughput diagnostic platforms for diagnostic results, automated generation of localised epidemiological information, automated anonymous notification of potential contacts of positive cases and automated generation of lists of contacts who did not respond to request for testing to the local public health personnel.
- Regular simulation exercises involving the laboratory network should be carried as part of the overall simulation exercises of the national preparedness framework.

Speed Up the Industry 4.0 Transformation in Manufacturing and Labour-Intensive Industry

What we have learned from this pandemic is the fact that infectious disease transmission is facilitated by human population density in a particular setting. It is a fact that large work-place clusters were amongst the migrant workers in large manufacturing industries. Foreign workers are the drivers of COVID-19 cases in the early phases of the pandemic in this country. Malaysian industrial competitiveness strength continues to be based on low labour cost spearheaded by foreign direct investment (FDI) (Kanapathy, 2014). If Malaysia continue to depend on cheap migrant labour, we will continue to face health security threat. Therefore, we need to push forward the industry 4.0 transformation where it is envisaged that the manufacturing system would become fully integrated and automated (including robotic) as a result of digital adaptation, which will lead to less dependence on cheap labour (MITI, 2018).

Review the Policy on Unskilled Foreign Workers to Reduce Health Security Risk

It is estimated that there are about 1.8 – 3 million documented plus another 1.5 – 4.6 million undocumented foreign workers in Malaysia (Anderson, 2021). During the current pandemic, the poor ventilation and overcrowded living conditions of the workers contributed to enhanced transmission amongst them, even though most of them were asymptomatic. As they live in the general community, they risk transmitting the infection to the general population which could be reflected by the high number of sporadic cases amongst Malaysians. In Singapore, they had similar problem with foreign workers as the driver of COVID-19 during the early phases of the pandemic. Like Malaysia, the workers were the main driver of cases in the country, at one point reaching 88% of the total cases (Koh, 2020). Hundreds of cases were detected daily amongst this group of the population through intensified screening amongst the workers. However, because of their more organised and structured housing facilities, the entire workers were quarantined within their dormitories when cases were detected in the housing unit. As such, the authority managed to prevent spill over of the infection to the general public. In fact, their humane and professional treatment of the workers has been highlighted by WHO as amongst the best practices in the management of COVID-19 amongst the vulnerable group (WHO, 2020e). As a result, COVID-19 was very well-controlled in Singapore. In Malaysia, in the early phases, we did the opposite and pushed the workers to the margin (Wahab, 2020). Yet, we blamed them for our own wrongdoing (NST, 2020). Nevertheless, recent announcement by the government that all non-citizens residing in Malaysia, including foreign workers and students, will be covered under the COVID-19 immunisation programme is highly commendable (NST, 2021). Since foreign workers are the main driver of COVID-19 cases in the country, it is only sensible to vaccinate them to protect Malaysians. Indeed, within that context and epidemiologically, foreign workers should be amongst priority group to be given vaccines.

The positive impact of good laws is limited by the enforcement of the law. In the short term, Malaysia need to enforce the minimum standard of housing as stipulated in Act 446 to reduce the various health risk, not just COVID-19. In the long term, the government need to seriously revisit the policies on immigration and management of migrant workers. For the last 2 decades, series of amnesty actions have been taken but the influx of undocumented workers continue immediately thereafter. There must be a political will to address this issue holistically, once and for all, or else Malaysia will continue to face health security threat, not only from pandemics, but also from importation of various other endemic exotic infections which has never existed nor largely under control or has long been eradicated in Malaysia (Figure 30). Most of these diseases are not covered under existing workers screening programme under FOMEMA.

Ethical and legal implication regarding healthcare provision for illegal immigrants and foreign workers must be clearly addressed and specific not only during the pandemic but also post-pandemic. Policies for inter-agency and amongst all relevant Ministries must be specific and clear for timely execution of pandemic containing measures.

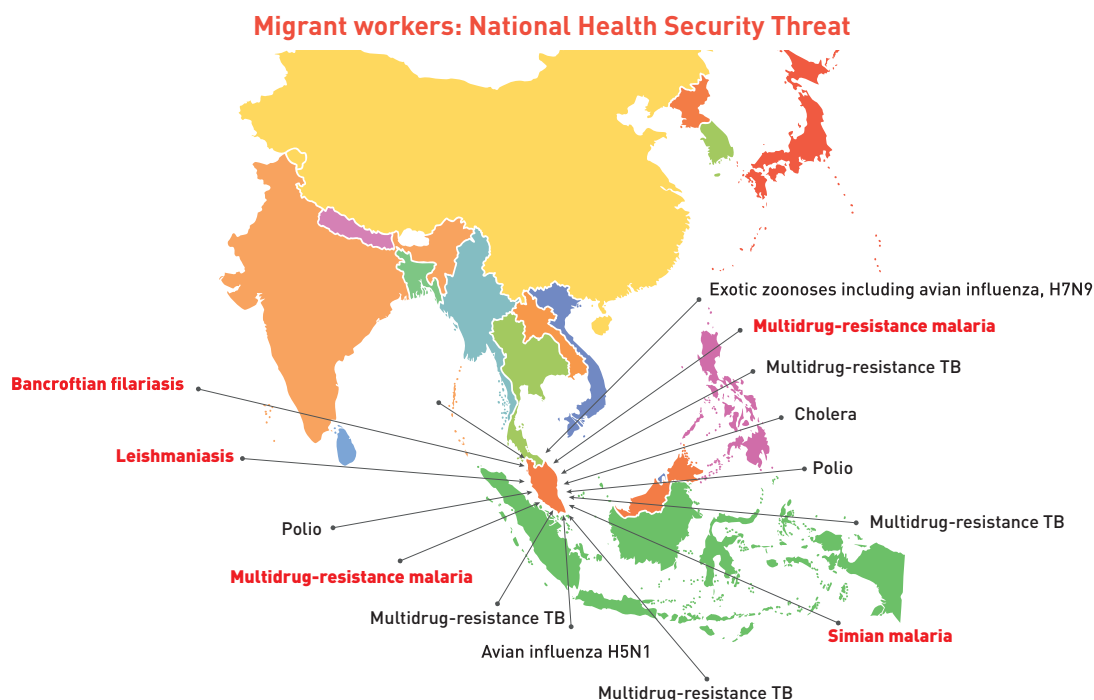


Figure 30: National health security threat from migrant workers. The source country of these workers is endemic of these exotic, severe and emerging infections

Policy on Strategic Industries for National Health Security Agenda (NHSA)

During the pandemic, there was a serious shortage of PPE globally. Malaysia was also affected because we are a net importer of PPE except a few items, such as the latex surgical glove. However, the local industries responded to the demand and many Bursa-listed companies started to diversify into PPE production. PPE is one of the very essential items and its availability during public health emergencies and crises can be a matter of life and death. Therefore, the government is proposed to review and consider this industry as a strategic industry for NHSA and may consider, amongst others, the following:

a. Enhancing and promoting new normal for PPE GVC and domestic manufacturers (78) which include amongst others:

- Promoting robustness and resilience in GVCs and domestic manufacturing.
- Creating a stable regulatory environment (including through trade and investment agreements that can include provisions for smoother operations).
- Promoting standards and certification procedures, including risk awareness, review transport, logistics, and custom clearance regulations to better mitigate disruptions.
- Developing stress tests for critical supply chains and include criteria for robustness of supply chains in government procurement procedures on a non-discriminatory basis.
- Promoting the diffusion of digital technologies that can improve information systems for risk managements.

b. Consider the introduction of new laws/ regulations/ guidelines on restricted export of specific pharma and non-pharma supplies during an emergency:

As of now, Malaysia has quite a good number of local PPE producers and steps should be taken to secure the supplies for internal use during emergencies. This was practised by the US and several other countries during COVID-19 to block exportation of key supplies (be it a local or MNC) on the basis of emergency order/national security.

c. Implement measures for a more resilient supply chain. Some of the proposed measures include:

- Bolster capacity in the home country to address security concerns for products that deemed essential.
- Expand the number of international production sites to avoid over-reliance or dependence on one or two locations.
- Seek large and growing end markets that can be served from an international production network.
- Nurture production, research, and marketing partnerships with firms in related industries.
- Regulatory policies are crucial for all healthcare supply chains, both in the home market (such as the legal liability concern over N95 face masks) and also in the transparency of international supply chains, where informal subcontracting has often compromised quality and lowered confidence in these arrangements.
- Contingency plans for future crises will be essential. The need to incorporate a broader systemic and strategic perspective based on the principles of robust and resilient supply chains that combine the virtues of global reach and local responsiveness.

d. Provide support and incentivise local players in the areas of diagnostic kit development and production of diagnostic reagents in a more coordinated and focused manner.

For example, as one of the key aspects in emergency preparedness, it is strongly believed that Malaysia has the capacity and expertise to build the core platform technology and to produce specific RTK as soon as the key information of the causative pathogens is ready (genomic sequence, sample) during outbreaks. Nevertheless, a serious, national R&D effort would be essential to make an impact and most importantly to ensure such capabilities in biotechnology could be translated into practical usage (not just academic R&D). Hence, there is a need to strategies on the approach, e.g., joint collaboration between universities, private sectors and the MOH with secured funding. There are also some semblances of the global COVAX model (for COVID-19 vaccine development) of public funding to incentivise the industry to invest in these strategic products development. The MOH plays a key role in this partnership as the ultimate major end-user and determinant of the required standards for such kits. The MOH may further enhance their expertise by including external experts for advice.

e. Establish National Framework, Guideline, Strategies and Tools on Ethics During Disease Outbreak Investigation and Response and Public Health Emergency

The WHO has produced the guidance for the management of ethical issues in infectious disease outbreak. Nevertheless, countries are encouraged to develop practical strategies and tools to apply the principles in this guidance document to their specific settings, taking into account local social, cultural, and political contexts (WHO, 2016). The Academy of Medicine Malaysia (AMM) has conducted a series of National Ethics Seminars but has not specifically address the ethic issues in outbreak management. The Academy of Science Malaysia (ASM) may collaborate with AMM and other interested professional bodies in the development of the said ethical framework and guidelines.

f. Sustainable Investment on Research and Development on Strategic Areas Towards Enhancing National Health Security

Research and development (R&D) are an integral part of public health response to infectious disease outbreak. It helps to understand the current epidemic, develop tools for diagnosis, surveillance and treatment and provide evidence base for future outbreak or emergence of new pathogen with pandemic potential.

g. Vaccine development and production

The development and production of vaccines should be considered as a strategic initiative under the NNSA. National Science Council has agreed to develop National Vaccine Development Roadmap towards the capacity to produce vaccine for human in 10 years time (by 2030). The 9Bio Initiative for production of halal vaccine did not materialise and we must learn from the past and not repeat the same mistake.

h. Drug-reprofiling with R&D in re-purposing

Drug-reprofiling with R&D in re-purposing of current available drugs should be given the focus during severe outbreak of novel pathogens. Drug repurposing platforms with the necessary drug libraries and expertise to carry out screening activities urgently.

i. R&D on zoonoses

Research and development on zoonoses should be given the priority for a long-term support. More than 70% of newly emerging infections and almost all of the recent pandemic threats (H5N1, SARS, MERS-CoV) and both of the recent most pandemics (H1N1 and SARS-CoV-2) are zoonotic infections. The zoonotic reservoir serves as a potential source for viral recombination which could result in novel harmful viruses. In Malaysia, almost 80% of malaria cases are simian malaria while rabies and leptospirosis are endemic. We had our share in severe novel infection (Nipah virus) and Malaysian scientists have uncovered several novel viruses in various species of bats. Limited and unsustainable research funding have limited the understanding of these novel viruses and its potential to cause pandemic.

j. Revisit ventilation designs

It is advisable to revisit ventilation designs in the architecture to address the indoor airborne transmission of infectious diseases. Improvement of current architectural designs and ventilation system both in healthcare setting as well as commercial buildings and living quarters may reduce the risk of indoor transmission of airborne diseases. The availability of appropriately ventilated isolation wards, clinics and laboratories would also be needed in anticipation of future air borne infectious disease outbreaks, which would potentially be even more serious than the current outbreak. Furthermore, we should explore better distancing and ventilation which could be achieved by relocating activities from indoors to the outdoors.

k. Develop a National Research Agenda and Carry Out a Comprehensive Scientific Audit of Public Research Assets in the Country

It is timely that a national research agenda is formulated to proactively address the outstanding and emerging issues related to the current pandemic, as well as to address the possibilities of future pandemics. ASM should be tasked to take the lead to organise researchers from the public and private universities, along with research organisations and the industry where possible. Research would need to be supported by the availability of

specimens and data in a timely manner, while facilities across the country should be made available to researchers who need them. Issues which hinder research should be addressed systematically. This should include adequate budget for cutting edge research, national post-doctoral programme, periodic review sessions of research organisations and major research groups by independent panels with relevant scientific expertise, facilitation of local and international collaborations, further facilitation of mobility of researchers across organisations as well as the industry, rigorous scientific review of all research proposals, encouragement of long term research programmes which address long term goals, improved availability of scientific literature; especially for those outside research universities, harnessing the use of the internet to improve linkages (including facilitation of acquisition of knowledge) with top international research organisations, and lastly, for the improvement in career pathway of researchers and other issues as identified in the 2013 report “PRA Performance Evaluation: Unlocking Vast Potentials, Fast-Tracking the Future” by the National Science and Research Council, Malaysia. It is, therefore, timely that ASM carries out a national audit on public research assets in the country in order to evaluate the improvements made so far, as well as to make further recommendations to the government.

SCOPE 2

Post-Pandemic Analysis

Capacity Building

- MOH should take the opportunity to improve the infrastructure and human resource strength to ensure sustainability of the healthcare provision.
- Budget allocation for pandemic and post-pandemic healthcare provision should include the costs for immunisation against COVID-19, as well as conditions resulting from MCO, i.e., allocations for target groups identified by other related ministries.
- The need to strengthen and consolidate current services within MOH and with other ministries, agencies and private healthcare sector is imperative in order to cope with the COVID-19-induced healthcare burden, as well as to manage disrupted care for non-COVID-19 conditions.

Enhance Collaboration and Data Sharing

- Existing policies should be revamped to streamline communication between Ministries and all relevant agencies to ensure better and effective coordination of healthcare delivery amongst all parties involved. The need to reduce ‘bureaucracy’ is cogent, as it hinders the advancement in healthcare delivery in conditions of dire need. In times of crisis and disaster, operating procedures need to be simplified and decisions are to be made based on need and capacity. Existing policies need to be revisited to accommodate pandemic situations, and to ensure transparent and judicious use of finite resources. The gaps in communication identified during the pandemic should be used as a basis in designing future policies for a cohesive and seamless post pandemic intra- and interagency management.
- It is imperative to have clear policies on data sharing and access for the benefit of making data-guided decisions. Policies which are leveraged on the fact that there is no single authority which dictates how and to whom the data should be shared with, as long as the conditions for data sharing meet the Ethics Review Board.
- The public-private initiatives should be initiated, with clear indications and justification to ensure its sustainability beyond COVID-19 pandemic. Criteria and involvement of private healthcare sector in assisting during pandemic and post-pandemic period must be clearly justified and sustainable for all stakeholders.

Digital Transformation

- Healthcare provision must be prepared to transform to deliver “COVID-19-proof services”, i.e., methods which reduce transmission or contact.
- Digital healthcare delivery is not possible if the IT literacy of the Malaysian population shows no improvement from its current state.

Recommendations to Support the SME Sectors

Engagement with SMEs and relevant government agencies is necessary to ensure constant review of the effectiveness and sufficiency of government policies in dealing with the effects and after-effects of the MCO and coronavirus to facilitate dynamic and appropriate responses. The following recommendations are based on concerns from the SMEs that were presented at a webinar entitled ‘SMEs Beyond the MCO – Lessons from the Prihatin Stimulus, hosted by KSI Strategic Institute for Asia Pacific’ on 30th April 2020, and were written as a policy brief which the necessary stakeholders can examine and apply in terms of appropriate public policy.

Recommendations for SMEs

a. SMEs need to Review Business Models

SMEs need to explore new markets, new customer segments, introduce new products, redesign packaging sizes and quantities which are suitable and relevant for the new marketplace, and determine what consumers are willing to spend on. They need to predict what may emerge from the new normal.

b. Adoption of New Technologies to Enhance Operational Efficiency

SMEs cannot merely depend on the lower wages of foreign workers or expect costs to fall. Hence, SMEs must consider the adoption of new technologies, digitalisation, and implementing e-commerce solutions to reduce costs, and save time and resources (Kergroach, 2020). Barriers to technology adoption, such as the lack of capital investment, poor managerial skills, lack of skilled employees, limited capacity for technology management and knowledge acquisition, and limited access to finance and capital need to be overcome (Burhanuddin et al., 2009). SMEs also need to learn how to leverage on social media platforms for the purposes of marketing and branding, ultimately to reach out to a higher volume of customers.

c. Improve Risk Management

SMEs should build cash reserves when the opportunity presents itself. This will allow them to protect their business during times of difficulty. They should refrain from overinvesting through the expansion and purchase of major assets, such as properties, which are difficult to liquidate during difficult times. The customer base should be diversified, instead of depending on a single group of customers. SMEs trading internationally should also practice foreign exchange hedging for the purpose of risk management.

d. Implement Cashless Payments

SMEs should implement cashless means of transactions, such as cloud-based point of sales (POS) systems and account reconciliation packages (ARP). With the risk of coronavirus contamination present on physical bank notes and coins, cashless payments, such as mobile e-wallets and contactless debit and credit cards are expected to experience a higher uptake.

e. Formalise the Informal Sector

SMEs in the informal sector should register their businesses with CCM and LHDN, register their employees with EPF and SESCO, and move forward by conducting their businesses in a proper manner to gain access to the benefits of social protection.

f. Implement High Occupational Health and Safety Standards

Government's SOPs and precautionary measures, such as wearing face mask, body temperature screens, social distancing, and sanitisation processes need to be practiced. Apart from being a regulatory measure, the onus is on the businesses themselves to realise that an outbreak within their premises will be a costly affair should workers or customers contract the virus. Physical layouts of some offices will present difficulties for the practice of social distancing. Staff rotations (where staff alternate working from office/home on different days to minimise the number of persons physically present in the office) may be a solution but this could also have an adverse effect on productivity. The commute to work will pose a challenge as public buses and trains in Malaysia are crowded, especially during rush hour. SMEs that have the option to allow their employees to work from home should consider this as a 'semi-permanent' solution until the virus threat has been minimised. This will ease congestion for employees of SMEs who need to be present at the workplace, particularly those in industries requiring access to equipment and materials.

g. Keeping Informed

SMEs must keep up to date with the government announcements made from time to time, especially those from MITI relating to SMEs.

Recommendations for Government

a. Reduce Bureaucratic Processes

For businesses to obtain EPF's 6-month deferment would require the approval of special committees. The process is time-consuming, particularly when time and resources are limited. Instead, a blanket deferment regardless of business size should be given to provide businesses with savings in terms of working capital. The government must actively find ways to reduce red tape and the cost of doing business to allow businesses to go back to their normal routine.

b. Transparency and Oversight on Cash Transfers

While Prihatin's allocation of RM3,000 micro grants and zero-interest micro credit facility were much welcomed initiatives, oversight is needed on how these funds are channelled to micro enterprises, particularly with calls to simplify the process for direct transfers. Digitising these processes will allow greater transparency in terms of tracing applications.

c. Review Internal Procedures and Regulations to Facilitate Digital Adoption

Digital adoption should be a new norm, yet many traditional requirements are still demanded (e.g., need for a company stamp, signing a declaration form) which is challenging to do online and goes contrary to the message of wanting businesses to adopt new technologies and digitise. Laws and regulations need to be amended to reflect and encourage digital adoption.

d. Referral System for Loans as Alternative

To speed up the recognition and processing of new clients, banks can consider the use of a referral system with the business chambers and business associations. Such practices are used and recognised by banks and financial institutions overseas.

e. Ministry of Human Resources Mediation

Guidance and mediation are required from the Ministry between employers and their employees as disputes in work arrangements arising from the MCO are bound to lead to numerous legal actions should such conditions not be remedied.

f. Facilitate Business Registration

The government must take a proactive role to persuade SMEs in the informal sector to register their businesses. Full compliance to law and legislation will enable all SMEs in the informal sector to enjoy the benefits of social protection and at the same time increase the government's source of revenues (in terms of taxes and business licenses) which can be used in a cycle of financial assistance programmes.

g. Other Recommendations

- Increase Special Relief Facility (SRF) by another RM5 billion which will help SMEs to last an additional 3 months.
- Take the lead in organising digital EXPOs for trade promotion.
- Loosen regulations to speed up the entry of new businesses by making it simpler for them to obtain business licenses.
- Suspend all statutory notices for at least 6 months.
- CCM late submission fees are deterring businesses from registering. Such cost of doing business must be reduced.
- Combat corruption to allow businesses to thrive.
- Allow businesses to keep the government in check to ensure policies are not politically driven but serves a pragmatic purpose.
- The government needs to cultivate an ecosystem that allows SMEs and businesses to thrive, which are conditions necessary after the lifting of the MCO.

Recommendations to Support the Education Sector

a. Enhanced Internet Accessibility and Connectivity

- Internet and connectivity strengths at education institutions should be improved.
- The National Fibreisation and Connectivity Plan (NFCCP) should be implemented according to the plan.
- Full coverage of internet connectivity including Sabah and Sarawak should be provided.

b. Prepared for Online Teaching and Learning

- Accelerate digital learning transformation from conventional teaching to proper digital learning by students.
- Training in learning and teaching designs that fit online pedagogy needs to be emphasised.
- Allocation should be provided for subscriptions for the use of e-resources, efficient learning, teaching and examining platforms.
- Online assessment design and platforms need to be developed that fit local needs while maintaining the validity of the tests. All alternative methods will have to be in full compliance with the directives and guidelines issued by the Malaysian Qualifications Agency (MQA).
- Alternative forms of assessment should be employed. For example, semester exams through e-learning platforms, and final exam substituted by final assignments, projects, and papers.
- Increase the number of trained Instructional Designers for online pedagogy amongst lecturers and technical engineers.

- Publications, online module design and development should be given equivalent value to encourage quality online course providers.
- The method of awarding diplomas and degrees should be by appointment to replace the traditional ceremony.
- Engaging the industry and community in the early development of curriculum by bringing industry on-campus, constantly subjecting students to field experience and work-based training.
- Educate students about the best practices. Administrators should undertake simple measures to prevent the spread of the disease on their campuses. This should include instructing students on the appropriate protocols for hand washing, covering sneezes and coughs with their elbows, and self-isolating if they are experiencing flu or cold-like symptoms. Educators should also be aware of students who have travelled extensively during the semester break and remind those who have been abroad in heavily affected places to be mindful about returning to campus.

c. Salvaging Private Higher Learning Institutions

- In the case of private universities which are in the critical state of collapsing, transferring their students to better institutions must be the priority.
- There must be a managed structural reform to allow poor performers to close-down, and non-viable colleges to merge with larger, better structured universities with stable finances and good leaders, or even merge with public universities and become a special entity for profit.
- Encourage IHLs to merge by providing tax rebates or other similar mechanisms.
- A new model to market, recruit, register, teach, test and graduate international students should be set up to draw international students back despite the constraints of travel bans.
- To allow private universities and colleges to enrol affected students using the Sijil Pelajaran Malaysia (SPM) or Sijil Tinggi Pelajaran Malaysia (STPM) trial results. This is to ensure the survival of many private higher learning institutions in the country.
- Allow international students to register with IHLs while they are still in their home country, as currently they need to be physically presence in Malaysia for registration.
- Allow a more flexible credit transfer mechanism to attract Malaysian who are doing their degree outside Malaysia and continue their programme in Malaysia.
- Special loans (e.g., PTPTN) for local students who have financial difficulties due to COVID-19.

d. New Policies under the Era of Pandemic

- Work from home monitoring system or procedures need to be put in place to drive efficiency of educators.
- Transferring all international sponsored scholars (e.g., JPA, etc.) to local IHL to continue their studies.
- Formulate new set of key performance indicators for academics which able to drive impact to the society.
- Monitor mental health of students and staffs as well as provide necessary supports.

Recommendations to Support the Tourism Sector

a. Target Tourism – Improving worthiness

Travel and tourism are universal, but no two places, nor two people are alike. Every person, whether he or she travels as a person or as part of a group, does so for highly individualised, personal, business or leisure-related reasons. The challenge during this ravaging COVID-19 pandemic or post-pandemic, would be how to prevent immeasurable harm, and whether the available mitigation and over-capacity management can be utilised to suit the new normal (Pullman and Rodgers, 2010). Improving each destination worthiness may revive livelihoods and local economies, as well as observing the new normal by dispersing the crowds.

b. Complying with Set Risk

There are notions that for tourism to take off again, all must be willing to live with COVID-19 as eradicating the virus seems far fetch at the moment. The question is what level of risk would be tolerable and what says other economic stakeholders. It is therefore pertinent for the community-as-destinations to perform deep-dive assessments to generate first-hand strategic information of what is and what is not happening, what is and what is not flourishing, what is and what is not possible, etc., and paste them against the current restrictions and modified routines of living with COVID-19.

c. Smart Tourism

COVID-19 pandemic requires, as proposed, a smarter tourism, and this is by design. It requires bettering the community-as-destination worthiness by re-creating greater values, re-designing and delivering delightful and unique experiences worthy of COVID-19 pandemic risk. With a lot of uncertainties to the future of COVID-19 crises, tourism needs a smart design to transform and transcend beyond the restrictive borders of COVID-19 in order to revive and revitalise the dying industry.

SCOPE 3

Application of Artificial Intelligence (AI) and Big Data Analytics (BDA) for Infectious Disease Researches

This study highlights key recommendations that could lead to significant success in the fight against the COVID-19 pandemic in Malaysia from the AI/BDA perspectives. From analyses of the respondents' feedback and the selected primary studies, this study proposes a taxonomy for a set of AI/BDA based recommendations to mitigate the effect of COVID-19 in Malaysia. The taxonomy consists of 6 major classes, such as dataset impact, research and development impact, collaborative impact, economic impact, social impact, and stakeholders/authority impact. The economic impact is further classified into global, internal, and external economic impacts; whereas stakeholders/authorities are further divided into governmental and non-governmental authority impact as presented in Figure 31.

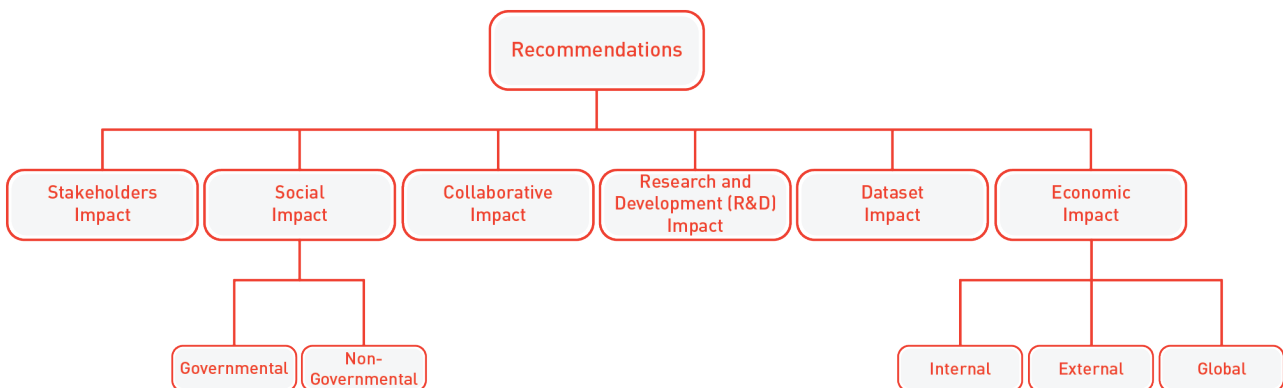


Figure 31: Impact of AI/BDA Recommendations

Dataset Impact

Reliable data is needed to incorporate all the possible predictions associated with the pandemic in the future models and dashboard. In this regard, a reliable data centre, or a network of interoperable data centres should be central to the initiative. This data centre should be accompanied by clear regulations and guidelines for its governance, management, and operation. Data in the data centre should be made available to authorised researchers and personnel without compromising the data security, confidentiality, and privacy. This addresses the data authorisation and protection, as well as the data source and credibility challenges.

The data centre should systematically collect, store, update and dispose of relevant data for enabling AI/BDA applications to contribute to the management of COVID-19 and similar crises in the future. Hospitals and healthcare facilities should actively contribute data to this repository for more concerted nationwide efforts and even for better alignment to worldwide efforts. Fundamental to this recommendation is a thorough study to decide what data to be collected, who should contribute the data, how to deposit, store and retrieve the data. Together with this study is a robust, secure, scalable, and interoperable hardware and software architecture to support the data centre. This addresses the data availability and collection challenges.

Research and Development (R&D) Impact

A knowledge base for COVID-19 related AI/BDA research is needed for consolidating and aligning R&D efforts in the country. This will first avoid redundancy in similar initiative by different developers or researchers, as highlighted in our literature review. Secondly, the knowledge base serves as a single point of reference to showcase Malaysia's AI/BDA R&D initiatives in handling and tackling COVID-19. Thirdly, outputs of R&D activities can be disseminated; success and failure experience can be passed on from one project to another, promoting continuity across the R&D initiatives. The MOSP initiative is an example of such a knowledge base. Examples of AI/BDA research as an effective means of handling the pandemic include:

- Predict the infection dynamics, the number of cases according to different time and location and whether different decisions should be made for different states in Malaysia dates to safely end MCO, measures to effectively minimise the transmission of the infectious agent, plan and lift public health interventions accordingly.
- Repurpose old compounds and discover new drugs, identify potential vaccine candidates.
- Enhance the response of communities to the ongoing pandemic.
- Contact tracing (huge part of anti-epidemic measures according to WHO) and early detection of infection and infection clusters to boost proactive measures.
- Enhance the reliability of existing AI/BDA applications.
- Improve the existing systems' ability to gain reliable information.
- Integrate with classical surveillance systems to foster a stable framework for the nation's future sustainability.
- Integrate with geographic information systems (GIS) to locate the risk areas in order to contain the disease.
- Promote hygiene education in the community, e.g., regular handwashing in fighting the disease.

Collaborative Impact

COVID-19 is a complex real-world problem spanning far beyond the territory of healthcare. Interdisciplinary and concerted efforts involving political, economic, societal and scientific communities are crucial to effectively manage the disease and its various impacts on the countries. AI/BDA applications, while seemingly technological in nature, is not exempted from this basic requirement. Encourage collaborations between institutions, government, and industries. As discussed earlier, a system like CoronaTracker, although it provides comprehensive information about COVID-19, lacks indicators of involvement from medical researchers and practitioners in interpreting and modelling the data. To address this issue, interdisciplinary discourse and collaboration should be promoted to enhance accuracy and effectiveness in AI/BDA applications for handling COVID-19.

Economic Impact (Internal, External, and Global)

AI/BDA applications can help the government cushion the impact of the COVID-19 outbreak in short-time, support the recovery in the medium term, and make the economy more inclusive, competitive, and resilient to similar shocks in the long term. One of the focus areas is building the digital foundation and enablers, mitigating the risks in the digital economy while expanding the new economy services, digital payments, digital entrepreneurship, and e-government, in response to reduced physical and social contact amongst the citizens. In line with this, an investment in building relevant skillsets, regulations, and institutions to modernise the old economy is needed. AI/BDA applications play the role of an enabler and enhancer of efficiency and security of the digital economy.

Social Impact

Take advantage of the lockdown to tap into developers' skills. Unlike other workers, programmers utilise their talent more while in isolation, with less distraction and interference. Considering this, the IT industry is expected to further flourish at this trying period of the COVID-19 pandemic if the opportunity is properly explored. More so, this idea helps in reducing the cost of running the companies significantly, as there is limited transportation cost, no apartment or office rent for the staff, thus entails more profit. However, supporting facilities like Internet connectivity, virtual collaborative work environment and tools are essential in maintaining staff productivity. Thus, automating the associated works using AI/BDA is essential.

a. Expectations from Policymakers

- The government should devise policies and frameworks in enabling and promoting the public and private sectors to invest in AI/BDA applications in addressing the COVID-19 pandemic. More emphasis on AI/BDA applications in addressing the COVID-19 pandemic through funding from the government and NGOs is the key factor to manage the pandemic and post-pandemic. The government must first be convinced of the capability and potentials of AI/BDA applications before convincing the people of the capability of AI/BDA applications in handling the pandemic.
- The government can play the moderator and facilitator role to coordinate the public and private sectors and align their efforts in using AI/BDA applications in handling the pandemic. This coordination helps in reducing the waste of resources.
- The government must be committed to ensure that AI/BDA applications of such magnitude are sustained post-pandemic to strengthen disease control in Malaysia and leverage the resources invested in the applications during the pandemic for more non-COVID-19 specific use cases.

b. Expectations from Non-governmental agencies

NGOs can help to convince the people and policymakers in the country to change their views on the capability of AI/BDA systems in handling the pandemic. They should also actively participate in a coordinated effort with the public and private sectors in using AI/BDA applications in handling the pandemic while preventing the waste of resources.

SCOPE 4

The Introduction of the Temporary Measures for Reducing the Impact of Coronavirus Disease 2019 (COVID-19) Act 2020 and Its Implications

The Temporary Measures for Reducing the Impact of Coronavirus Disease 2019 (COVID-19) Act 2020 (“Covid Act”) was gazetted and came into force on 23rd October 2020. The Government through the Temporary Measures for Reducing the Impact of Coronavirus Disease 2019 (COVID-19) (Extension of Operation) Order 2020 has extended the applicability of Part II of the Covid Act until 31st March 2021. The other provisions of the Covid Act will be in force for two years from 23rd October 2020, or in accordance with the date and period in the relevant parts of the Covid Act.

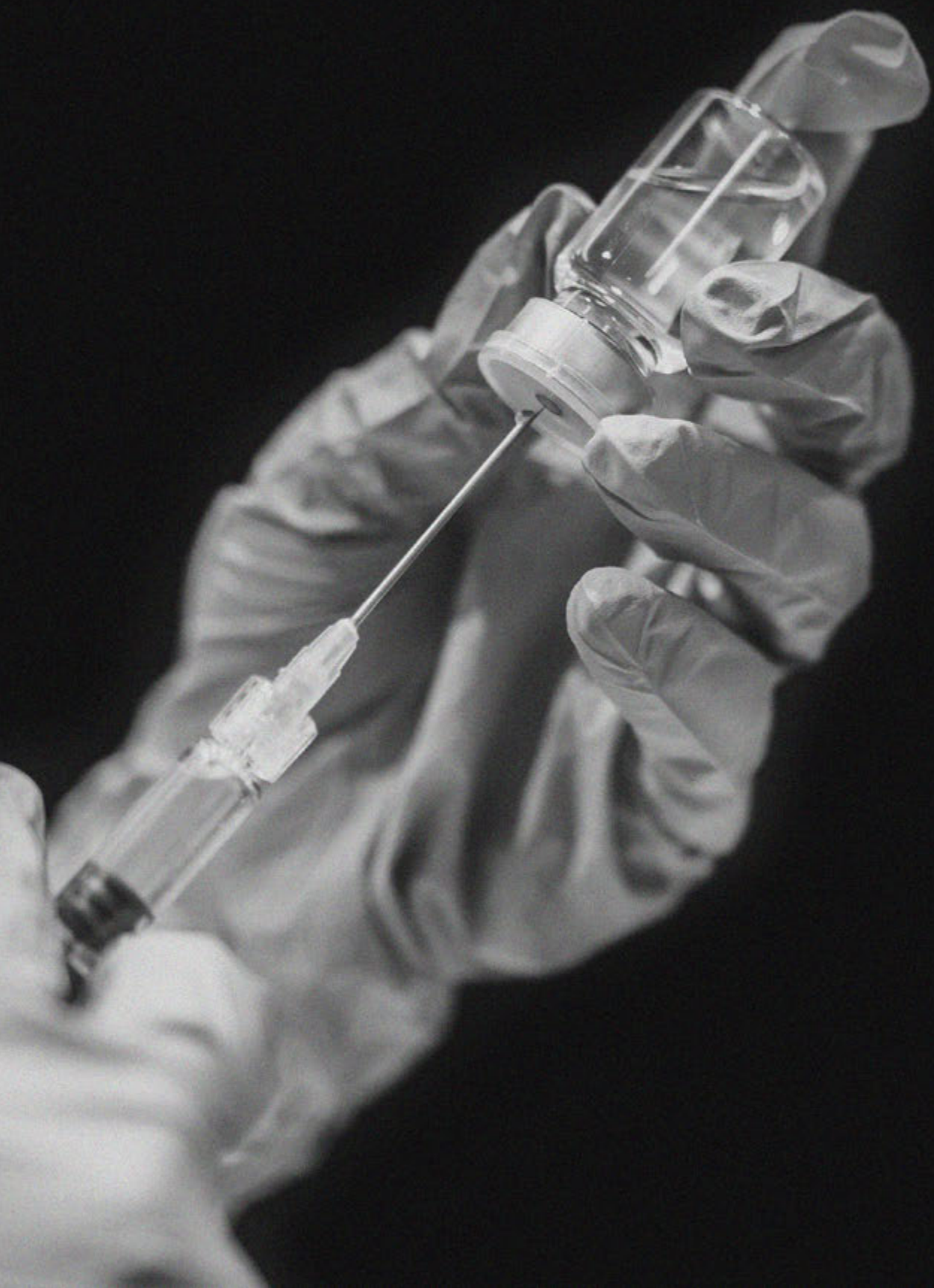
The aim of the Covid Act is to provide parties some form of temporary relief from legal obligations, as well as to protect parties who may be affected by the measures taken under the Prevention and Control of Infectious Disease Act 1988 to overcome the COVID-19 pandemic.

Henceforth, it is deemed important for this report to cover the legal perspective on the introduction of The Temporary Measures for Reducing the Impact of Coronavirus Disease 2019 (COVID-19) Act 2020 and its implications. Issues and concerns, such as the inability to perform contractual obligations, implication on Housing Development Laws, insurance, Insolvency Act 1967, and responsibility of employer at workplace are included herein.

The Introduction of the Temporary Measures for Reducing the Impact of Coronavirus Disease 2019 (Covid-19) Act 2020 and Its Implications



Figure 32 - The Implications of COVID-19 Act
(Details of the implications can be found in Appendix pg. 156)



CONCLUSIONS

It is critical to address the prevailing social disparities between populations and close the gap in health inequity, especially during the COVID-19 pandemic and its aftermath. Amongst the top priority matters that Malaysia need to address the healthcare problems due to social disparities during this COVID-19 pandemic is through data sharing between academics and the data owner. All parties can work together to ensure that effective healthcare services can be provided with an evidence-based approach. At the moment of writing, due to data constraints and transparency, the problems of healthcare gap due to the socio-economic differences exist, however the magnitude of the problem is unknown. Through data sharing, academics can help to find scientific evidence that can support and assist in policy and decision making, while MOH can focus on healthcare service delivery to citizens.

Apart from that, another area that must be improved while we are battling with the pandemic is to provide education access to the youngsters to improve the literacy of citizens, defined as people's knowledge and capacity to obtain, process, and understand information and services to make appropriate decisions, particularly on health-related issues. Through education, the knowledge and awareness of the disease and related preventive measures could be nurtured from a young age. There is also needs to improve employment opportunities to the low socio-economic people through effective infrastructure development. This could also help to reduce social inequalities, as well as health disparities amongst the people. While financial assistance provided by the government through welfare initiatives and also *Prihatin* packages could help to alleviate the financial implications, the approach could result in temporary relief. Continuous and sustainable approaches through work opportunities could help them to improve their socio-economic status and reduce health inequalities in Malaysia.

To minimise the health inequalities due to socio-economic disparities, we should build a tougher economy, sturdier and more resilient to any economic shock for our community. The efforts require the policymaker to address underlying structural and institutional weaknesses, including improving the data monitoring system, simplifying bureaucratic processes, promoting social dialogue, and addressing inequality and discrimination. This could serve for the future prioritisation of needs amongst these populations to improve health outcomes and to minimise socio-economic disparities in Malaysia, particularly during and post COVID-19 pandemic.

This report also presents the status, strengths, and shortcomings of research with respect to using AI/BDA applications for tackling the COVID-19 pandemic in Malaysia. It also discusses relevant issues and challenges in the aspects of data, system, and economy of using AI/BDA applications for COVID-19 and future disease outbreaks. Recommendations in relation to stakeholders, social, collaborative, R&D, dataset, and economic impacts are given to assist in policymaking, planning and implementing AI/BDA solutions to create a resilient Malaysian society and economy in the face of crises, such as COVID-19.

BIBLIOGRAPHY



- Laws of Malaysia Act 342: Prevention And Control Of Infectious Diseases Act 1988. Date of Royal Assent: 13 August 1988; Date of publication in the Gazette: 8 September 1988; Date of coming into operation: 1 April 1989.
- ABDALHAMID, B., BILDER, C. R., MCCUTCHEN, E. L., HINRICHS, S. H., KOEPEL, S. A. & IWEN, P. C. 2020. Assessment of Specimen Pooling to Conserve SARS CoV-2 Testing Resources. *Am J Clin Pathol*, 153, 715-718.
- ABDALQADER, M., SHEBL, H., GHAZI, H., BAQBAID, M. F., JUN, H. C. W., HASAN, T. N., MOHAMMED, M. F., ABDALRAZAK, H. A. & ADS, H. O. 2020. The facts about corona virus disease (COVID-19): The current scenario and important lessons. *Global Journal of Public Health Medicine*, 168-178.
- ADAMS, J. G. & WALLS, R. M. 2020. Supporting the health care workforce during the COVID-19 global epidemic. *Jama*, 323, 1439-1440.
- AHMAD, K., ERQOU, S., SHAH, N., NAZIR, U., MORRISON, A. R., CHOUDHARY, G. & WU, W.-C. 2020. Association of poor housing conditions with COVID-19 incidence and mortality across US counties. *PloS one*, 15, e0241327.
- AHMAD NAQIB IDRIS 2020. Reasons behind Emergency Proclamation hardly legitimate and sets a dangerous precedent, says former Bar Presidents. *The Edge Market*; 17 January 2021. <https://www.theedgemarkets.com/article/reason-behind-proclamation-emergency-hardly-legitimate-and-sets-dangerous-precedent-says>.
- ALBITAR, O., BALLOUZE, R., OOI, J. P. & GHADZI, S. M. S. 2020. Risk factors for mortality among COVID-19 patients. *Diabetes Research and Clinical Practice*, 166, 108293.
- ALEMAN, V. D., FERNANDEZ, E. G., VARON, D., SURANI, S., GATHE, J. & VARON, J. 2020. SOCIOECONOMIC DISPARITIES AS A DETERMINANT RISK FACTOR IN THE INCIDENCE OF COVID-19. *Chest*, 158, A1039.
- ALIYYAH, R. R., RACHMADTULLAH, R., SAMSUDIN, A., SYAODIH, E., NURTANTO, M. & TAMBUNAN, A. R. S. 2020. The perceptions of primary school teachers of online learning during the COVID-19 pandemic period: A case study in Indonesia. *Journal of Ethnic Cultural Studies*, 7, 90-109.
- ALSAYED, A., SADIR, H., KAMIL, R. & SARI, H. 2020. Prediction of epidemic peak and infected cases for COVID-19 disease in Malaysia, 2020. *International Journal of Environmental Research Public Health*, 17, 4076.
- ANDERSON, J. 2021. Managing labour migration in Malaysia: foreign workers and the challenges of "control" beyond liberal democracies. *Third World Quarterly*, 41(1), 86-104.
- ANGUS, D. C., DERDE, L., AL-BEIDH, F., ANNANE, D., ARABI, Y., BEANE, A., VAN BENTUM-PUIJK, W., BERRY, L., BHIMANI, Z., BONTEN, M., BRADBURY, C., BRUNKHORST, F., BUXTON, M., BUZGAU, A., CHENG, A. C., DE JONG, M., DETRY, M., ESTCOURT, L., FITZGERALD, M., GOOSSENS, H., GREEN, C., HANIFFA, R., HIGGINS, A. M., HORVAT, C., HULLEGIE, S. J., KRUGER, P., LAMONTAGNE, F., LAWLER, P. R., LINSTRUM, K., LITTON, E., LORENZI, E., MARSHALL, J., MCAULEY, D., MCGLOTHIN, A., MCGUINNESS, S., MCVERRY, B., MONTGOMERY, S., MOUNCEY, P., MURTHY, S., NICHOL, A., PARKE, R., PARKER, J., ROWAN, K., SANIL, A., SANTOS, M., SAUNDERS, C., SEYMOUR, C., TURNER, A., VAN DE VEERDONK, F., VENKATESH, B., ZARYCHANSKI, R., BERRY, S., LEWIS, R. J., MCARTHUR, C., WEBB, S. A., GORDON, A. C., WRITING COMMITTEE FOR THE, R.-C. A. P. I., AL-BEIDH, F., ANGUS, D., ANNANE, D., ARABI, Y., VAN BENTUM-PUIJK, W., BERRY, S., BEANE, A., BHIMANI, Z., BONTEN, M., BRADBURY, C., BRUNKHORST, F., BUXTON, M., CHENG, A., DE JONG, M., DERDE, L., ESTCOURT, L., GOOSSENS, H., GORDON, A., GREEN, C., HANIFFA, R., LAMONTAGNE, F., LAWLER, P., LITTON, E., MARSHALL, J., MCARTHUR, C., MCAULEY, D., MCGUINNESS, S., MCVERRY, B., MONTGOMERY, S., MOUNCEY, P., MURTHY, S., NICHOL, A., PARKE, R., ROWAN, K., SEYMOUR, C., TURNER, A., VAN DE VEERDONK, F., WEBB, S., ZARYCHANSKI, R., CAMPBELL, L., FORBES, A., GATTAS, D., HERITIER, S., et al. 2020. Effect of Hydrocortisone on Mortality and Organ Support in Patients With Severe COVID-19: The REMAP-CAP COVID-19 Corticosteroid Domain Randomized Clinical Trial. *JAMA*, 324, 1317-1329.
- ANNUAR, A. 2020. Covid-19: After MCO, survey finds nearly 70pc SMEs lost half income. *Malay Mail*, 27 March 2020.
- ARIFFIN, M. R. K., GOPAL, K., KRISHNARAJAH, I., ILIAS, I. S. C., ADAM, M. B., SHAM, N. M., ARASAN, J., ABD RAHMAN, N. H. & DOM, N. S. M. 2020. Coronavirus disease 2019 (COVID-19) infectious trend simulation in Malaysia: a mathematical epidemiologic modelling study.
- ARINO, J., BOWMAN, C. S. & MOGHADAS, S. M. 2009. Antiviral resistance during pandemic influenza: implications for stockpiling and drug use. *BMC infectious diseases*, 9, 1-12.
- ATALAN, A. 2020. Is the lockdown important to prevent the COVID-19 pandemic? Effects on psychology, environment and economy-perspective. *Annals of medicine and surgery*, 56, 38-42
- AZZERI, A., CHING, G. H., JAAFAR, H., NOOR, M. I. M., RAZI, N. A., THEN, A. Y.-H., SUHAIMI, J., KARI, F. & DAHLUI, M. 2020. A Review of Published Literature Regarding Health Issues of Coastal Communities in Sabah, Malaysia. *International journal of environmental research public health*, 17, 1533.
- BAENA-DÍEZ, J. M., BARROSO, M., CORDEIRO-COELHO, S. I., DÍAZ, J. L. & GRAU, M. 2020. Impact of COVID-19 outbreak by income: hitting hardest the most deprived. *Journal of Public Health*, 42, 698-703.

- BARNES, S. J. 2020. Information management research and practice in the post-COVID-19 world. *International Journal of Information Management*, 55, 102175.
- BEIGEL, J. H., TOMASHEK, K. M., DODD, L. E., MEHTA, A. K., ZINGMAN, B. S., KALIL, A. C., HOHMANN, E., CHU, H. Y., LUETKEMEYER, A., KLINE, S., LOPEZ DE CASTILLA, D., FINBERG, R. W., DIERBERG, K., TAPSON, V., HSIEH, L., PATTERSON, T. F., PAREDES, R., SWEENEY, D. A., SHORT, W. R., TOULOUMI, G., LYE, D. C., OHMAGARI, N., OH, M. D., RUIZ-PALACIOS, G. M., BENFIELD, T., FATKENHEUER, G., KORTEPETER, M. G., ATMAR, R. L., CREECH, C. B., LUNDGREN, J., BABIKER, A. G., PETT, S., NEATON, J. D., BURGESS, T. H., BONNETT, T., GREEN, M., MAKOWSKI, M., OSINUSI, A., NAYAK, S., LANE, H. C. & MEMBERS, A.-S. G. 2020. Remdesivir for the Treatment of Covid-19 - Final Report. *N Engl J Med*, 383, 1813-1826.
- BERARDI, C., ANTONINI, M., GENIE, M. G., COTUGNO, G., LANTERI, A., MELIA, A. & PAOLUCCI, F. 2020. The COVID-19 pandemic in Italy: policy and technology impact on health and non-health outcomes. *Health Policy Technology*, 9, 454-487.
- BERNAMA. 2020. COVID-19: 9,167 cases detected via MySejahtera - Health DG. *Bernama*, 19 November 2020.
- BERNAMA 2021. Salient points of COVID-19 emergency declaration. 12 January 2021. https://www.bernama.com/en/general/news_covid-19.php?id=1921299.
- BOGNER, P., CAPUA, I., LIPMAN, D. J. & COX, N. J. 2006. A global initiative on sharing avian flu data. *Nature*, 442, 981.
- BONI, M. F., LEMEY, P., JIANG, X., LAM, T. T., PERRY, B. W., CASTOE, T. A., RAMBAUT, A. & ROBERTSON, D. L. 2020. Evolutionary origins of the SARS-CoV-2 sarbecovirus lineage responsible for the COVID-19 pandemic. *Nat Microbiol*, 5, 1408-1417.
- BRAGAZZI, N. L., DAI, H., DAMIANI, G., BEHZADIFAR, M., MARTINI, M. & WU, J. 2020. How big data and artificial intelligence can help better manage the COVID-19 pandemic. *International journal of environmental research and public health*, 17, 3176.
- BROUDER, P. 2020. Reset redux: possible evolutionary pathways towards the transformation of tourism in a COVID-19 world. *Tourism Geographies*, 22, 484-490.
- BURHANUDDIN, M., ARIF, F., AZIZAH, V. & PRABUWONO, A. S. Barriers and challenges for technology transfer in Malaysian small and medium industries. 2009 International Conference on Information Management and Engineering, 2009. IEEE, 258-261.
- BURKI, T. 2020. China's successful control of COVID-19. *Lancet Infect Dis*, 20, 1240-1241.
- BUSINESSSTODAY. 2020. Malaysian manufacturers can now produce 5 million pieces of key PPEs in a month Available: <https://www.businessstoday.com.my/2020/05/19/malaysian-manufacturers-can-now-produce-5-million-pieces-of-key-ppes-in-a-month/>.
- CARRASCO, L. R., LEE, V. J., CHEN, M. I., MATCHAR, D. B., THOMPSON, J. P. & COOK, A. R. 2011. Strategies for antiviral stockpiling for future influenza pandemics: a global epidemic-economic perspective. *J R Soc Interface*, 8, 1307-13.
- CARVALHO, M. 2020. Manufacturers producing more PPE Available: <https://www.thestar.com.my/news/nation/2020/05/30/manufacturers-producing-more-ppe>.
- CHAN, H. F., BRUMPTON, M., MACINTYRE, A., ARAPOC, J., SAVAGE, D. A., SKALI, A., STADELMANN, D. & TORGLER, B. 2020. How confidence in health care systems affects mobility and compliance during the COVID-19 pandemic. *PloS one*, 15, e0240644.
- CHANDRA, Y. 2020. Online education during COVID-19: perception of academic stress and emotional intelligence coping strategies among college students. *Asian Education Development Studies*.
- CHENG, C. 2020. COVID-19 in Malaysia: Economic impacts & fiscal responses. Institute of Strategic and International Studies (ISIS) Malaysia. Policy Brief, 1-20.
- CHUA, K. B. 2003. Nipah virus outbreak in Malaysia. *J Clin Virol*, 26, 265-75.
- CHUNG N 2020. Test backlog caused spike in reported cases, says Noor Hisham. <https://www.freemalaysiatoday.com/category/nation/2020/10/18/high-covid-19-cases-in-sabah-due-to-testing-backlog-says-noor-hisham/>.
- CLARKE, L. 2020. An introduction to economic studies, health emergencies, and COVID 19. *Journal of Evidence Based Medicine*, 13, 161-167.
- CODEBLUE. 2020a. Despite Pandemic, MOH's 2021 Budget Only Rises 4% From 2020 [Online]. CodeBlue. Available: <https://codeblue.galencentre.org/2020/11/06/despite-pandemic-mohs-2021-budget-only-rises-4-from-2020/> [Accessed 6 November 2020].
- CODEBLUE. 2020b. DG Explains Malaysia's 8,000 Pending Covid-19 Test Results. <https://codeblue.galencentre.org/2020/04/06/dg-explains-malysias-8000-pending-covid-19-test-results/>.
- CODEBLUE 2020c. Health gets RM31Bil in budget 2020, 7pc raise. 11 October 2020. <https://codeblue.galencentre.org/2019/10/11/health-gets-rm31bil-in-budget-2020-7pc-raise/>.
- CODEBLUE 2020d. Open letter to PM: 10 critical actions to manage COVID-19 – Health Experts. <https://codeblue.galencentre.org/2021/01/07/open-letter-to-pm-10-critical-actions-to-manage-covid-19-health-experts/>.

- CODEBLUE 2020e. Patient 26 Linked To 114 Coronavirus Infections, 986 Tabligh Index Cases Identified. <https://codeblue.galencentre.org/2020/03/24/patient-26-linked-to-114-coronavirus-infections-986-index-tabligh-cases-identified/>.
- DAVALBHAKTA, S., SHARMA, S., GUPTA, S., AGARWAL, V., PANDEY, G., MISRA, D. P., NAIK, B. N., GOEL, A., GUPTA, L. & AGARWAL, V. 2020. Private Health Sector in India-Ready and willing, yet underutilized in the Covid-19 pandemic: A cross-sectional study. *Frontiers in Public Health*, 8.
- DE GIUSTI, A. 2020. Policy Brief: Education during COVID-19 and beyond. *Revista Iberoamericana de Tecnología En Educación y Educación En Tecnología*, e12-e12.
- DE JONG, J. C., BEYER, W. E., RIMMELZWAAN, G. F., FOUCHIER, R. A. & OSTERHAUS, A. D. 2004. [Neuraminidase inhibitors oseltamivir and zanamivir: new means of defence against influenza]. *Ned Tijdschr Geneesk*, 148, 73-9.
- DEQUIN, P.-F., HEMING, N., MEZIANI, F., PLANTEFÈVE, G., VOIRIOT, G., BADIÉ, J., FRANÇOIS, B., AUBRON, C., RICARD, J.-D. & EHRMANN, S. 2020. Effect of hydrocortisone on 21-day mortality or respiratory support among critically ill patients with COVID-19: a randomized clinical trial. *Jama*, 324, 1298-1306.
- DEVADASON, E. S. & MENG, C. W. 2014. Policies and laws regulating migrant workers in Malaysia: A critical appraisal. *Journal of Contemporary Asia*, 44, 19-35.
- DOSM. 2020. Main Findings of Special Survey 'Effects of COVID-19 on the Economy and Companies/ Business Firms' - Round 1 [Online]. DOSM. Available: https://www.dosm.gov.my/v1/index.php?r=column/cone&menu_id=RkJt0ThJSIBJNStOV1liM1JsKzdZUT09 [Accessed].
- DOYLE, M. 2020. WHO doctor says lockdown should not be the main coronavirus defense. ABC News 12 October 2020. <https://www.abc.net.au/news/2020-10-12/world-health-organization-coronavirus-lockdown-advice/12753688>.
- DZULKIFLY D 2020. Muhyiddin: tourism industry hit hardest by Covid-19, faces RM3.37b loss. Malay Mail; Retrieved from <https://www.malaymail.com/news/malaysia/2020/03/13/muhyiddin-tourism-industry-hit-hard-by-covid-19-tolose-rm3.37b-while-gdp-s/1846323>.
- DZULKIFLY D 2021. Selangor MB says record-breaking Covid-19 cases due to backlog, failure to report in 'real time'. <https://www.malaymail.com/news/malaysia/2021/01/30/selangor-mb-says-record-breaking-covid-19-cases-due-to-backlog-failure-to-r/1945380>.
- EDRE, M., ZA, M. A. & JAMALLUDIN, A. 2020. Forecasting Malaysia COVID-19 Incidence based on Movement Control Order using ARIMA and Expert Modeler. *IJUM Medical Journal Malaysia*, 19.
- ELBE, S., ROEMER-MAHLER, A. & LONG, C. 2014. Securing circulation pharmaceutically: Antiviral stockpiling and pandemic preparedness in the European Union. *Security Dialogue*, 45, 440-457.
- ELYATT, H. 2020. Full lockdown should be "a very-very last resort" and can be avoided, WHO's Europe Chief says. CNBC, 15 October 2020. <https://www.cnn.com/2020/10/15/lockdowns-should-be-last-resort-whos-europe-chief-says.html>.
- ERNST & YOUNG MALAYSIA. 2020. COVID-19 - a game changer for digital transformation, according to EY [Online]. EY.com. Available: https://www.ey.com/en_my/news/2020/06/covid-19-a-game-changer-for-digital-transformation-according-to-ey [Accessed].
- FMM. 2020. FMM - MIER Business Conditions Survey 1H2020 (GI/31/2020) [Online]. FMM.org.my. Available: [https://www.fmm.org.my/General_Information-@-FMM_%E2%80%93_MIER_Business_Conditions_Survey_1H2020_\(GI-s-31-s-2020\).aspx](https://www.fmm.org.my/General_Information-@-FMM_%E2%80%93_MIER_Business_Conditions_Survey_1H2020_(GI-s-31-s-2020).aspx) [Accessed].
- FMT. 2020a. MP questions low RM1,000 fine for factory breaching SOPs when ordinary people get high penalties; December 26, 2020 10:56 PM [Online]. Available: <https://www.freemalaysiatoday.com/category/nation/2020/12/26/mp-questions-low-rm1000-fine-for-factory-breaching-sops-when-ordinary-people-get-high-penalties/> [Accessed].
- FMT. 2020b. Sabah backlog of 12,720 Covid-19 test samples. <https://www.freemalaysiatoday.com/category/highlight/2020/10/23/sabah-backlog-of-12720-covid-19-test-samples/>.
- FODJO, J. N. S., DE MOURA VILLELA, E. F., VAN HEES, S., DOS SANTOS, T. T., VANHOLDER, P., REYNTIENS, P., VAN DEN BERGH, R. & COLEBUNDERS, R. 2020. Impact of the COVID-19 pandemic on the medical follow-up and psychosocial well-being of people living with HIV: A cross-sectional survey. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 85, 257-262.
- FONG, L. F. 2020. Large private hospitals ready for Covid-19 patients if situation worsens. *The Star Malaysia*, 7 April 2020.
- FOO, L.-P., CHIN, M.-Y., TAN, K.-L. & PHUAH, K.-T. 2020. The impact of COVID-19 on tourism industry in Malaysia. *Current Issues in Tourism*, 1-5.
- GANASEGERAN, K., CH'NG, A. S. H. & LOOI, I. 2020. COVID-19 in Malaysia: Crucial measures in critical times. *Journal of Global Health*, 10.
- GEREFFI, G. 2020. What does the COVID-19 pandemic teach us about global value chains? The case of medical supplies. *Journal of International Business Policy*, 3, 287-301.
- GILL, B. S., JAYARAJ, V. J., SINGH, S., MOHD GHAZALI, S., CHEONG, Y. L., MD IDERUS, N. H., SUNDRAM, B. M., ARIS, T. B., MOHD IBRAHIM, H. & HONG, B. H. 2020. Modelling the effectiveness of epidemic control

- measures in preventing the transmission of COVID-19 in Malaysia. *International Journal of Environmental Research Public Health*, 17, 5509.
- GONZALEZ, T., DE LA RUBIA, M., HINCZ, K. P., COMAS-LOPEZ, M., SUBIRATS, L., FORT, S. & SACHA, G. 2020. Influence of COVID-19 confinement on students' performance in higher education. *J PLoS one*, 15, e0239490.
- GRAY, D. J., KURSCHEID, J., MATIONG, M. L., WILLIAMS, G. M., GORDON, C., KELLY, M., WANGDI, K. & MCMANUS, D. P. 2020. Health-education to prevent COVID-19 in schoolchildren: a call to action. *Infectious diseases of poverty*, 9, 1-3.
- GREENHALGH, T., KOH, G. C. H. & CAR, J. 2020. Covid-19: a remote assessment in primary care. *Bmj*, 368.
- GREER, A. L. & SCHANZER, D. 2013. Using a dynamic model to consider optimal antiviral stockpile size in the face of pandemic influenza uncertainty. *PloS one*, 8, e67253.
- HABIBU, S. 2020. Screening a must for 1.7 million foreign workers. *The Star Malaysia*, 26 November 2020.
- HAMZAH, F. B., LAU, C., NAZRI, H., LIGOT, D., LEE, G., TAN, C. & SHAIK, M. 2020. CoronaTracker: worldwide COVID-19 outbreak data analysis and prediction. *Bull World Health Organ*, 1.
- HASANAT, M. W., HOQUE, A., SHIKHA, F. A., ANWAR, M., HAMID, A. B. A. & TAT, H. H. 2020. The Impact of Coronavirus (Covid-19) on E-Business in Malaysia. *Asian Journal of Multidisciplinary Studies*, 3, 85-90.
- HAWKINS, R. B., CHARLES, E. & MEHAFFEY, J. 2020. Socio-economic status and COVID-19-related cases and fatalities. *Public health*, 189, 129-134.
- HAY, A. J. & MCCAULEY, J. W. 2018. The WHO global influenza surveillance and response system (GISRS)-A future perspective. *Influenza Other Respir Viruses*, 12, 551-557.
- HOGAN, C. A., SAHOO, M. K. & PINSKY, B. A. 2020. Sample pooling as a strategy to detect community transmission of SARS-CoV-2. *Jama*, 323, 1967-1969
- HONG, T. H. 2020. 1/3 of SMEs only have enough cashflow for expenses March 2020 [Online]. *minimeinsights.com*. Available: <https://www.minimeinsights.com/2020/03/31/1-3-of-smes-only-have-enough-cashflow-for-expenses-march-2020/> [Accessed].
- HU, Z., GE, Q., LI, S., JIN, L. & XIONG, M. 2020. Artificial intelligence forecasting of covid-19 in china. *arXiv preprint arXiv:2002.07112*.
- HURT, A. C. 2019. Antiviral Therapy for the Next Influenza Pandemic. *Trop Med Infect Dis*, 4.
- IDSA & SHEA 2005. Joint Position Statement of the Infectious Diseases Society of America and Society for Healthcare Epidemiology of America on Antiviral Stockpiling for Influenza Preparedness. https://shea-online.org/images/white-papers/Osetamivir_Stockpiling_Position_Paper.pdf.
- IHSR 2020. Malaysia Health Sector Response to COVID-19 Pandemic. Selangor MYS. Institute for Health System Research (IHSR), Ministry of Health.
- ILO. 2020. COVID-19 leads to massive labour income losses worldwide [Online]. *ILO.org*. Available: https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_755875/lang--en/index.htm [Accessed].
- JAAFAR, M. H. & AZZERI, A. 2020. WINNING THE WAR AGAINST COVID-19 IN MALAYSIA: AN ACHIEVABLE GOAL? *Malaysian Journal of Public Health Medicine*, 20, 148-149.
- JAAFAR, S. S. 2021. MCO 2.0 unlikely to be as destructive on Malaysia's economic growth as earlier lockdown, says Standard Chartered. *The Edge*; 14 January 2021. <https://www.theedgemarkets.com/article/mco-20-unlikely-be-destructive-malaysias-economic-growth-says-standard-chartered>.
- JAMISON, D., GELBAND, H., HORTON, S., JHA, P., LAXMINARAYAN, R., MOCK, C. & NUGENT, R. 2017. *Disease Control Priorities, Third Edition: Volume 9. Improving Health and Reducing Poverty*. Washington, DC: World Bank. World Bank. <https://openknowledge.worldbank.org/handle/10986/28877> License: CC BY 3.0 IGO. .
- JR, J. K. & CHUNG, C. 2020. Health DG: No shortage of PPE, challenge is in distributing them. *The Star Malaysia* [Online]. Available: <https://www.thestar.com.my/news/nation/2020/04/08/health-dg-no-shortage-of-ppe-challenge-is-in-distributing-them>.
- KANAPATHY, V. 2014. Industrial restructuring in Malaysia: Policy shifts and the promotion of new sources of growth [Online]. Available: https://www.nomurafoundation.or.jp/en/wordpress/wp-content/uploads/2014/09/20000127-28_Vijakumari_Kanopathy.pdf [Accessed].
- KANTAMNENI, N. 2020. The impact of the COVID-19 pandemic on marginalized populations in the United States: A research agenda. *Elsevier*.
- KAWACHI, I., COLDITZ, G. A., STAMPFER, M. J., WILLETT, W. C., MANSON, J. E., ROSNER, B., SPEIZER, F. E. & HENNEKENS, C. H. 1993. Smoking cessation and decreased risk of stroke in women. *Jama*, 269, 232-236.
- KERGROACH, S. 2020. Giving momentum to SME digitalization. *Journal of the International Council for Small Business*, 1, 28-31.
- KHALIDI, J. 2020. Inequality Affects the Covid-19 Pandemic. *KR News*, 22, 20.
- KHAN, K. S., TORPIANO, G., MCLELLAN, M. & MAHMUD, S. 2021. The impact of socioeconomic status on 30 day mortality in hospitalized patients with COVID 19 infection. *Journal of medical virology*.
- KIM, M. & WANG, L. 2020. Malaysia – Introducing Epidemiological Model: JP Morgan; Asia Pacific Equity Research; 23 March 2020.

- KOH, D. 2020. Migrant workers and COVID-19. *Occupational and Environmental Medicine*, 77, 634–636.
- KRUMHOLZ, H. M. 2014. Big data and new knowledge in medicine: the thinking, training, and tools needed for a learning health system. *Health Affairs*, 33, 1163-1170.
- KUHFELD, M., SOLAND, J., TARASAWA, B., JOHNSON, A., RUZEK, E. & LIU, J. 2020. Projecting the potential impact of COVID-19 school closures on academic achievement. *Educational Researcher*, 49, 549-565.
- KUMWENDA, S. 2019. Challenges to hygiene improvement in developing countries, IntechOpen.
- LAM, T. T., JIA, N., ZHANG, Y. W., SHUM, M. H., JIANG, J. F., ZHU, H. C., TONG, Y. G., SHI, Y. X., NI, X. B., LIAO, Y. S., LI, W. J., JIANG, B. G., WEI, W., YUAN, T. T., ZHENG, K., CUI, X. M., LI, J., PEI, G. Q., QIANG, X., CHEUNG, W. Y., LI, L. F., SUN, F. F., QIN, S., HUANG, J. C., LEUNG, G. M., HOLMES, E. C., HU, Y. L., GUAN, Y. & CAO, W. C. 2020. Identifying SARS-CoV-2-related coronaviruses in Malayan pangolins. *Nature*, 583, 282-285.
- LAW, K. B., PEARIASAMY, K. M., GILL, B. S., SINGH, S. S. L., SUNDRAM, B. M., RAJENDRAN, K., DASS, S. C., LEE, Y. L., GOH, P. P. & IBRAHIM, H. M. 2020. Predicting the early depleting transmission dynamics of COVID-19: A time-varying SIR model.
- LENG, K. Y. & SARAVANAMUTTU, J. 2020. Migrant Workers: Wake-Up Call for Malaysia.
- LIANG, Y. & KELEMEN, A. 2016. Big Data science and its applications in health and medical research: Challenges and opportunities. *J Biom Biostat*, 7, 2.
- LIM, I. 2021. Najib claims much talked-about Emergency plan not to arrest Covid-19, but for politics. *The Malay Mail*. 11 Jan 2021 03:50 PM MYT. <https://www.malaymail.com/news/malaysia/2021/01/11/najib-claims-much-talked-about-emergency-plan-not-to-arrest-covid-19-but-fo/1939370>.
- LIM, K. L., JOHARI, N. A., WONG, S. T., KHAW, L. T., TAN, B. K., CHAN, K. K., WONG, S. F., CHAN, W. L. E., RAMZI, N. H., LIM, P. K. C., HAKIM, S. L. & VOON, K. 2020. A novel strategy for community screening of SARS-CoV-2 (COVID-19): Sample pooling method. *PLoS One*, 15, e0238417.
- LIM, L. L. 2020. The socioeconomic impacts of COVID-19 in Malaysia: Policy review and guidance for protecting the most vulnerable and supporting enterprises. Available: https://www.ilo.org/asia/publications/WCMS_751600/lang--en/index.htm.
- LOHSE, S., PFUHL, T., BERKO-GOTTEL, B., RISSLAND, J., GEISLER, T., GARTNER, B., BECKER, S. L., SCHNEITLER, S. & SMOLA, S. 2020. Pooling of samples for testing for SARS-CoV-2 in asymptomatic people. *Lancet Infect Dis*, 20, 1231-1232.
- MADHAV, N., OPPENHEIM, B., GALLIVAN, M., MULEMBAKANI, P., RUBIN, E. & WOLFE, N. 2017. Pandemics: risks, impacts, and mitigation. In: JAMISON, D., GELBAND, H. & HORTON, S. (eds.) *Disease Control Priorities: Improving Health and Reducing Poverty 3rd Edition* ed. Washington: The International Bank for Reconstruction and Development / The World Bank.
- MAHMUD, A. & LIM, P. Y. 2020. Applying the SEIR Model in Forecasting The COVID-19 Trend in Malaysia: A Preliminary Study. medRxiv.
- MALAYMAIL. 2020. Socso: Job losses in Malaysia increased by 42pc in Q1 due to Covid-19 [Online]. MalayMail.com. Available: <https://www.malaymail.com/news/malaysia/2020/06/03/socso-job-losses-in-malaysia-increase-by-42pc-in-q1-due-to-covid-19/1872211> [Accessed].
- MARGMA, M. R. G. M. A. 2020. MARGMA Industry Brief 2020 on the Rubber Glove Industry.
- MARIE, J. A. 2020. [Survey] Malaysian SMEs deeply affected by COVID-19 outbreak and MCO [Online]. Recommend.my. Available: <https://www.recommend.my/blog/survey-malaysian-smes-deeply-affected-by-covid-19-outbreak-and-mco/> [Accessed].
- MARTINS, L. D., DA SILVA, I., BATISTA, W. V., DE FÁTIMA ANDRADE, M., DE FREITAS, E. D. & MARTINS, J. A. 2020. How socio-economic and atmospheric variables impact COVID-19 and influenza outbreaks in tropical and subtropical regions of Brazil. *Environmental research*, 191, 110184.
- MAT, N. F. C., EDINUR, H. A., RAZAB, M. K. A. A. & SAFUAN, S. 2020. A single mass gathering resulted in massive transmission of COVID-19 infections in Malaysia with further international spread. *Journal of Travel Medicine*.
- MCNEELY, C. L., SCHINTLER, L. A. & STABILE, B. 2020. Social determinants and COVID 19 disparities: Differential pandemic effects and dynamics. *World Medical Health Policy*, 12, 206-217.
- MINDEF. 2020. High-Level of Compliance among Malaysian to MCO [Online]. Available: <http://www.mod.gov.my/en/mediamenu-2/news/710-high-level-of-compliance-among-malaysian-to-mco> [Accessed 18 January 2020].
- MINISTRY OF PUBLIC HEALTH THAILAND 2020. Thailand experience in COVID-19 response. Supakit Sirilak editor, Ministry of Public Health Thailand, Bangkok.
- MITI 2018. Industry 4WRD: National Policy on Industry 4.0. Kuala Lumpur: Ministry of International Trade and Industry.
- MOH 2006 National Influenza Pandemic Preparedness Plan.
- MOH 2012. Malaysia Strategic Workplan for Emerging Diseases (MySED), 2012 – 2015.
- MOH 2017. Malaysia Strategy for Emerging Diseases and Public Health Emergencies (MySED) II Work Plan (2017 – 2021).
- MOH. 2020a. Current situation of COVID-19 pandemic in Malaysia [Online]. Available: <http://covid-19.moh.gov>.

- my/ [Accessed 29 November 2020].
- MOH 2020b. Guideline on COVID-19 testing using antigen Rapid Test Kit (RTK-Ag) for health facilities, Ministry of Health Malaysia Version 3.0. http://covid-19.moh.gov.my/garis-panduan/garis-panduan-kkm/Annex_4c_GARISPANDUAN_RTKAG_version_3.0.pdf.
- MOH 2020c. Makluman Kejadian Kejadian Kluster Radang Paru-Paru (Pneumonia) di Wuhan, Republik Rakyat China. MOH.
- MOH 2020d. Tindakan KKM Bagi Pengesanan Kontak (Contact Tracing) kepada Kes Pertama Positif Novel Coronavirus di Negara Singapura pada 24 Januari 2020.: MOH.
- MOH. 2020e. Updates on The Coronavirus Disease 2019 (COVID-19) Situation in Malaysia Available: <https://kpkkesihatan.com/2020/04/14/kenyataan-akhbar-kpk-14-april-2020-situasi-semasa-jangkitan-penyakit-coronavirus-2019-covid-19-di-malaysia/>.
- MOH PROCUREMENT AND PRIVATISATION DIVISION 2020.
- MOHAMAD, E., THAM, J. S., AYUB, S. H., HAMZAH, M. R., HASHIM, H. & AZLAN, A. A. 2020. Relationship Between COVID-19 Information Sources and Attitudes in Battling the Pandemic Among the Malaysian Public: Cross-Sectional Survey Study. *Journal of medical Internet research*, 22, e23922.
- MOHD, M. H. & SULAYMAN, F. 2020. Unravelling the Myths of R0 in Controlling the Dynamics of COVID-19 Outbreak: a Modelling Perspective. *Chaos, Solitons & Fractals*, 109943.
- MORENS, D. M., FOLKERS, G. K. & FAUCI, A. S. 2004. The challenge of emerging and re-emerging infectious diseases. *Nature*, 430, 242-9.
- NACCHO 2019. STATEMENT OF POLICY: Pandemic Influenza Antivirals. <https://www.naccho.org/uploads/downloadable-resources/08-04-Pandemic-Antivirals.pdf>.
- NAIR, M., AHMED, P., VAITHILINGAM, S., WEI, D. L. L., QING, Y. H., JUIN, L. W. & L, P. W. 2020. Business in Turbulence. Available: https://www.monash.edu.my/__data/assets/pdf_file/0003/2320752/BUSINESS-IN-TURBULENCE-IMPACT-OF-COVID-19.pdf.
- NKOSI, V., HAMAN, T., NAICKER, N. & MATHEE, A. 2019. Overcrowding and health in two impoverished suburbs of Johannesburg, South Africa. *BMC public health*, 19, 1-8.
- NOH, F. 2021. First phase of Covid-19 vaccination will cover a million Malaysians. *New Straits Times*, 2 January 2021.
- NOOR, H. H. M. 2020. Covid-19: Mulai esok individu pulang dari Sabah akan dikuarantin. *Harian Metro*, 26 September 2020.
- NOR AIN MOHAMED RADHI & ARFA YUNUS. 2020. No double standards in determining Covid-19 SOP enforcement. *New Straight Times*; August 24, 2020: [Online]. Available: <https://www.nst.com.my/news/nation/2020/08/618961/no-double-standards-determining-covid-19-sop-enforcement> [Accessed].
- NST. 2020. Respect dignity, human and labour rights of migrant workers in Malaysia [Online]. *News Straits Times*. Available: <https://www.nst.com.my/news/nation/2020/12/650440/respect-dignity-human-and-labour-rights-migrant-workers-msia> [Accessed 8 December 2020].
- NST. 2021. Non-citizens residing in Malaysia to get free COVID-19 vaccine [Online]. *New Straits Times*. Available: <https://www.nst.com.my/news/nation/2021/02/664950/non-citizens-residing-malaysia-get-free-covid-19-vaccine> [Accessed 11 February 2021].
- OECD 2020a. COVID-19 and global value chains: Policy options to build more resilient production networks. *OECD Policy Response to Coronavirus (COVID-19)*.
- OECD 2020b. Trade Interdependencies in COVID-19 Goods. *OECD Policy Response to Coronavirus (COVID-19)*.
- OMAR, A. R. C., ISHAK, S. & JUSOH, M. A. 2020. The impact of Covid-19 Movement Control Order on SMEs' businesses and survival strategies. *Geografia-Malaysian Journal of Society Space*, 16.
- OTTO, B., KUZMA, S., STRONG, C. & CHERTOCK, M. 2020. Combating the coronavirus without clean water. *Water Resources Institute*.
- PANWAR, H., GUPTA, P., SIDDIQUI, M. K., MORALES-MENENDEZ, R. & SINGH, V. 2020. Application of deep learning for fast detection of COVID-19 in X-Rays using nCOVnet. *Chaos, Solitons & Fractals*, 138, 109944.
- PARK, C.-Y., KIM, K. & ROTH, S. 2020. Global shortage of personal protective equipment amid COVID-19: supply chains, bottlenecks, and policy implications. *ADB Briefs*.
- PATEL, J., NIELSEN, F., BADIANI, A., ASSI, S., UNADKAT, V., PATEL, B., RAVINDRANE, R. & WARDLE, H. 2020. Poverty, inequality and COVID-19: the forgotten vulnerable. *Public health*, 183, 110.
- PELL, C., ALLOTEY, P., EVANS, N., HARDON, A., IMELDA, J. D., SOYIRI, I. & REIDPATH, D. D. 2016. Coming of age, becoming obese: a cross-sectional analysis of obesity among adolescents and young adults in Malaysia. *BMC Public Health*, 16, 1-10.
- PKC, L., A, A., KL, L., SF, W., K, V. & HS, L. 2020. Covid 19 - A Malaysian private university's immediate response to provide testing services. *International e-Journal of Science, Medicine and Education.*, 14, 1-4.
- PMO 2020. Prime Minister Office: Prihatin Rakyat Economic Stimulus Package (PRIHATIN). Speech by YAB Prime Minister of Malaysia. <https://www.pmo.gov.my/2020/03/speech-text-prihatin-esp/>.
- PULLMAN, M. & RODGERS, S. 2010. Capacity management for hospitality and tourism: A review of current approaches. *International journal of hospitality management*, 29, 177-187.

- QAZI, A., QAZI, J., NASEER, K., ZEESHAN, M., HARDAKER, G., MAITAMA, J. Z. & HARUNA, K. 2020. Analyzing situational awareness through public opinion to predict adoption of social distancing amid pandemic COVID 19. *Journal of medical virology*.
- RAHMAN, A., RASHID, M., LE KERNEC, J., PHILIPPE, B., BARNES, S. J., FIORANELLI, F., YANG, S., ROMAIN, O., ABBASI, Q. H. & LOUKAS, G. 2019. A secure occupational therapy framework for monitoring cancer patients' quality of life. *Sensors*, 19, 5258.
- RAHMAN, F. 2020. The Malaysian response to COVID-19: building preparedness for 'surge capacity', testing efficiency and containment. *European Pharmaceutical Review*.
- RAJARATNAM, S. 2009. School of International Studies. Pandemic Preparedness in Asia. Nanyang Technological University, Singapore.
- RAO, S. & CHOU, C.-H. 2019. An investigation of over-crowding among the UK households. *Eastern Journal of European Studies*, 10, 5-24.
- RATNASINGAM, J., KHOO, A., JEGATHESAN, N., WEI, L. C., ABD LATIB, H., THANASEGARAN, G., LIAT, L. C., YI, L. Y., OTHMAN, K. & AMIR, M. A. 2020. How are small and medium enterprises in Malaysia's furniture industry coping with COVID-19 pandemic? Early evidences from a survey and recommendations for policymakers. *BioResources*, 15, 5951-5964.
- RECOVERY, C. G. 2020. Dexamethasone in hospitalized patients with Covid-19—preliminary report. *New England Journal of Medicine*.
- SAFUAN, S. & EDINUR, H. A. 2020. Sri Petaling COVID-19 cluster in Malaysia: challenges and the mitigation strategies. *Acta Biomed*, 91, e2020154.
- SALIM, N., CHAN, W. H., MANSOR, S., BAZIN, N. E. N., AMARAN, S., FAUDZI, A. A. M., ZAINAL, A., HUSPI, S. H., KHOO, E. J. H. & SHITHIL, S. M. 2020. COVID-19 epidemic in Malaysia: Impact of lock-down on infection dynamics. *medRxiv*.
- SALLEH, N. H. M. & AMRIE, H. 2020. No disruptions in hospital treatment for non-Covid-19 cases [Online]. *FreeMalaysiaToday.com*. Available: <https://www.freemalaysiatoday.com/category/nation/2020/04/02/no-disruptions-in-hospital-treatment-for-non-covid-19-cases/> [Accessed].
- SHAH, A. U. M., SAFRI, S. N. A., THEVADAS, R., NOORDIN, N. K., ABD RAHMAN, A., SEKAWI, Z., IDERIS, A. & SULTAN, M. T. H. 2020. COVID-19 outbreak in Malaysia: Actions taken by the Malaysian government. *International Journal of Infectious Diseases*, 97, 108-116.
- SHAHARUDIN, A. A. 2020. Protecting the agriculture sector during the Covid-19 crisis. *KRI VIEWS*, 27, 1-14.
- SHARUDIN, A. H. 2020. A quarter of Malaysian workers fear job loss — survey [Online]. *The Edge Markets*. Available: <https://www.theedgemarkets.com/article/quarter-malaysian-workers-fear-job-loss-%E2%80%94-survey> [Accessed].
- SHU, Y. & MCCAULEY, J. 2017. GISAID: Global initiative on sharing all influenza data—from vision to reality. *Eurosurveillance*, 22, 30494
- SIM, B. L. H., CHIDAMBARAM, S. K., WONG, X. C., PATHMANATHAN, M. D., PEARIASAMY, K. M., HOR, C. P., CHUA, H. J. & GOH, P. P. 2020. Clinical characteristics and risk factors for severe COVID-19 infections in Malaysia: a nationwide observational study. *The Lancet Regional Health-Western Pacific*, 4, 100055.
- SINGH, S., SUNDRAM, B. M., RAJENDRAN, K., LAW, K. B., ARIS, T., IBRAHIM, H., DASS, S. C. & GILL, B. S. 2020. Forecasting daily confirmed COVID-19 cases in Malaysia using ARIMA models. *The Journal of Infection in Developing Countries*, 14, 971-976.
- SINGU, S., ACHARYA, A., CHALLAGUNDLA, K. & BYRAREDDY, S. N. 2020. Impact of social determinants of health on the emerging COVID-19 pandemic in the United States. *Frontiers in public health*, 8.
- SME CORP. 2013. SME Definitions [Online]. Available: <https://www.smeCorp.gov.my/index.php/en/policies/2020-02-11-08-01-24/sme-definition> [Accessed].
- SOLAND, J., KUHFIELD, M., TARASAWA, B., JOHNSON, A., RUZEK, E. & LIU, J. 2020. The Impact of COVID-19 on student achievement and what it may mean for educators. *Brown Center Chalkboard. KIU journal of Humanities*, 8, 67-73.
- SONG, X., LIU, X. & WANG, C. 2020. The role of telemedicine during the COVID-19 epidemic in China—experience from Shandong province. *BioMed Central*.
- SU-LYN, B. 2020. Poll Reveals Almost Half Of Private, Public Health Workers Don't Feel Safe Available: <https://codeblue.galencentre.org/2020/05/08/poll-reveals-almost-half-of-private-public-health-workers-dont-feel-safe/>.
- SULLIVAN, T. J., PATEL, P., HUTCHINSON, A., ETHRIDGE, S. F. & PARKER, M. M. 2011. Evaluation of pooling strategies for acute HIV-1 infection screening using nucleic acid amplification testing. *Journal of clinical microbiology*, 49, 3667-3668
- TANG, B., WANG, X., LI, Q., BRAGAZZI, N. L., TANG, S., XIAO, Y. & WU, J. 2020. Estimation of the transmission risk of the 2019-nCoV and its implication for public health interventions. *Journal of clinical medicine*, 9, 462.
- THE LANCET 2020. Zoonoses: beyond the human-animal-environment interface. *Lancet*, 396, 1.
- TOMAZINI, B. M., MAIA, I. S., CAVALCANTI, A. B., BERWANGER, O., ROSA, R. G., VEIGA, V. C., AVEZUM, A.,

- LOPES, R. D., BUENO, F. R., SILVA, M., BALDASSARE, F. P., COSTA, E. L. V., MOURA, R. A. B., HONORATO, M. O., COSTA, A. N., DAMIANI, L. P., LISBOA, T., KAWANO-DOURADO, L., ZAMPIERI, F. G., OLIVATO, G. B., RIGHY, C., AMENDOLA, C. P., ROEPKE, R. M. L., FREITAS, D. H. M., FORTE, D. N., FREITAS, F. G. R., FERNANDES, C. C. F., MELRO, L. M. G., JUNIOR, G. F. S., MORAIS, D. C., ZUNG, S., MACHADO, F. R., AZEVEDO, L. C. P. & INVESTIGATORS, C. C.-B. I. 2020. Effect of Dexamethasone on Days Alive and Ventilator-Free in Patients With Moderate or Severe Acute Respiratory Distress Syndrome and COVID-19: The CoDEX Randomized Clinical Trial. *JAMA*, 324, 1307-1316.
- TONG, G. 2020. DG: Almost a third of COVID-19 deaths in third wave happened before reaching the hospital [Online]. *Malaysiakini*. Available: <https://www.malaysiakini.com/news/562618> [Accessed 28 October 2020].
- TUAH, Y. 2020. Rise of the PPE industry. *The Borneo Post* [Online]. Available: <https://www.theborneopost.com/2020/06/21/rise-of-the-ppe-industry/>.
- USFDA. 2020. FDA approves first treatment for COVID-19. October 22, 2020.
- USMAN, M., ALI, Y., RIAZ, A., RIAZ, A. & ZUBAIR, A. 2020. Economic perspective of coronavirus (COVID 19). *Journal of public affairs*, 20, e2252.
- VADURRO, M. 2018. The Importance of Health Education [Online]. Southern New Hampshire University. Available: <https://www.snhu.edu/about-us/newsroom/2018/02/importance-of-health-education> [Accessed].
- VENKATESH, V. 2020. Impacts of COVID-19: A research agenda to support people in their fight. *International Journal of Information Management*, 55, 102197.
- WAHAB, A. 2020. The outbreak of COVID-19 in Malaysia: pushing the migrant workers at the margin. *Social Sciences and Humanities Open*
- WANG, J. & HONG, N. 2020. The COVID-19 research landscape: Measuring topics and collaborations using scientific literature. *Medicine*, 99.
- WANG, S., KANG, B., MA, J., ZENG, X., XIAO, M., GUO, J., CAI, M., YANG, J., LI, Y. & MENG, X. 2020. A deep learning algorithm using CT images to screen for Corona Virus Disease (COVID-19). *MedRxiv*.
- WEAVER, M. R., CONOVER, C. J., PROESCHOLDBELL, R. J., ARNO, P. S., ANG, A., ULDALL, K. K. & ETTNER, S. L. 2009. Cost-effectiveness analysis of integrated care for people with HIV, chronic mental illness and substance abuse disorders. *Journal of Mental Health Policy Economics*, 12, 33.
- WHO. 2004. Informal consultation on influenza pandemic preparedness in countries with limited resources: Kuala Lumpur, Malaysia, 23-25 June 2004. [Online]. Available: https://apps.who.int/iris/bitstream/handle/10665/69822/WHO_CDS_CSR_GIP_2004_1_eng.pdf?sequence=1&isAllowed=y [Accessed].
- WHO 2007. *International Health Regulation: Areas of work for implementation*. World Health Organization, Geneva.
- WHO 2011. Sixty-fourth World Health Assembly. Resolution 64.5: Pandemic influenza preparedness: sharing of influenza viruses and access to vaccines and other benefits. World Health Organization, Geneva.
- WHO 2016. *Guidance for managing ethical issues in infectious disease outbreaks*. World Health Organization, Geneva. <https://apps.who.int/iris/bitstream/handle/10665/250580/9789241549837-eng.pdf?sequence=1&isAllowed=y>.
- WHO 2017. *Asia Pacific Strategy for Emerging Diseases and Public Health Emergencies (APSED III): Advancing implementation of the International Health Regulations (2005)*. Manila, Philippines. World Health Organization Regional Office for the Western Pacific; 2017. Licence: CC BY-NC-SA 3.0 IGO.
- WHO 2018. *Joint external evaluation tool: International Health Regulations (2005), second edition*. Geneva: World Health Organization; 2018. Licence: CC BY-NC-SA 3.0 IGO.
- WHO 2020a. *Antigen detection in the diagnosis of SARS-CoV-2 infection using rapid immune assay*, World Health Organisation. Geneva, Switzerland.
- WHO. 2020b. *Ethics and COVID-19: Resource allocation and priority-setting*. [Online]. Available: <https://www.who.int/ethics/publications/ethics-and-covid-19-resource-allocation-and-priority-setting/en/> [Accessed].
- WHO 2020c. *Joint External Evaluation of IHR Core Capacities. Malaysia: Mission Report, 21 – 25 October 2019*. World Health Organisation, Geneva.
- WHO. 2020d. *Maintaining essential health services: new operational guidance for the COVID-19 context* [Online]. WHO. Available: <https://www.who.int/news/item/01-06-2020-maintaining-essential-health-services-new-operational-guidance-for-the-covid-19-context> [Accessed].
- WHO 2020e. *The migrant worker whose COVID-19 story inspired Singapore*.
- WHO. 2020f. *Shortage of personal protective equipment endangering health workers worldwide* [Online]. World Health Organization. Available: <https://www.who.int/news/item/03-03-2020-shortage-of-personal-protective-equipment-endangering-health-workers-worldwide> [Accessed].
- WHO. 2020g. *A UN framework for the immediate socio-economic response to COVID-19*. Available: https://www.un.org/sites/un2.un.org/files/un_framework_report_on_covid-19.pdf.
- WHO 2020h. *Western Pacific Region: JEE mission reports*. World Health Organization, Geneva. <https://www.who.int/ihr/procedures/mission-reports-western-pacific/en/>.

- WHO. 2020i. Zoonoses: Key Facts. [Online]. Available: <https://www.who.int/news-room/fact-sheets/detail/zoonoses> [Accessed 8 Feb 2021].
- WHO. 2021. International Health Regulation. [Online]. Available: https://www.who.int/health-topics/international-health-regulations#tab=tab_1 [Accessed 8 Feb 2021].
- YELIN, I., AHARONY, N., TAMAR, E. S., ARGOETTI, A., MESSER, E., BERENBAUM, D., SHAFRAN, E., KUZLI, A., GANDALI, N., SHKEDI, O., HASHIMSHONY, T., MANDEL-GUTFREUND, Y., HALBERTHAL, M., GEFFEN, Y., SZWARCWORD-COHEN, M. & KISHONY, R. 2020. Evaluation of COVID-19 RT-qPCR Test in Multi sample Pools. *Clin Infect Dis*, 71, 2073-2078.
- YUNUS, R. 2020. Private universities suffer as foreign students intake ceases [Online]. *The Malaysian Reserve*. Available: <https://themalaysianreserve.com/2020/09/01/private-universities-suffer-as-foreign-students-intake-ceases/> [Accessed].
- ZAINUL, E. 2020. These Malaysian companies jump onto the pandemic bandwagon, how many will make it? . Available: <https://www.theedgemarkets.com/article/these-malaysian-companies-jump-pandemic-bandwagon-how-many-will-make-it>.

APPENDIX



The following are the talking points by Professor Dato' Dr Aishah Bidin, FASc on her presentation titled **Legal Implication of COVID-19** as presented to the Companies Commission of Malaysia (CCM) in August 2021, as well as to the Legal Unit of the Prime Minister's Department (JPM) in a Business & Human Rights conference in September 2021.

A. Implications on Contractual Obligations – Legal Shield

The *first* relief under the COVID-19 Act is providing respite for contracting parties who could not perform their contractual obligations from 18th March 2020 and who continue to be unable to perform. First, under clause 7 of the COVID-19 Act, this relief applies to a party who could not perform any contractual obligation arising from any of the scheduled categories of contracts due to the measures prescribed, made or taken under the Prevention and Control of Infectious Diseases Act 1988 to control or prevent the spread of COVID-19. Of note, there is no requirement to show that the inability was substantially or materially due to the movement control measures. In Singapore's COVID-19 Act, there was the requirement that the inability to perform was to a material extent caused by a COVID-19 event.

Second, triggering this relief under clause 7 will prevent the other party to the contract from exercising his or their rights under the contract. Significantly, this clause 7 does not provide any end date in terms of allowing the other party to eventually exercise their rights. It appears to permanently stop the other party from exercising any of their rights. It seems too open ended. Further, as a comparison, Singapore's COVID-19 Act set out the very specific types of actions which were restrained, e.g., commencing court action, enforcing security, repossession of goods, or forfeiture. Malaysia's version is wide in having a blanket reference to prevent the exercising of rights under the contract.

Third, the scheduled categories of contracts for now are seven categories:

- a) Construction work contract or construction consultancy contract and any other contract related to the supply of construction material, equipment or workers.
- b) Performance bond or equivalent granted pursuant to a construction contract or supply contract.
- c) Professional services contract.
- d) Lease or tenancy of non-residential property.
- e) Event contract, e.g., for any business meeting, incentive travel, conference, wedding, party or other social gathering or sporting event.
- f) Contract by a tourism enterprise and a contract for promotion of tourism.
- g) Religious pilgrimage-related contract.

Fourth, where there is a dispute on the inability of the party to perform any contractual obligation, this may be settled by way of mediation (see clause 9 of the COVID-19 Act). This means that it is a voluntary process and does not compel parties to mediate. This voluntary mediation could be a critical weakness of the dispute resolution process in the COVID-19 Act. That would mean that there is a high likelihood that there will be more court and arbitration proceedings. Parties will be in dispute whether there was the proper inability to perform as set out in the COVID-19 Act.

Fifth, the Minister (for this relief, it is the Minister of Law) can amend the scheduled categories of contracts through a gazette notice (see clause 8 of the COVID-19 Act). The Minister can also issue a gazette notice to extend the period of operation past the 31st December 2020 period (see clause 5(2) of the COVID-19 Act).

Sixth, there is a saving provision in clause 10 of the COVID-19 Act. Notwithstanding clause 7 providing relief, any contract terminated, any deposit forfeited, any damages received, any legal proceedings commenced, any judgment or award granted, and any execution carried out since 18th March 2020 shall still be valid. This is also an indication that this COVID-19 Act does come quite late in the day and where many legal actions have already been taken.

B. Implications on Housing Development Laws

The second significant area in the COVID-19 Act relates to housing development laws and modifications to the Housing Development (Control and Licensing) Act 1966. The description herein affects the statutory form contracts for sale in the forms in Schedules G, H, I and J of the housing development regulations entered into before 18th March 2020.

First, where due to the measures taken under the Prevention and Control Infectious Diseases Act 1988, the purchaser fails to pay any instalment from 18th March 2020 to 31st August 2020, the developer shall not impose any late payment charges (see clause 34 of the COVID-19 Act). The purchaser may apply to the Minister for an extension of time to pay and the Minister may extend the time up to 31st December 2020 (see clause 34(2) and (3) of the COVID-19 Act).

Second, on late delivery of vacant possession and liquidated damages. The period from 18th March 2020 to 31st August 2020 shall be excluded from the calculation of time for delivery of vacant possession and for liquidated damages for late delivery of vacant possession (see clause 35(1) of the COVID-19 Act). The developer may apply to the Minister for an extension of time of this period and the Minister may extend the period up to 31st December 2020 (see clause 35(2) and (3) of the COVID-19 Act). Interestingly, there is also one wide provision in clause 35(4) of the COVID-19 Act. It sets out that if the purchaser is unable to enter into possession of a housing accommodation from the date of service of notice of vacant possession from 18th March 2020 to 31st August 2020, the purchaser shall not be deemed to have taken such vacant possession. This provision is vague. It does not state that the purchaser has to show the inability to take vacant possession is due to COVID-19 or for some other reason.

Third, on the defect liability period. The period from 18th March 2020 to 31st August 2020 shall be excluded for calculation of the defect liability period and the time for the developer to carry out repair works (see clause 36(1) of the COVID-19 Act). The purchaser can apply for extension from the Minister and the Minister can grant an extension of the period up to 31st December 2020 (see clause 36(2) and (3) of the COVID-19 Act).

Fourth, the saving provision in clause 37 of the COVID-19 Act. The COVID-19 Act shall not affect legal proceedings already commenced, or any judgment or award obtained, relating to recovery of late payment charges payable by purchaser or liquidated damages payable by the developer or any other sum from 18th March 2020. Any such late payment charges or liquidated damages that has been paid shall be deemed to have been validly paid, and shall not be refunded. One last thing is that it is not clear who is the “Minister” referred to in this Part of the COVID-19 Act. Presumably, it is to be the Minister who is in charge of housing. But it is not made clear in this Part XI of the COVID-19 Act.

C. Implications on Insolvency Act 1967 – Indebtedness up to RM100,000 from RM 50,000

This area makes a modification to the personal bankruptcy laws.

First, the minimum threshold for the presentation of the bankruptcy petition is now raised from RM50,000 to RM100,000 (see clause 20 of the COVID-19 Act).

Second, this modification will take effect from the date of the publication of the Act and until 31st August 2021. The Minister may issue a gazette notice to further extend the operation of this modification (clause 19 of the COVID-19 Act).

Third, the saving provision under clause 21 of the COVID-19 Act. Any proceedings, actions or other matters required which are still pending immediately before the date of publication of the Act shall still be dealt with under the unmodified Insolvency Act 1967.

D. Implications on the Insurance

The General Insurance Association of Malaysia (“PIAM”), and the General Insurance Association of Malaysia and The Life Insurance Association of Malaysia (“LIAM”), and the Malaysian Takaful Association (“MTA”) reaffirmed that the member companies remain open to support the policy holders.

Further, the industry has also made efforts to help affected people cope with the immediate health effects of the virus and the subsequent economic consequences whereby PIAM stated that PIAM, LIAM and MTA has pledged an RM8 million contribution to establish a special fund for COVID-19 testing for medical insurance policyholders and medical takaful certificate holders. In addition, PIAM addressed questions posed on general insurance protection in relation to this pandemic:

- a) Coverage by the Hospital and Surgical Insurance (“HSI”) – HSI policy covers cost of hospitalisation and healthcare services, including room and board, doctor and surgery fees, medical supplies and services, etc., due to covered illnesses or accidents. A standard HSI policy generally excludes all types

of communicable diseases requiring quarantine, such as the current COVID-19 outbreak. However, many Insurers, out of goodwill, have agreed to waive the exclusion and provide cover for COVID-19. This is in addition to extra coverage offered by individual Insurers.

- b) Travel Insurance – A travel insurance policy generally covers travel related accidents, medical expenses, inconveniences, etc., suffered during the period of travel as stipulated in the policy. However, most policies will exclude travel to countries where travel ban or advisory had been issued by the local or foreign government of the destination country. As the terms and coverage of one policy may differ with another, consumers are advised to seek confirmation from respective Insurers before travelling.
- c) Motor Insurance – PIAM further addressed that all motor insurance shall be kept valid during the MCO period. Renewal of motor insurance can be done online.

Property Damage/Business Interruption (“PD/BI”)

A. Falling Under the Definition of “Loss”

Many modern policy forms in use in the market will contain an “infectious disease extension” clause (the “ID Extension”) that will specifically write coverage for this event into the policy. Such clauses will add the closure of the insured’s business or premises due to an “order of a competent public authority as the direct and sole result of...any infectious or human contagious disease...,” to the definition of “loss” for the purposes of business interruption cover.

B. Closure Due to Governmental Order

Under an ID Extension, it is essential that the cause of the Insured’s business or premises being shut down is due to a governmental order. This is because coverage may not be afforded in the absence of such an order. As such, documentation of any governmental order must be obtained and preserved for use in establishing your insurance claim.

C. Language

Certain policies where there is language which requires that the infection for which resulted in the closure of business or premises (again via government order) is actually “present” at the location or upon the premises Insured. In such circumstances, Insureds must be certain of their language requirements and that they have adequate documentation from authorities, such as:

- i. When a closure is ordered;
- ii. That such a closure is the result of the authority finding that the virus is actually present in the vicinity/location.

Thus, closing business as a precaution, without a virus actually being present, may endanger coverage. In this regard, Insureds are advised to read carefully.

D. Measurement of Trading Losses

Another complication is the measurement of trading losses as Insurers would likely factor in the wider reduction in trade across the country/region and seek to adjust any trading losses of an Insured against the current wider economic downward trends post virus outbreak.

Commercial General Liability Insurances (“CGL”)

In general, CGL policies comprised various types, and will respond to pandemic events if the Insured has been negligent in, or found liable for, failing to protect other persons/parties from infection where they have a duty to do so. Such coverage is triggered if liability is legally present or established.

Typically, the wording of the coverage under these policies generally reads as follows: *“Insurers will pay those sums that the insured becomes legally obligated to pay as damages because of “bodily injury”, “personal injury” or “property damage” to which this insurance applies.”*

As can be seen, “Liability” is necessary for this coverage to be triggered. If there is liability, then the policy will respond subject to its limits. Thus, Insureds are encouraged to use reasonable precautions that will decrease liability and/or severity of any loss due to failing to prevent the spread of the disease where the Insureds have a duty to do so. There are no, usual, exclusions for infectious disease liability under CGL policies (but, of course, individual, particularly manuscript, policies should be reviewed for any deviation from this norm).

Employees' Compensation ("EC")

It is expected that courts will endeavour to find coverage where an employee, through no fault of their own, was exposed to the COVID-19 virus at work in a demonstrable way. It is essential that the exposure take place in an employment setting along with the appropriate documentation for the employee to receive medical care and compensation through the EC policy. Thus, coverage may not be afforded under the policy if the virus was contracted elsewhere.

Life Insurance

Bank Negara Malaysia ("BNM") has announced additional measures to support SMEs and individuals by providing deferment of payment of life insurance premiums and family takaful contributions for three months without affecting the policy coverage. This option will be available from 1st April 2020 until 31st December 2020.

Further, in a press statement by LIAM entitled "Life Insurance Companies Offer Additional Relief Measures for Policyholders in facing the COVID-19 crisis 7" dated 20th March 2020, LIAM listed several instances of additional benefits of relief measures taken by insurers:

- a) RM5,000 Cash Relief for customers who are diagnosed with COVID-19;
- b) Cash benefits/allowance for hospitalisation (for example up to RM250 per day up to 30 days of hospitalisation);
- c) Special lump-sum death benefits (ranging from RM5,000 - RM20,000 upon death of the insured); and
- d) Four insurance companies pledge RM1 million each as part of their financial assistance/support programme for customers affected by COVID-19.

In another press release entitled "COVID-19 Pandemic: LIAM and MTA announce relief measures to ensure policyholder/certificate holders affected by COVID-19 continue to have life insurance/family takaful protection even in the midst of temporary financial difficulties" dated 27th March 2020, LIAM and MTA also announced several relief measures to ensure policyholders/certificate holders affected by COVID-19 continue to have life insurance/family takaful protection even in the midst of temporary financial difficulties, which are:

- a) Deferment of payment of life insurance premiums and family takaful contributions; and
- b) Extension of flexibilities to reinstate or preserve life insurance and family takaful protection.

Additionally, life insurers and family takaful operators will also provide the following assistance to the policyholders and takaful participants affected by COVID-19 until 31st December 2020:

- a) Extending the period during which a policyholder and takaful participant affected by COVID-19 can reinstate a policy/certificate that has lapsed;
- b) Provide options to enable policyholders and takaful participants affected by COVID-19 to continue to meet their premium/contribution payments and maintain their policies/certificates. This may include changes in the sum assured/covered, adjustments to the premium/contribution structure and conversion into a paid-up policy; and
- c) Waive fees and charges imposed for changes made to policies/certificates; and waive any penalties/consequences for late payments of premiums/contributions, particularly where policyholders/takaful participants affected by COVID-19 are unable to access electronic payment channels during the Movement Control Order.

E. Implications on the Responsibility of Employers at Workplace

What are the measures that should be taken by an employer should an employee exhibit COVID-19 symptoms?

The employer must immediately direct his employee to be tested by a certified medical practitioner. Should the employee be tested positive and accordingly placed under quarantine by a certified medical practitioner pursuant to Section 15(1) of the Prevention and Control of Infectious Diseases Act 1988 ("the PCIDA 1988"), the employer must take all necessary measures to ensure that the workplace remains a safe and healthy workplace for all employees pursuant to Section 15 of the Occupational Safety and Health Act 1994 ("the OSHA 1994"), including and not limited to conducting health surveillance on all employees, directing employees to seek urgent treatment and cleaning and sanitising the workplace area. Healthcare services, including room and board, doctor and surgery fees, medical supplies and services, etc., due to covered illnesses or accidents. A standard HSI policy generally excludes all types

What rights does an employee have if he/she is required to be put under quarantine?

Should an employee be placed under quarantine by a certified medical practitioner, the employee is entitled to receive full payment of his salary. This is in line with the Guidelines for Handling Disease-Related Issues Including COVID-19 at Work Places (“the Guidelines”) issued by the Labour Department of the Ministry of Human Resources, Malaysia. Therefore, it is prohibited for the employer to consider the employee’s quarantine period as unpaid leave, as the employee is still entitled to receive his salary in full. The employer must also not deduct the number of days of quarantine from the employee’s annual leave. He must also be entitled to any and all benefits such as paid sick leave and hospitalisation benefits, regardless if the employee is quarantined at home or in the hospital.

Can an employer disallow an employee from coming to work?

As per the Guidelines, if the employee had not been quarantined by a certified medical practitioner under Section 15(1) of the PCIDA 1988, an employer does not have the authority to restrict him from attending work. However, an employer may instruct an employee to not attend work by providing him with paid sick leave.

Employers are also encouraged to implement flexible work policies, such as the ‘work-from-home’ policy in order to ensure that the working environment remains conducive and continuously in line with the requirements under Section 15 of the OSHA 1994.

How does an employer handle travels to high-risk countries?

All employers and employees are advised to postpone any work-related and personal travels until the threat of COVID-19 has decreased significantly. However, as of yet, there are no directives issued by the Ministry of Human Resources, the Ministry of Health and/or other relevant authorities which impose any restrictions on individuals travelling overseas. However, should there be circumstances in which employees are required to travel overseas, the employer must take all necessary measures to limit the risk carried by such travels, such as requiring the employee to undergo an immediate medical examination at the expense of the employer and placing the employee in self-quarantine for a period of 14-days immediately after returning.

Within the context of the global spread of COVID-19, the employers have discovered a new reality, which also raises the following questions within the scope of the processing of personal data:

- i. Can the employer ask its employees to undergo COVID-19 diagnosis tests it provides?
- ii. Can the employer systematically check the body temperature of its employees?
- iii. Can the employer require its employees to periodically complete questionnaires relating to COVID-19 symptoms? And questionnaires relating to recent trips of its employees and the dates they left and returned to the country? Can these questionnaires include questions relating to people living with the employee?
- iv. Can the employer require its employees to state whether or not they belong to risk groups? Can the employer inform the rest of the employees when it identifies a company employee infected by COVID-19?
- v. Can the employer ask an employee suspected of being infected with COVID-19 to give the names of the employees with whom they have recently been in contact?
- vi. Can the employer share data on employees suspected of being infected with COVID-19 with the health authorities?

The employers should be aware that personal data related to their employees’ health conditions constitutes “sensitive personal data” of the employees under section 2 of the Personal Data Protection Act 2010 (“the Act”) where we reproduce as below:

“sensitive personal data” means any personal data consisting of information as to the physical or mental health or condition of a data subject, his political opinions, his religious beliefs or other beliefs of a similar nature, the commission or alleged commission by him of any offence or any other personal data as the Minister may determine by order published in the Gazette;”

In light of the above, the employers must be cautious in dealing with sensitive personal data of the employees. It is a legal duty of the employers to ensure that the collection and processing of such sensitive personal data comply with the principles of the Act.

Protection of Sensitive Personal Data Under the Act

The general principle of the Act stipulates that any sensitive personal data of a data subject shall not be processed by the data user unless it falls within the following exceptions, as provided in Section 40(1) of the Act:

- a) The data subject has given his explicit consent to the processing of the personal data;
- b) The processing is necessary:—
 - i. for the purposes of exercising or performing any right or obligation which is conferred or imposed by law on the data user in connection with employment;
 - ii. in order to protect the vital interests of the data subject or another person, in a case where:—
 1. consent cannot be given by or on behalf of the data subject; or
 2. the data user cannot reasonably be expected to obtain the consent of the data subject.

In the present circumstances, the employers may be required to collect the employees' temperature data if such obligation is imposed by the relevant authorities, as one of the conditions before any approval is granted for the re-opening of the business or operation. In addition, the employers also have a general duty to ensure the safety, health and welfare at work of all his employees.

Nonetheless, there is yet to be any specific rules, regulation or guideline issued by the authorities to regulate the collection of sensitive personal data of the employees due to or as a result of the COVID-19 pandemic. Although the employers may justify that the processing of sensitive personal data is necessary to protect the vital interest of the employees as COVID-19 is now a public health concern, it is advisable for the employers to obtain explicit consent from the employees and disclosure of such data shall only be permitted under very limited circumstances.

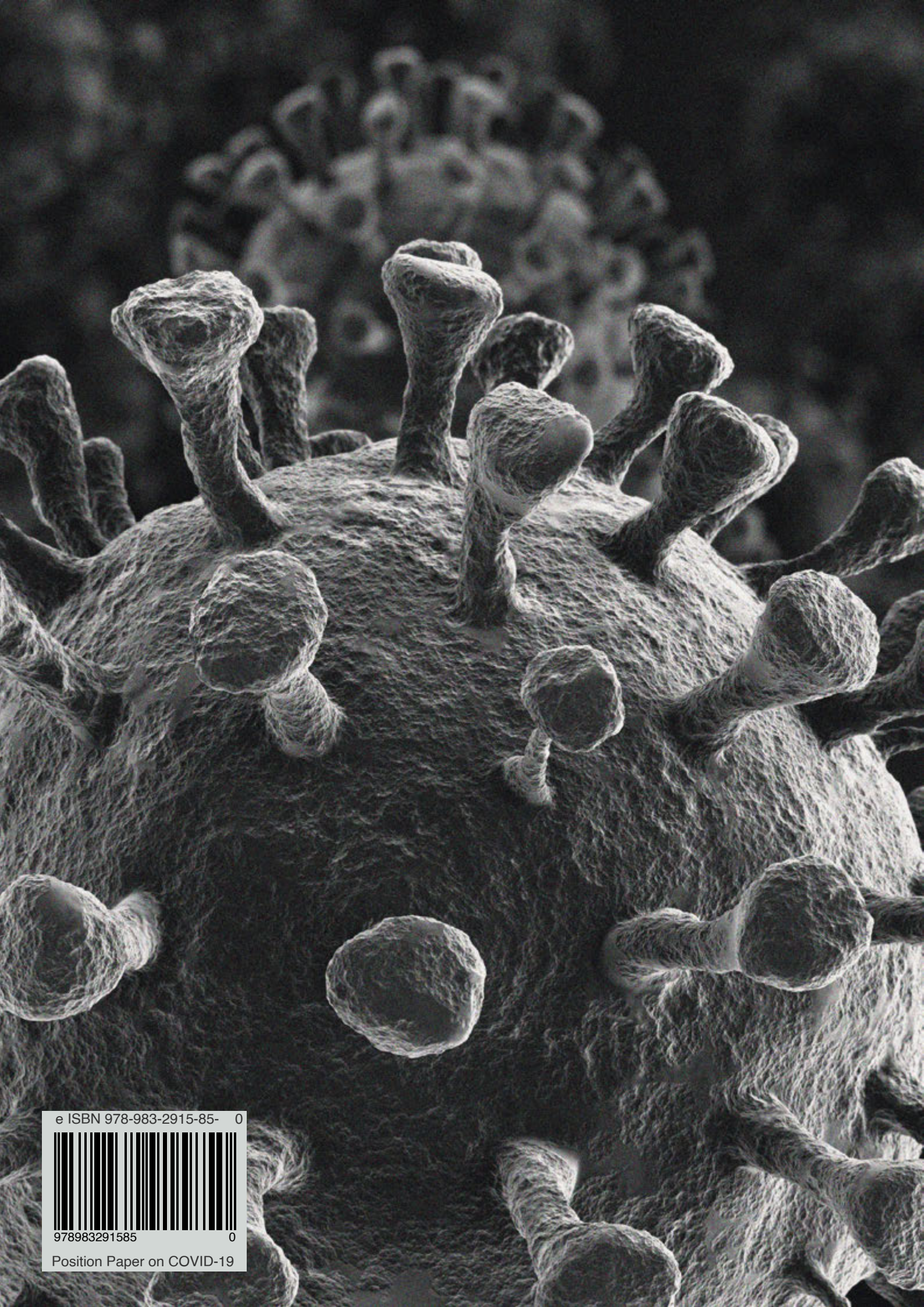
Besides, when dealing with the sensitive personal data of the employees, the employers must also comply with other data protection principles under the Act, such as the Notice and Choice Principle, the Disclosure Principle, the Security Principle and the Retention Principle.

In light of the above, it is recommended that the employers could take the following actions:

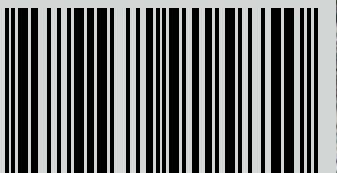
- a) The employers shall obtain explicit consent from the employees in the form of written notice if it is not already included in the employees' Personal Data Protection Notice. The notice shall include but not limited to what type of sensitive personal data to be collected, the purpose of the collection and also consent to disclose to the relevant authorities.
- b) The employers shall ensure that the personal data collected must not be used or disclosed for other unrelated purposes other than in relation to COVID-19.
- c) The employers shall take reasonable steps to protect the sensitive personal data from any loss, misuse, modification or unauthorized access.
- d) The employers shall put in place appropriate measures to ensure that the sensitive personal data shall be destroyed or permanently deleted when it is no longer required.

The pressing need to contain the outbreak of the COVID-19 pandemic is no doubt, the primary concern for the healthcare authorities and the employers. Nonetheless, the employers shall not deviate from their duty to handle the personal data of their employees with care in compliance with the data protection principles stipulated under the Act. In any case, the employees should be informed of the processing of any personal data the employers intend to carry out, and the employers must apply appropriate safety measures in line with the risk of such processing.

Considering the unresolved number of COVID-19 cases nationwide, it is therefore suggested for the government to extend the lifespan of the COVID-19 Act so that the affected parties and sectors would not be further hurt.



e ISBN 978-983-2915-85- 0



978983291585

0

Position Paper on COVID-19