JOURNAL OF GOVERNANCE AND INTEGRITY (JGI)
ISSN: 2600-7479 e-ISSN: 2600-786X
VOL. 5, ISSUE 3, 360 – 369
DOI: https://doi.org/10.15282/jgi.5.3.2022.8535

ORIGINAL ARTICLE

UTILISING A CAUSAL LOOP DIAGRAM TO EXPLORE PUBLIC INTEGRITY FOR EFFECTIVE COVID-19 PREVENTIVE MEASURES IN MALAYSIA

Jack Kie Cheng[1,*], Puteri Fadzline Muhamad Tamyez[1], Fazeeda Mohamad[1], Zetty Ain Kamaruzzaman[1], Faridah Zulkipli[2], and Maizura Mohd Zainudin[3]

[1]Faculty of Industrial Management, Universiti Malaysia Pahang, 26600 Pahang, Malaysia
[2]Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, 32610 Perak, Malaysia
[3]Kulliyyah of Medicine, International Islamic University Malaysia, 25200 Pahang, Malaysia

ABSTRACT – COVID-19 creates an unprecedented crisis in our lifetimes. The escalating rates of COVID-19 infection bring calamity to many parts of the world. Malaysia has been in a fierce battle with COVID-19 since March 2020 but the endgame is still obscure. Since the beginning of the pandemic, many preventive measures were implemented by the Malaysian government. Some of the strategies such as lockdown, although expensive is effective in flattening the curve of COVID-19 but after a while, negative unintended consequences such as pandemic fatigue emerged due to prolonged confinement. After two years of the pandemic, with the success of COVID-19 vaccination programme, Malaysia may be ready to return to normalcy. However, the world is constantly alarmed with the new deadly COVID-19 variant which puts Malaysia at constant risk of resurge of cases. This paper aims to understand how implemented preventive measures interacted with each other and collectively influence the spread of COVID-19 in Malaysia. By understanding these interactions, more effective, economical, and sustainable countermeasures that save lives without compromising people's livelihood can be introduced. The causal loop diagram, an essence of system dynamics is developed to capture these interconnections and provide meaningful insights. Preventive measures such as the enforcement of standard operating procedures, movement restrictions, vaccination programs, as well as mass tracking, screening, and testing are captured in the developed causal loop diagram. The developed causal loop diagram reveals that most of the government-imposed preventive measures can only control the spread of COVID-19 in short term. In long term, the community needs to also share the responsibility of breaking the COVID-19 chain. Instead of adhering to the SOPs for the fear of fines, public integrity and the awareness of adherence should be for the collective good.

ARTICLE HISTORY
Received: 19-7-2022
Revised: 21-9-2022
Accepted: 3-10-2022
Published: 31-12-2022

KEYWORDS
System Dynamics
Causal Loop Diagram
Preventive Measures
COVID-19
Public Integrity

INTRODUCTION

The emergence of the coronavirus disease 2019 (COVID-19) pandemic at the beginning of 2020 has significantly impacted the global economy, health, and society. As of 5 July 2022, there have been 547,901,157 confirmed cases of COVID-19 worldwide, including a total of 6,339,899 deaths reported to WHO (WHO, 2020). Malaysia is no exception, being swept by the COVID-19 outbreak in early 2020. Since then, the Malaysian government had taken several comprehensive measures to control the spread of COVID-19 within the country and alleviate mass panic (Shah et al., 2020). The earliest countermeasure was the implementation of a movement control order (MCO) nationwide on 18 March 2020 (Povera & Harun, 2020). During the period of MCO, everyone was instructed to stay indoors, and all interstate and overseas travelling, along with mass gatherings across the country were prohibited. Only essential sectors were allowed to operate while all businesses were shut except shops selling food and daily necessities.

The implementation of MCO served to slow down the transmission chain within the community and at the same time provided the Ministry of Health the opportunity to trace, isolate, and manage all identified positive cases (Aziz et al., 2020). The implemented MCO was then gradually relaxed to Conditional MCO (CMCO) and Recovery MCO (RMCO) when cases of COVID-19 declined steadily. During CMCO and RMCO periods, some of the restrictions imposed during MCO were eased. Nevertheless, easing restrictions in turn accelerated the spread of COVID-19 due to an increase in people's movement and failure to adhere to the regulated standard operating procedures (SOPs). Whenever there was a spike in cases, the enforcement of MCO returned. Lockdowns were effective at the beginning of the pandemic to flatten the curve of COVID-19. However, in long run, this countermeasure has an adverse effect on the nation's economy and society (Salim et al., 2020). Prolong confinement and physical distancing amplified stress and anxiety within the community (Moni et al., 2021; Shang et al., 2021) which then leads to pandemic fatigue where people are tired of all preventive measures and less likely to adhere to the regulated COVID-19 SOPs.

*CORRESPONDING AUTHOR | Jack Kie Cheng | ✉ jackkie@ump.edu.my

© The Authors 2022. Published by Penerbit UMP. This is an open access article under the CC BY license.

The Malaysian government started the nationwide vaccination program on 24 February 2021 (Anand, 2021) and by 30 December 2021, 97.6% of the adult population in Malaysia are fully vaccinated against COVID-19 (Bernama, 2021). While the national COVID-19 immunization program is a success, it is still a far cry from winning the battle against COVID-19. Despite the fact that vaccination effectively shielded people against severe illness and death, it does not prevent the spread of COVID-19. In late 2021, the world was alarmed by the emergence of a new COVID-19 variant which is more deadly than the previous COVID-19 variants. The Health Minister announced in July 2022 that Malaysia is at risk of entering a new wave of COVID-19 due to the upsurge of Omicron BA.5 sub-variant within the local community (Harun, 2022). This new variant is reported to be the most transmissible version of COVID-19 to date. With the potential rise of COVID-19 cases, there is a need to understand the interaction of previous and current implemented preventive measures in order to devise effective strategies that are capable of controlling the future escalation of COVID-19 without jeopardizing life and livelihood of the community as confinement and lockdown are no longer an effective measure.

The aim of this paper is to understand how one implemented countermeasure interacted with the other and collectively strengthen or weaken the spread of COVID-19 within the community in Malaysia. The role of community and public integrity is also observed in this study. This paper focuses on the preventive measures that were carried out to prevent the spread of COVID-19 in Malaysia (before the virus penetrated the community). A causal loop diagram, through the foundation of system dynamics, is developed to understand these interactions. The remainder of this paper is organized as follows: Section 2 briefly presents an overview of literature related to system dynamics and public integrity. Section 3 explains the essence of system dynamics methodology while section 4 provides a discussion on the results stemming from the developed causal loop diagram. Section 5 concludes the paper.

RELATED WORK

System Dynamics

Ever since the global outbreak of COVID-19, system dynamics have been used to solve issues related to curbing the pandemic chain. System dynamics is a methodology for framing, understanding, and analyzing complex systems and problems with the aid of computer modelling and simulation software (Azar, 2012). The system dynamics approach originated from the research of Professor Jay W. Forrester at the Massachusetts Institute of Technology in the late 1950s. While traditional analysis approaches focus on breaking down problems into smaller parts and solving them separately, system dynamics involves a broader view and focuses on looking at possible interactions among the subsystems to create a better understanding of the big picture (Cheng, 2010).

The need for system dynamics constantly arises as our best efforts to solve a problem actually make it worse due to our well-intentioned efforts to solve pressing problems to lead to policy resistance where policies are delayed, diluted, or defeated by the unforeseen reactions of other people or nature (Sterman, 2000). System dynamics, therefore, is a powerful method to gain useful insights into situations of dynamic complexity and policy resistance. It is increasingly used to design more successful policies in companies and public policy settings (Sterman, 2000).

Bradley et. al. (2020) mentioned that the systems approach is able to help policymakers to look beyond the chain of COVID-19 infection and allow a better understanding of how to prevent and respond to the pandemic without affecting the community. The first study focusing on the application of system dynamics to the COVID-19 outbreak was done by Sy et. al (2020) who proposed several policy developments such as increasing public health capacity, community quarantine, and gradual lifting of quarantine, to name a few. The impact and effectiveness of these interventions were then simulated and observed.

Researchers from different countries had also made use of the advantages portrayed by system dynamics to solve COVID-19-related issues in their home countries. For instance, Niwa et. al. (2020) investigated the effectiveness of several social measures implemented in Japan to combat COVID-19 outbreaks through system dynamics modelling. Zhao et. al. (2020) observed the structure of COVID-19 transmission through the implementation of infection, prevention, and control policies during the work resume phase in Shanghai using system dynamics while a study was conducted in Korea by Lee et. al. (2020) to review the dynamics response of healthcare mask production during COVID-19.

The spread of COVID-19 and its effect on Indonesia's economy was modelled by Sihombing et. al. (2020) using system dynamics. Another interesting study was carried out by Venkateswaran and Damani (2020) where they developed a customized system dynamics model for India to calibrate the effectiveness of several actions such as testing, tracing, social distancing, and hygiene in tackling COVID-19. Price and Propp (2020) developed a framework for assessing different late-stage models of COVID-19 through an extensive study conducted in Virginia where the study aimed at aiding policymakers through the developed system dynamics model to determine the plans to relax physical distancing by strategy.

Public Integrity

Integrity is driven by a person's willingness to act according to the internalized values, beliefs, norms, and principles that constitute their moral compass (Sajari et al., 2019). The importance of ethics and integrity should be emphasized to reduce unethical behaviour within society. Several attempts have been made to show the importance of public integrity in controlling the spread of COVID-19 in Malaysia. The Malaysia Ministry of Health emphasized stricter rules, where

individuals who fail to report positive antigen rapid test results for COVID-19 may face fines up to RM5,000. This is also in accordance with the Infectious Diseases Act, where it is a crime not to declare a positive test result via the MySejahtera application. Therefore, living with COVID-19 increases the importance of personal and community social responsibility (Han & Abu Bakar, 2022).

Economists examine this rule through the lens of contract theory where incentives are given to encourage or discourage specific behaviours. An example is by assuming individuals tested positive. If self-isolation is done as it is the right thing to do even in the absence of rules, thus, openly and honestly reporting the result is irrelevant (as long as it is effortless to do, which it is for most people). According to contract theory, the RM5,000 fine is likely to reduce tests by those who are unwilling or unable (due to financial reasons) to voluntarily isolate (Holden, 2022).

On the other hand, the mandatory COVID-19 diagnostic testing and 14-day quarantine are two specific health measures that secured the industry's reopening, particularly for international business transactions. According to recent research, these practices help control the spread of COVID-19 infection (Wells, Townsend & Pandey, 2021). However, isolated cases of COVID-19 diagnostic testing certification fraud have been reported in some countries, including the Philippines and India. The fraudulent act may raise serious ethical and economic concerns because it involves deception and lying. It would destabilize the world's recovering economy by unleashing a new wave of COVID-19 infection as the virus' asymptomatic carrier would be free to travel using a forged document.

If not taken seriously, falsifying documents certifying a person who has received COVID-19 vaccination could occur later. In order to address such misconduct, there is a need for a social control mechanism where a special body is mandated to investigate anyone found guilty of misconduct (Ayodele, Cheng, Haron, & Dabor, 2020). In the context of managing a pandemic, the government has a moral and legal obligation to protect the general public from such unethical and illegal behaviour. The government's intervention must include the implementation of preventive measures to counteract the potential malpractice of using forged COVID-19 diagnostic tests and vaccination certifications. At the same time, the general public must accept some responsibility. With the global economy in a state of emergency, individuals must exercise their social responsibility by avoiding and reporting any fraudulent COVID-19 tests, vaccines, or treatment to the appropriate authorities. At the same time, public health must also be grounded in ethical virtues (Deguma & Deguma, 2021).

From a different perspective, when quarantine measures are relaxed, different protocols must be followed if one wishes to return to work or travel (Gozum et al., 2021). When quarantine measures are relaxed, there are people who faked COVID-19 diagnostic tests and vaccination certifications. As a result, various individuals' dishonesty impacted virus mitigation. Citizens should be truthful, honest, and transparent in their COVID-19 test declarations (Deguma & Deguma, 2021; Gozum et al., 2021).

Honesty is the quality of being truthful and free of deception, which is necessary for human relationships. This quality is critical for maintaining public health during the COVID-19 pandemic (Wells & Molina, 2017). The government should closely monitor all health facilities to ensure that the protocol for declaring COVID-19 test results and vaccination certification is strictly followed (Sarmiento, Yap, Espinosa, Ignacio, & Caro, 2021). The COVID-19 pandemic has instilled widespread scepticism in the public about the government's ability to conduct nationwide testing, produce reliable and effective vaccines, as well as educate the public on the efficacy and side effects of vaccines. These concerns created fear and distrust, making people hesitant to get vaccinated (Cohen, 2021).

With the government's strong political will to have true, honest, and transparent leadership and governance, the question of the truthfulness, honesty, and transparency of authentic and precise COVID-19 test results and vaccination certifications can be addressed (Kaplan, 2018). Besides that, timely and accurate information pertaining to COVID-19 should also be released by the government. Without a proper channel to retrieve information, the general public will rely on social media where the information is unreliable (Azizul & Kamaruddin, 2021).

Several studies have utilized system dynamics to improve integrity during the COVID-19 pandemic. Currie et al. (2020) developed a system dynamics model to assess the potential contribution of mobile smartphone tracing applications to control COVID-19. Gazzeh et al. (2022) on the other hand sustained the integrity and the impact of flows on urban system dynamics.

SYSTEM DYNAMICS METHODOLOGY

Since the original publication appeared roughly 60 years ago (Relić & Božikov, 2020), the application of system dynamics has substantially increased along with its capability to solve many real-world modelling issues (Richardson, 1996). System dynamics is widely employed in research, across a wide range of industries, businesses, and even public health policy plans. The strength of system dynamics modelling encourages policymakers to utilize system dynamics as an analysis tool to improvise management and devise policies. The application of system dynamics has been generally acknowledged in creating modifications and improvements, particularly in policy making and at the introduction of a new situation.

System dynamics simulation entails creating a model of a system in order to investigate the system that has an impact on the issue being researched. This method simplifies the system in some ways but is sufficiently detailed to allow appropriate inferences on the actual system (Sadiku & Ilyas, 1995). The vast array of real-world systems being represented may include existing or hypothetical systems that may not yet exist. A system is typically modelled using either logic or mathematics. The program is frequently used to mimic the features and operations of the system. With the system

dynamics simulation approach, the operating time is ensured to be at a real rate and access to the evaluation process is provided without the requirement for specialized modelling and mathematical understanding (Ginters et al., 2010).

Ports, agriculture, technology, computers, security, aviation, economics, marketing, and healthcare are a few areas that employed system dynamics as a tool for analysis and strategic planning. These applications demonstrated the effectiveness of system dynamics as a research method. Instead of working directly with the problem, system dynamics provide a safe condition to simulate numerous possibilities before implementing them into the real world. The analyses of the model very much depend on how reliable the model is. Therefore, creating an appropriate model that accurately depicts the real system is crucial in any simulation modelling setting.

In developing models using system dynamics, the construction of a causal loop diagram is a core concept. It is an important element to represent the structure of system feedback (Sterman, 2000). The system's structure determines how the system behaves. By changing the structural connections, the system can be more easily visualized.

Causal Loop Diagram

In system dynamics modelling, the negative or positive feedback process is often represented by a causal loop diagram. A causal loop diagram is a conceptual tool that reveals the concept of a dynamic process where the chain of causes and effects are recognized through related variables and looping to the original cause or effect (Maani & Cavana, 2000). Therefore, it demonstrates the causal relationships between individual system variables and provides an understanding of the root causes of dynamics, improving mental models and is great for delivering important feedback that caused problems (Sterman, 2000). The flexibility to graphically represent the feedback structure of complex systems makes the causal loop diagram a useful tool.

In a causal loop diagram, variables are connected by causal links indicated by arrows. A reinforcing loop or positive correlation means that as the cause increases, so does the effect, and if the cause decreases, the effect will decrease as well. Conversely, a balancing loop or negative connection signifies inverse influence where when the cause increases, the effect decreases, and if the cause decreases, the effect increases.

Figure 1 shows a simple causal loop diagram example between the reinforcing loop and balancing loop of chickens and eggs. Here, the reinforcing loop is depicted with the symbol R where when more eggs are laid, the number of chickens increases. Increasing the number of chickens in turn will produce more eggs. On the other hand, the balancing loop (denoted by the symbol B) will work to balance the chicken population as it grows. For instance, when the number of chickens increases, more of the chicken will seek to cross the road, increasing the likelihood of accidents with moving cars. Fatalities due to road crossings, therefore, reduced the number of chickens. The positive links (plus sign) denote connections where the cause and effect grow together as the cause rises while negative linkages (minus sign) are those in which the effect increases when the cause lowers and decreases when the cause increases.

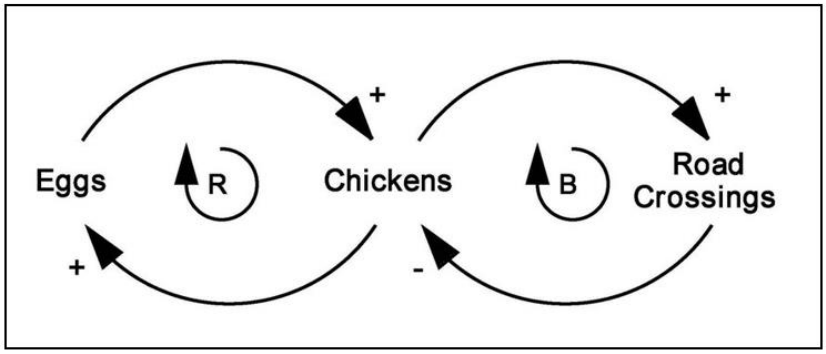

Figure 1. Simple causal loop diagram representing chickens and eggs (Sterman, 2000)

RESULTS AND DISCUSSION

The enforcement of SOPs, movement restrictions, vaccination program, as well as tracking, screening, and testing are strategies administered in Malaysia to break the transmission of COVID-19. The SOPs include donning a face mask in public and updating and scanning the MySejahtera apps as a guideline for businesses and service sectors that are allowed to operate. This SOP is also enforced on those who are doing religious activities, sports, and recreation activities. Movement restrictions are in the form of MCO, CMCO and RMCO lockdown. In the early stage of the pandemic, the Ministry of Health conducted mass tracking, screening, and testing within the community prevalent to COVID-19. By mid of 2021, the COVID-19 self-test kit is made available so that the public can conduct the test themselves.

These preventive measures are depicted in Figure 2 through the development of a causal loop diagram. There are a total of four balancing loops and four reinforcing loops where reinforcing loops are denoted by an R while B represents the balancing loops. Balancing loop B1 describes the tracking, screening, and testing of preventive measures while balancing loops B2 and B4 reveal the dynamics of the implemented movement restriction measures. Balancing loop B3

along with reinforcing loops R4 and R3 present the intricacies of SOPs enforcement in Malaysia. The complexity of all reinforcing and balancing loops will be demonstrated next.

The reinforcing loop R1 explains that an increase in the spread of COVID-19 will escalate the number of people exposed to the virus which in turn will further increase the spread of COVID-19. When the number of people exposed to COVID-19 is higher, the tendency of people to get infected with the disease increases, as depicted in reinforcing loop R2. Balancing loop B1 shows that, by increasing tracking, screening, and testing of the exposed population, the spread of COVID-19 can be reduced.

Balancing loop B2 exhibits in cases where the spread of COVID-19 surged, movement restriction is restored to reduce human mobility, therefore, reducing the spread of COVID-19. This loop can be further extended to balancing loop B3 where decreasing human movement and interaction further reduce SOP violations as the community is contained at home. This will then reduce the outspread of COVID-19. However, reinforcing loop R3 tells the flip side of lockdown where increasing movement restriction inevitably increases pandemic fatigue where people grew tired of adhering to the regulated SOPs, thus increasing SOP violation and in the end contributing to the increase in COVID-19 transmission.

Reinforcing loop R4 portrays a similar situation where tighter movement restriction poses an adverse impact on the economy as many businesses are forced to either operate with minimal capacity or temporarily shut down. The slowdown in economic activities over a period of time will impact people's livelihoods as people lose their job. This is evident through the emergence of the Bendera Putih movement where struggling Malaysian call out for aid. Unstable livelihood increases pandemic fatigue and triggers more SOP violations and contributes to the increase of the spread of COVID-19. Balancing loop B4 illustrates that a prolonged movement restriction further triggers pandemic fatigue. The escalation of pandemic fatigue sparks mental health issues and suicidal cases in the community which increases the pressure to relax movement restrictions.

The developed causal loop diagram also exhibits auxiliary factors that may increase or reduce SOP violations. It is important to understand these variables as adhering to or violating the SOPs influence the spread of COVID-19. Accelerating the national vaccination process increases the number of vaccinated populations. However, vaccinated people tend to violate the SOPs and in turn, spread the virus. There are also groups in a community that are in denial of the threat posed by COVID-19. These COVID-19 sceptics are also prone to bypass the regulated SOPs.

Apart from factors that escalate SOPs violation and the spread of COVID-19, there are also factors that lead the public to adhere to the regulated SOPs. By increasing the community awareness of the need to obey the stipulated SOPs, the number of SOPs violations will be reduced. Providing widely available, accurate, and transparent information through the official governmental website, channels, as well as awareness campaigns, builds trust and understanding among the people. Fines and penalties are also effective in reducing SOP violators. In times when the number of death due to COVID-19 rises, fear and anxiety magnify within the community, therefore, reducing SOP violations. A summary of feedback loops that explained the impact of the implemented COVID-19 preventive measures is illustrated in Table 1.

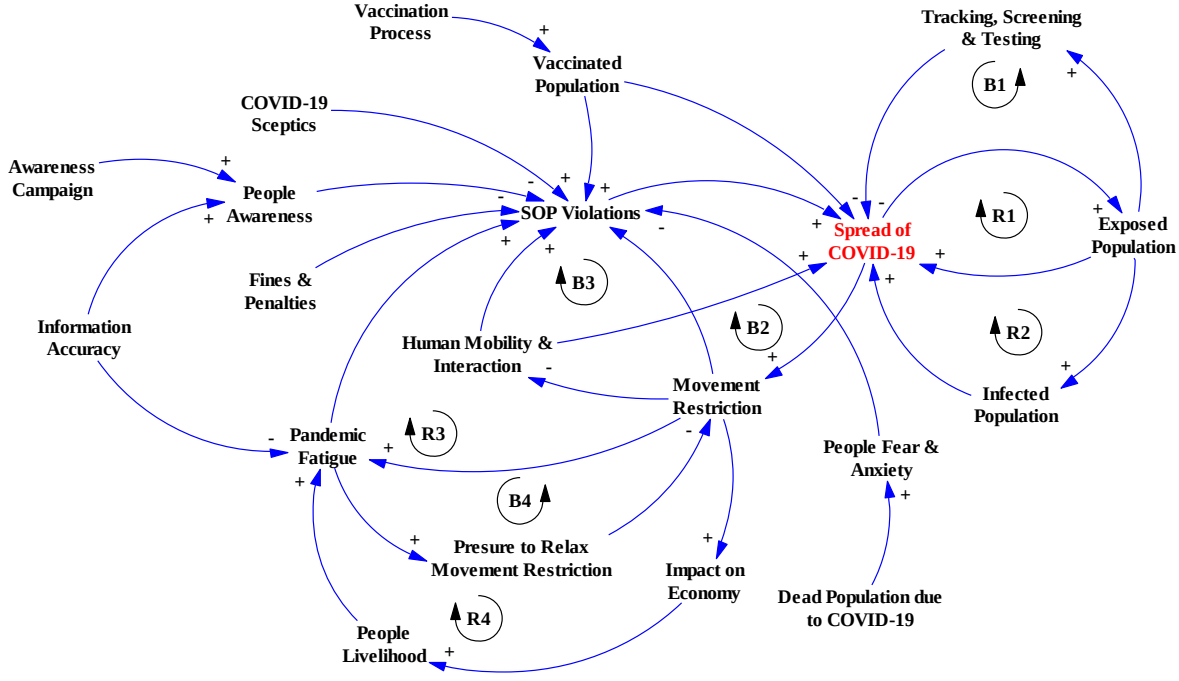

Figure 2. Causal loop diagram of COVID-19 preventive measures implemented in Malaysia

Table 1. Summary of feedback loops representation on COVID-19 preventive measures implemented in Malaysia

Feedback Loop	Representation
R1	Increase Spread of COVID-19 > Increase Exposed Population > Increase Spread of COVID-19
R2	Increase Spread of COVID-19 > Increase Exposed Population > Increase Infected Population > Increase Spread of COVID-19
R3	Increase Spread of COVID-19 > Increase Movement Restriction > Increase Pandemic Fatigue > Increase SOP Violation > Increase Spread of COVID-19
R4	Increase Spread of COVID-19 > Increase Movement Restriction > Increase Impact on the Economy > Increase Impact on People Livelihood > Increase Pandemic Fatigue > Increase SOP Violation > Increase the Spread of COVID-19
B1	Increase Spread of COVID-19 > Increase Exposed Population > Increase Tracking, Screening & Testing > Reduce Spread of COVID-19
B2	Increase Spread of COVID-19 > Increase Movement Restriction > Reduce Human Mobility & Interaction > Reduce Spread of COVID-19
B3	Increase Spread of COVID-19 > Increase Movement Restriction > Reduce Human Mobility & Interaction > Decrease SOP Violation > Reduce Spread of COVID-19
B4	Increase Movement Restriction > Increase Pandemic Fatigue > Increase Pressure to Relax Movement Restriction > Reduce Movement Restriction

The developed causal loop diagram also reveals that a decline in SOP compliance will escalate the spread of COVID-19. Most of the SOP violations are man-made which signifies that the community is largely oblivious to the fact that the battle against COVID-19 could not be won by only relying on the preventive measures implemented by the government. There are incidents where people who are not vaccinated opt to buy fake vaccination certificates to avoid restrictions imposed on the unvaccinated. Other examples of lacking integrity within the community are reporting ungenuine information to the MySejahtera apps, hiding the fact of being infected by COVID-19, resisting to participate in mass testing and self-administrated test, failing to practice social distancing and putting the mask on in public, avoiding quarantine, and running away from the quarantine centre. These actions put others and even the entire nation at risk of escalation in the COVID-19 outbreak.

As mentioned by Salleh and Heidecke (2019), human governance is understanding the aspects of being human in regards to the "what", the "who" and the "why". The "who" and "why" are essential to reflect upon our role within the community, why we do what we do and what are the consequences of our actions. Therefore, the community plays a huge role in sharing the responsibility of breaking the COVID-19 chain. Instead of adhering to the SOPs for the fear of fines, public integrity and human governance in the form of the awareness to adherence should be for the collective good.

Turi et al. (2018) quoted the disaster management cycle theory where the framework consists of mitigation, preparedness, response, and recovery. This is in line with Malaysia as the nation is moving towards the recovery phase where the economy and community are returning to normalcy. With that being said, the government ought to devise policies in accordance with the recovery phase to bring back the affected community to normal life, which is post-COVID-19.

CONCLUSION

Although much of the SOPs are relaxed since Malaysia entered into the transition to the endemic phase on 1 April 2022, the threat of a more deadly and transmissible version of COVID-19 is still prevalent. The emergence of new COVID-19 variants will exacerbate the spread within the community with the alarming number of death without effective COVID-19 preventive measures. The developed causal loop diagram demonstrates the interaction of currently and previously implemented COVID-19 preventive strategies in Malaysia. Interdependencies and interrelationships among strategies such as SOPs regulation, movement restriction, vaccination programs, and mass tracking and testing provide a clear visualization of how these countermeasures collided and ultimately served to reduce or increase the spread of COVID-19 within society.

Understanding this push and pull relationship is important to recognize if these implemented preventive measures are capable to prevent the spread of COVID-19 in long run. It is evident that previously implemented countermeasures such as lockdown in the form of movement restrictions are no longer efficacious in containing the virus as long-term confinement has an adverse impact on the nation's economy and the community's livelihood. The emergence of pandemic fatigue due to prolong movement restriction and strict SOPs regulation are also revealed in the finding of this study. Pandemic fatigue triggers more SOPs violations and in turn escalates the spread of COVID-19. Movement restriction or MCO has proven to be a costly measure to control the spread of COVID-19.

Now more than ever, rather than depending on government intervention, the responsibility should also be shared by the community. In long run, public integrity through community solidarity and individuals' responsibilities will be more effective in shielding the community from the threat of new COVID-19 variants. For future research, the causal loop

diagram can be expanded to include countermeasures implemented once the spread of COVID-19 penetrated the community along with the implication to the healthcare system.

ACKNOWLEDGEMENT

The authors would like to thank Sustainable Research Collaboration Grant funded by IIUM, UMP & UiTM under RDU200728 for supporting this project.

REFERENCES

Anand, R. (2021). PM Muhyiddin receives first Covid-19 vaccine as Malaysia kicks off mass inoculation campaign. *New Straits Times*. https://www.straitstimes.com/asia/se-asia/pm-muhyiddin-receives-first-covid-19-vaccine-as-malaysia-kicks-off-mass-inoculation

Ayodele, F. O., Cheng, E. H., Haron, H., & Dabor, E. L. (2020). Are Ethical Issues Becoming Prevalent Among Business Management Researchers?. *Journal of Governance and Integrity*, 3(2). https://doi.org/10.15282/jgi.3.2.2020.5305

Azar, A.T. (2012). System dynamics as a useful technique for complex systems. *International Journal of Industrial and Systems Engineering*. Inderscience Enterprises Ltd. 10(4), 377-410.

Aziz, N. A., Othman, J., Lugova, H., & Suleiman, A. (2020). Malaysia's approach in handling COVID-19 onslaught: Report on the Movement Control Order (MCO) and targeted screening to reduce community infection rate and impact on public health and economy. *Journal of Infection and Public Health*, Vol. 13, Issue 12, 1823-1829.

Azizul, F. B., & Kamaruddin, D. B. (2021). An Empirical View of Business Ethics on Press Freedom: A Case Study. *Journal of Governance and Integrity*, 4(2), 125–134. https://doi.org/10.15282/jgi.4.2.2021.5865

Bernama. (2021). Covid-19 Watch: Over 22.8mil of the adult population in Malaysia fully vaccinated. *The Star*. https://www.thestar.com.my/news/nation/2021/12/31/covid-19-watch-over-228mil-of-the-adult-population-in-malaysia-fully-vaccinated

Bradley, D. T., Mansouria, M. A., Kee,F. & Garcia, L. M. T. (2020). *A systems approach to preventing and responding to COVID-19*. EClinicalMedicine. Elsevier Ltd. 21. DOI: https://doi.org/10.1016/j.eclinm.2020.100325

Cheng, J.K. (2010). A System Dynamics Simulation Approach to Container Terminal Planning. *Unpublished doctoral dissertation*, University Utara Malaysia, Kedah, Malaysia.

Cohen S. (2021) The 4 core values of cultivating a culture of transparency. LinkedIn. https://www.linkedin.com/pulse/20140810034128-21107679-the-4-core-values-of-cultivating-a-culture-of-transparency

Currie DJ, Peng CQ, Lyle DM, Jameson BA, Frommer MS (2020). Stemming the fow: how much can the Australian smartphone app help to control COVID-19?. *Public Health Research & Practice*, 30(2):e3022009. https://doi.org/10.17061/phrp3022009

Deguma, M. C., & Deguma, J. J. (2021). The possible threat of faking Covid-19 diagnostic tests and vaccination certifications: a call to an immediate action. *Journal of Public Health*, 43(2), e340-e341.

Gazzeh, K., Abubakar, I. R., & Hammad, E. (2022). Impacts of COVID-19 Pandemic on the Global Flows of People and Goods: Implications on the Dynamics of Urban Systems. *Land*, 11(3), 429.

Ginters, E., Barkane, Z., & Vincent, H. (2010). System Dynamics Use for Technologies Assessment. *The 22th European Modeling and Simulation Symposium (EMSS 2010)*, 8(EMSS), 357–361.

Gozum, I. E. A., Carreon, A. D., & Manansala, M. M. (2021). Emphasizing truthfulness in COVID-19 test declarations. *Journal of Public Health*, 43(2), e387-e388.

Han & Abu Bakar (2022). MoH to impose fines of up to $5,000 for not reporting positive antigen tests. *The Scoop*.

Harun, H. N. (2022). Malaysia entering new Covid-19 wave as Omicron BA.5 variant hits. *New Straits Times*. https://www.nst.com.my/news/nation/2022/07/811841/malaysia-entering-new-covid-19-wave-omicron-ba5-variant-hits-nsttv

Holden, Richard (2022). Vital Signs. The 3 problems with fines for not reporting positive COVID tests. The Conversation.

Kaplan GS. (2018). Building a culture of transparency health care. *Harvard Business Review*, 1–5. http://www.medtronic.me/content/dam/medtroniccom/global/Corporate/Initiatives/harvard-business-review/downloads/healthcare-insights/build-culture-transparency-healthcare_article_hbr_corpmark.pdf (5 March 2021, date last accessed).

Lee, E., Chen, Y. Y., McDonald, M. & O'Neill, E. (2020). Dynamic Response Systems of Healthcare Mask Production to COVID-19: A Case Study of Korea. *Systems*, 8 (2), 18. DOI: https://doi.org/10.3390/systems8020018

Maani, K. E., & Cavana, R. Y. (2000). System thinking and Modelling. Perason Education New Zealand Limited.

Moni, A. S. B., Abdullah, S., Abdullah, M. F. I. L. Bin, Kabir, M. S., Alif, S. M., Sultana, F., Salehin, M., Islam, S. M. S., Cross, W., & Rahman, M. A. (2021). Psychological distress, fear and coping among Malaysians during the COVID-19 pandemic. *PLoS ONE*, *16*, 1–21. https://doi.org/10.1371/journal.pone.0257304

Niwa, M.,Hara, Y., Sengoku, S. & Kodama, K. (2020). Effectiveness of Social Measures against COVID-19 Outbreaks in Selected Japanese Regions Analyzed by System Dynamic Modeling. I*nternational Journal of Environmental Research and Public Health*, 17(17), 6238, DOI: https://doi.org/10.3390/ijerph17176238

Povera, A., & Harun, H. N. (2020). MCO Phase 4 from April 29 to May 12. *New Straits Time*, *May*, 28–30. https://www.nst.com.my/news/nation/2020/04/586998/mco-phase-4-april-29-may-12

Price, C.C. & Propp, A. M. (2020). A Framework for Assessing Models of the COVID-19 Pandemic to Inform Policymaking in Virginia. *RAND Corporation*. DOI: https://doi.org/10.7249/RRA323-1

Relić, D., & Božikov, J. (2020). Application of a system dynamics model in forecasting the supply and age distribution of physicians. *Croatian Medical Journal*, *61*(2), 100–106. https://doi.org/10.3325/cmj.2020.61.100

Richardson, G. P. (1996). Problems for the Future of System Dynamics. *System Dynamics Review*, *12*(2), 141–157. https://doi.org/10.1002/(SICI)1099-1727(199622)12:2<141::AID-SDR101>3.0.CO;2-O

Sadiku, M. N. O., & Ilyas, M. (1995). *Simulation of Local Area Network*. CRC Press, Inc.

Sajari, A., Haron, H., & Ismail, I. (2019). Effectiveness of quality of chief integrity officer, ethical climate on the level of ethics and integrity in the Malaysian Federal. *Journal of Governance and Integrity*, *3*(1), 50–68. https://doi.org/10.15282/jgi.3.1.2019.5422

Salleh, A., & Matsham Heidecke, A. (2019). Insights: governance, integrity and corruption: a commentary from the perspective of human governance. *Journal of Governance and Integrity*, 2(2), 1–2. https://doi.org/10.15282/jgi.2.2.2019.5462

Salim, N., Chan, W. H., Mansor, S., Bazin, N. E. N., Amaran, S., Faudzi, A. A. M., Zainal, A., Huspi, S. H., Hooi, E. K. J., & Shithil, S. M. (2020). COVID-19 epidemic in Malaysia: Impact of lockdown on infection dynamics. *MedRxiv*, 1–27. https://doi.org/10.1101/2020.04.08.20057463

Sarmiento, P. J. D., Yap, J. F. C., Espinosa, K. A. G., Ignacio, R. P., & Caro, C. A. (2021). The truth must prevail: citizens' rights to know the truth during the era of COVID-19. *Journal of Public Health*, 43(2), e275-e276.

Shah, A. U. M., Safri, S. N. A., Thevadas, R., Noordin, N. K., Rahman, A. 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. https://doi.org/10.1016/j.ijid.2020.05.093

Shang, Y., Li, H., & Zhang, R. (2021). Effects of Pandemic Outbreak on Economies: Evidence From Business History Context. *Frontiers in Public Health*, *9*, 1–12. https://doi.org/10.3389/fpubh.2021.632043

Sihombing, L. B.; Malczynski, L., Jacobson, J., Soeparto, H. G. & Saptodewo, D. T. (2020). An analysis of the spread of COVID-19 and its effects on Indonesia's Economy: A dynamic simulation estimation. Available at SSRN: https://ssrn.com/abstract=3597004 or DOI: http://dx.doi.org/10.2139/ssrn.3597004

Sterman, J. D. (2000). *Business dynamics: System thinking and modeling for a complex world*. McGraw-Hill Companies.

Sy, C., Bernardo, E., Miguel, A., Juan, J. L. S., Mayol, A. P., Ching, P. M, Culaba, A., Ubando, A. & Mutuc, J. E. (2020). Policy development for pandemic response using system dynamics: A case study on COVID-19. *Process Integration and Optimization for Sustainability*, 4, 497–501. DOI: https://doi.org/10.1007/s41660-020-00130-x

Wells, C.R., Townsend, J.P., Pandey, A. (2021). Optimal COVID-19 quarantine and testing strategies. *Nature Communications*, (12), 356. https://doi.org/10.1038/s41467-020-20742-8

Wells, D. D. &Molina, A. D. (2017). The truth about honesty. *Journal of Public and Nonprofit Affairs*, 3(3):292–308.

WHO. (2020). Retrieved July 6, 2020 from https://covid19.who.int/

Turi, J. A., Basheer, H., Sorooshian, S., & Shaikh, S. (2018). Civil society strategies and projects in flood hit area: a case of pakistan flood affected areas. *Journal of Governance and Integrity*, 2(1), 49–58. https://doi.org/10.15282/jgi.2.1.2018.5538

Venkateswaran, J. & Damani, O. (2020). *Effectiveness of Testing, Tracing, Social Distancing and hygiene in tackling Covid-19 in India: A system dynamics model*. Cornell University. DOI: https://arxiv.org/abs/2004.08859v1

Zhao, J., Jia, J., Qian, Y., Zhong, L., Wang, J. & Cai, Y. (2020). COVID-19 in Shanghai: IPC Policy Exploration in Support of Work Resumption Through System Dynamics Modeling. *Risk Management and Health Care Policy*, 13, 1951-1963. DOI: https://doi.org/10.2147/RMHP.S265992

CONFLICT OF INTEREST

The author(s), as noted, certify that they have NO affiliations with or involvement in any organisation or agency with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, jobs, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, expertise or beliefs) in the subject matter or materials addressed in this manuscript.

AUTHORS' BIOGRAPHY

Author's Full Name: Jack Kie Cheng
Author's Email: jackkie@ump.edu.my
Author Professional Bio:
Jack Kie Cheng received her PhD and Bachelor Degree in Decision Sciences from Universiti Utara Malaysia. She is currently an Associate Professor at Universiti Malaysia Pahang. Prior to joining University Malaysia Pahang, she was a Research Associate in Kantar TNS Malaysia, where she worked on employee engagement and customer satisfaction market study for numerous industries. Now with the Faculty of Industrial Management, she taught courses such as Computer Modelling and Simulation, Operations Research, Managerial Decision Modelling, Project Management and

Strategic Management. Her area of research interest includes Systems Thinking, System Dynamics, Discrete Event Simulation and Operations Research, Logistics and Supply Chain Management.

Author's Full Name: Puteri Fadzline Muhamad Tamyez
Author's Email: fadzline@ump.edu.my
Author Professional Bio:
Puteri Fadzline Muhamad Tamyez is currently an Associate Professor in the Faculty of Industrial Management, Universiti Malaysia Pahang. She graduated from Universiti Technology MARA, Shah Alam, with a PhD in Business Management and from Universiti Sains Malaysia, Penang with BSc and MSc degrees in Bioresources, Paper and Coating Technology under the School of Industrial Technology. Prior to Universiti Malaysia Pahang, she had accumulated industrial experiences in the furniture and wood flooring industry for 4 years. At both companies, she is responsible for matters related to Quality Control and Production processes. Her research interests are Innovation Management and Product Management.

Author's Full Name: Fazeeda Mohamad
Author's Email: fazeedamohamad@ump.edu.my
Author Professional Bio:
Fazeeda Mohamad is currently a fulltime senior lecturer at the Faculty of Industrial Management, Universiti Malaysia Pahang. She holds a PhD in Technology Management from Universiti Malaysia Pahang, a Master Degree in Technical and Vocational Education from Universiti Tun Hussein Onn Malaysia and a Bachelor Degree in International Business from Universiti Teknologi MARA. Academically, she has taught courses under business management and logistics and supply chain management. In research, she has interest in Business Performance, Data Envelopment Analysis, Discrete Event Simulation and System Dynamics.

Author's Full Name: Zetty Ain Binti Kamaruzzaman
Author's Email: zetty@ump.edu.my

Author Professional Bio:
Zetty Ain Kamaruzzaman is currently a Head of Programme (Bachelor of Business Analytics with Honours) and Senior Lecturer at Faculty of Industrial Management, Universiti Malaysia Pahang. She holds a Doctor of Philosophy (Statistics) from Universiti Kebangsaan Malaysia, Master of Science (Statistics) from Universiti Sains Malaysia and Bachelor of Science with Hons. (Statistics) from Universiti Kebangsaan Malaysia. She has been teaching for more than three years and has five years of experience in construction industry. Her research interests include Statistics, Quantitative Finance and Business Analytics.

Author's Full Name: Faridah Binti Zulkipli
Author's Email: faridah7368@uitm.edu.my
Author Professional Bio:
Faridah Zulkipli is currently a Senior Lecturer at Faculty of Computer and Mathematical Sciences Universiti Teknologi MARA Perak Branch, Tapah Campus. She holds a Master of Science (Decision Science) and Bachelor of Science with Hons. (Decision Science) from Universiti Utara Malaysia. She has been teaching for more than thirteen years. Her research interests include Operations Research, Statistics and Quantitative Analysis.

Author's Full Name: Maizura Binti Mohd Zainudin
Author's Email: zmaizura@iium.edu.my
Author Professional Bio:
Maizura Mohd Zainudin is currently a Senior Lecturer at Kulliyyah of Medicine, International Islamic University Malaysia. She holds a Doctor of Philosophy (Medical Physiology) from Universiti Kebangsaan Malaysia and Bachelor of Medicine and Bachelor of Surgery, Bachelor's degree from International Islamic University Malaysia. Dr. Maizura started housemanship training at Hospital Tengku Ampuan Rahimah Klang in 2006. In 2008, she served Klinik Kesihatan Maran as a medical officer. Her research interests are cardiovascular diseases and women's health.