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Healthcare Supply Chain System Challenges and Mitigation Measures: A Systematic Review of Qualitative Evidence

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ABSTRACT

This paper aims to examine the current challenges faced by Malaysian hospitals during the post-COVID-19 pandemic. This paper employs a subjective environmental scanning approach and a review of the current literature and outlines the challenges as well as proposed mitigation measures to address these concerns. Based on a review and analysis of the literature, the key challenges that the Malaysian healthcare system is struggling with include misinformation and disinformation, high hospital bed occupancy, ICU management crisis, acute shortage of healthcare professionals, treatment delays among non-COVID patients, personal protective equipment (PPE) shortage, occupational burnout, and mental health issues among healthcare professionals, blood supply management issues, challenges concerning treatment, and the challenges concerning vaccination. Several mitigation measures have been proposed as a solution. This research draws the attention of hospital management and policymakers to the issues they confront during the post-COVID-19 pandemic so that suitable solutions may be developed to address them. Findings and suggested mitigation measures can add considerable value to current academic work, and deepen knowledge along with the development of a successful healthcare supply chain system. This study is among a few of its kind that offers mitigation measures for diversifying the healthcare business by venturing into the supply chain system.

Keywords: *challenges, healthcare system, mitigation measures, post-COVID-19*

1. INTRODUCTION

Supply Chain Management (SCM) is the managerial process of managing the flow of goods and services from the point of origin to the point of consumption, which involves several practices of strategic sourcing, demand forecasting, inventory management, transportation management, etc. Numerous organizations have adopted a widespread practice of SCM (Kadeer & Samad, 2022). In the current state, particularly after COVID-19 entered the scene, the healthcare sector has faced issues with rising expenses (Kaye *et al.*, 2021). To deal with the ongoing changes in their nature, context, and requirements, both scholars and practitioners have been concentrating more on diverse supply chain practices for SCM (Silva *et al.*, 2022). To reflect the performance in healthcare environments, a thorough review of its challenges and proposing the mitigation measures required. Omar *et al.* (2021) claim that the literature demonstrates a fragmented interest in supply chains in healthcare. SCM practices give the healthcare system the ability to strategically manage and continually control the intended objectives since they are an essential management tool and the path to success. By increasing product availability and reducing order cycle time, effective SCM can minimize the overall resources needed to offer the essential level of customer service and improve it while also lowering costs (Bahar *et al.*, 2021). As SCM involves coordination and collaboration with various stakeholders, which includes suppliers, intermediaries, service providers, and customers, its relative importance is increasing. In many ways, healthcare supply chains are distinctive from standard industrial supply chains. It is a complicated system that needs a constant flow of products and services to meet the demands of people who provide care for patients (Afshan & Sindhuja, 2015).

In December 2019, an emerging public health hazard was progressively uncovered ensuing in an early report of atypical pneumonia cases in Wuhan, China (Chan *et al.*, 2020). It was produced by severe acute respiratory syndrome coronavirus 2 SARS-CoV-2, which eventually spread from Wuhan to other parts of China and then to

almost every country in the world (Del Rio & Malani, 2020). On March 11, 2020, the World Health Organization (WHO) announced COVID-19 as a pandemic making it a public health emergency of international concern (WHO, 2020a). As of May 2023, the outbreak of COVID-19 had been confirmed in almost every country in the world. Over 687 million people have been infected by the virus worldwide, and there had been nearly 6.87 million fatalities. The United States, India, and Brazil are the country's most badly impacted (WHO, 2023). In Malaysia, the first case of COVID-19 was reported on January 25, 2020. Since then, the number of COVID-19 cases has increased significantly. Malaysia has also become one of the greatest numbers of positive cases among Southeast Asian countries. During the post-COVID-19 situation, Malaysia reported an average of 3,000 cases daily (MOH, 2022a)

Since it was first reported, the number of COVID-19 positive cases has grown. Concerns about the healthcare system's capacity to respond to patients' needs continue mounting especially for individuals who could require intensive care (Md Hamzah *et al.*, 2021). To deal with this issue, the Malaysian Ministry of Health (MOH) launched the National Crisis Preparedness and Response Centre (CPRC) on January 5, 2020, even before the WHO declared the virus an international health crisis (NST, 2020). At present, Malaysia has 135 government hospitals, nine special medical institutes, 210 private hospitals, and 61,158 doctors. Furthermore, the MOH has hired 830 additional nurses under a two-year agreement to serve in government hospitals around the nation to help with COVID-19 and it continues to serve during the post-COVID-19 pandemic. Moreover, to ensure well-equipped intensive care management, the MOH made accessible 926 ventilators in ICUs, 152 non-invasive ventilators, and 142 transport ventilators. Besides, 40 institutions with a total of 6,917 beds were prepared to treat COVID-19 patients, with 410 ICU beds and 634 ventilators readily accessible to the MOH. Additionally, MOH also placed an order for 800 additional medical ventilators to treat critical COVID-19 patients (Zainul, 2020) and the facilities are promising enough to cater for the post-COVID-19 situation.

Moreover, the MOH has always tried to be translucent to the public regarding its management approaches. Consequently, on March 1, 2020, MOH created an alliance with 38 professional medical societies to keep Malaysian citizens informed and provide correct information about the current COVID-19 situation (MHC, 2020). MOH is providing this information by using three key platforms including the MOH's official portal, a Crisis Preparedness and Response Centre (CRPC) and the Ministry of Health Malaysia (MOH) Facebook page and Telegram. Aside from the MOH, media, NGOs, and public institutions are altruistically contributing to the fight against this pandemic (Shah *et al.*, 2020).

This COVID-19 pandemic caused a disruption in supply chains all over the world. Govindan *et al.* (2020) supported that due to COVID-19, supply chain practices suffered across the globe. Bonadio *et al.* (2021) investigated the global supply chains of 64 countries in 33 economic sectors to grasp the impact of this recent pandemic and its economic impact on business and on the economy. They found a few pieces of findings such as domestic inputs due to lockdowns, less importance of foreign inputs, less resilience to pandemic-style labor supply, cost increase, reduction of efficiency, and limited access to new markets and technologies. As organizations strive to increase customer satisfaction while cutting costs, improving the healthcare supply chain system becomes more and more crucial. According to Mehralian *et al.* (2015), the improvement of the healthcare supply chain system will be aided by the optimization of efficient coordination and integration amongst all the supply chain stakeholders.

For a better healthcare supply chain system, Iacobucci (2020) examined the significance of the aspects of doctors' satisfaction and supply chain inputs. Furthermore, according to Baldauf *et al.* (2021) controlling the performance of healthcare services involves a combination of outcome-, structure-, and process-based essential success criteria. The performance of the healthcare supply chain system can be improved by elements such as standardized medicine coding, operational re-engineering, and information technology implementation (Afshan & Sindhuja, 2015). In addition, Finkenstadt and Handfield (2021) argued that the JIT mindset applied to hospitals leads to lower inventory costs and enhanced supply chain performance. Researchers discovered the need for more research in this area despite the abundance of literature on the various methods for measuring the healthcare supply chain system because the measurement of the healthcare supply chain system in the healthcare business lacks clarity and competence. Hence, this research aims to close this gap by identifying mitigation measures for the healthcare supply chain system challenges during post-COVID-19 in the context of the Malaysian healthcare industry. This current study proceeds by reviewing literature in the following section: the latter includes methodology and results. The discussion and conclusion sections are presented at the end of the manuscript.

2. LITERATURE REVIEW

Although multiple studies have been conducted on the efficiency of the Malaysian health system (Md Hamzah *et al.*, 2021), government initiatives (Shah *et al.*, 2020), and challenges to orthopaedic practice (Tay *et al.*, 2020), few studies have been undertaken on the challenges that the Malaysian healthcare system confronts. Furthermore, none of them provides a comprehensive overview, information concerning ongoing challenges, or mitigation measures to encounter these challenges. Therefore, this paper aims to provide a comprehensive review of the current challenges confronted by the Malaysian healthcare system as well as explore possible ongoing challenges and ways to overcome them. By evaluating these challenges, healthcare institutions and policymakers may take appropriate actions to strengthen the country's readiness and responsiveness. The primary aim of this paper is to evaluate the current challenges that the Malaysian healthcare system is facing during the COVID-19 and post-COVID-19 pandemic and propose a mitigation measure to handle it. This paper will also look at the challenges that the healthcare system might encounter in the future.

According to the weekly epidemiological update by WHO, the number of new COVID-19 cases and fatalities continues to climb due to numerous variants including

alpha, beta, gamma, delta, omicron and deltacron. There were over 549 million cases with nearly 1 million new cases daily and 6.34 million fatalities were recorded globally. Despite repeated attempts across the area, such as new regulations, factory closures, and vaccination programs, a substantial increase in COVID-19 infections from alpha variations has been recorded in regions of Southeast Asia. Till July 2022, India was the Asia country reported with the largest number of 43.5 million cases (WHO, 2023). Meanwhile, Malaysia has a total case of 4.58 million. This outbreak's frightening expansion and deadly variants underline the critical need for a stronger collective response to prevent massive mass deaths.

According to the country's weekly report by WHO, Malaysia confirmed nearly 3,000 new COVID-19 cases with 3 deaths on 5th July 2022. There were more than 4.58 million confirmed cases as of 5th July 2022. It includes 2,932 new cases. The country is currently in the phase of large-scale community transmission. The growth of new COVID-19 cases was observed in every state and territory. Moreover, the number of critically ill patients needing intensive care units (ICU) and ventilator support has also surged. COVID-19 sufferers have swamped both public and private healthcare institutions. During the early days, many hospitals were compelled to utilize refrigerated containers as temporary morgues, while car parks were used as makeshift quarantine centres for people with lesser symptoms. As a result, the healthcare system is informed to be overwhelmed, particularly in places that have been particularly hard hit. In response to a spike in the volume of patients, an exhausted healthcare system, and the introduction of more virulent COVID-19 virus strains with increased infectivity, the Prime Minister of Malaysia has declared a state-wide 14-day lockdown from June 1 to 14, 2021 (Teoh, 2021). At the current moment, too many negative effects of COVID-19 and one of them is that Malaysian are worried about inflation in the post-COVID-19 situation. Thus, it is imperative to ensure the current challenges faced particularly by Malaysian hospitals during the post-COVID-19 pandemic can be resolved so that it may help to reduce the medical personnel as well as citizen burden (Morden, 2022).

3. METHODOLOGY

Gathering and comprehending information that is pertinent to the industry is what is meant by ‘scanning’ or ‘analysing’ the business environment (David & David, 2017). Businesses can anticipate issues and opportunities that may have an impact on a business ecosystem through environmental scanning (Borges & Janissek-Muniz, 2018).

The study adopts an environmental scanning approach to better comprehend Malaysia's healthcare supply chain system considering the paucity of Malaysia-specific research. To make better decisions, environmental scanning entails analysing and utilising data about events, patterns, trends, opportunities, and potential threats. An organisation might examine the effects of various market trends, challenges, and expectations on its strategic management process by monitoring the environment through environmental scanning (Ab Talib & Wahab, 2021). Therefore, this study conducts a direct introspective observation of Malaysia's healthcare supply chain landscape to fulfil the targeted research purpose. Although observational research is unpopular in supply chain studies (Sachan & Datta, 2005), there is a growing trend to adopt the observation approach since the results may be more detailed, significant, and richer (Pålsson, 2007).

This study analysis technique employs an extensive review of the current literature. To ensure the reliability, authenticity, and conciseness of the information, several well-known scholarly databases including ScienceDirect, Springer Link, Sage Pub, Emerald, Lancet, PubMed, MDPI, and Google Scholar were utilized for data collection. To evaluate and obtain articles relating to the concerning issue, the funnelling technique was utilized. The previously published studies from the onset of the post-COVID-19 outbreak were searched based on the following search string: Challenges “post-COVID-19” OR Malaysian Healthcare System “post-COVID-19” OR Pandemic “post-COVID-19” OR Mitigation Measures “post-COVID-19”.

To identify the most appropriate articles, a three-stage screening procedure was implemented. Initially, this study used a systematic analysis of post-COVID-19 associated Malaysian healthcare system concerns and related mitigation methods research to combine and analyse data from prior literature published between 2016 and 2022. To identify the post-COVID-19-associated healthcare system problems, articles published between 2019 and 2022 were chosen for systemic review. To ensure that all articles related to post-COVID-19 are included, this study performed a citation chain for additional studies for each retrieved article. The primary reason for picking this time is to collect data and information on the present situation, anticipating that most published articles in this field have risen (Moher *et al.*, 2015; Ramish *et al.*, 2022). Previous research within the last five years is thought to give greater insight than research from previous years.

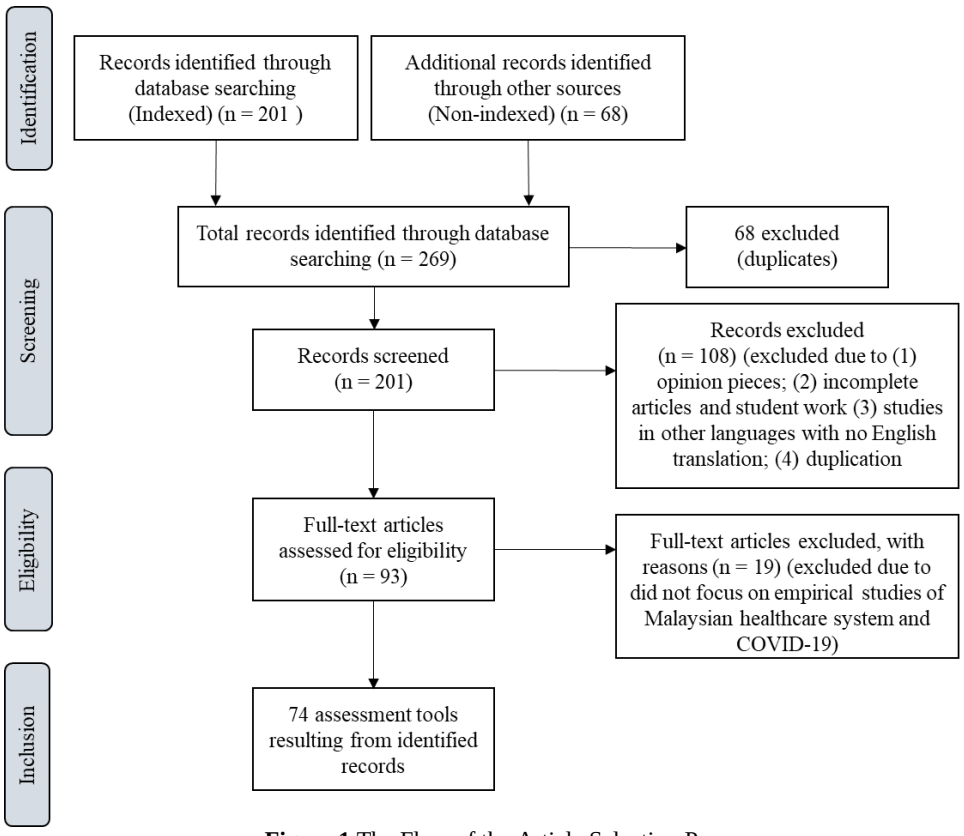

Figure 1 The Flow of the Article Selection Process
Source: Moher *et al.* (2015)

As shown in **Figure 1**, a total of 269 papers were chosen after careful evaluation of the abstracts. Articles were segregated based on certain inclusion criteria. The search was limited to Peer-Reviewed Journal Articles published in English to ensure the quality of the article published is more controlled in terms of scholarly qualities and high publication standards (Moher *et al.*, 2015). The screening process was done by several steps, namely, including and excluding literature from different databases (according to selection criteria), and removal of duplicate literature (similar articles found in different databases). The search was done individually by each author. Next, the result of the search was combined to confirm of articles to be screened. The first screening step resulted in a number of 269 included literature and 68 literatures excluded based on the selection criteria has not been met. Meanwhile, 108 pieces of duplicated literature have been removed in the second screening step. Throughout the screening process, the literature review yielded 93 useful pieces of literature ranging from journal articles to various reports (WHO, Centers for Disease Control and Prevention, MOH and newspapers). These articles were double screened based on the exclusion criteria. Opinion pieces, incomplete articles, studies in other languages with no English translation, and duplicates were eliminated. At the end of the process, 19 papers were excluded, and 74 articles were reviewed.

4. RESULTS

4.1 Characterization of the Publications Found

4.1.1 Misinformation and Disinformation

The issue of misinformation and disinformation is one of the prominent challenges that the healthcare system had to deal with. The outbreak was preceded by a bombardment of false and misleading information regarding the virus, its mode of transmission, prevention, and containment, notably on social media (van der Linden *et al.*, 2020). Even the WHO has cautioned about the enduring 'infodemic', or an overabundance of information leading to the prevalence of misleading facts about the virus (WHO, 2020b). According to Gupta *et al.* (2022), a flood of post-COVID-19 fake news resulted in untrustworthy information sharing among citizens. Thus, it was a challenging task for health professionals to develop effective methods to educate and prepare the public against the disease's novelty and obscurity (Farr *et al.*, 2021). Furthermore, cultural differences can lead to misinformation and disinformation between patients and medical professionals. Understanding a person's medical requirements and how to communicate with them can be greatly improved by being aware of how culture might affect a person's notions of health and medicine (Correa *et al.*, 2020; Guzman-Holst *et al.*, 2020).

4.1.2 High Hospital Bed Occupancy

From different statements made by Malaysian Health Minister, Khairy Jamaluddin, it became evident that most of the government hospitals in Malaysia are overburdened with high-risk mild COVID-19 patients as a solution to prevent deaths (CodeBlue, 2022). With the recent resurgence of post-COVID-19 cases, bed occupancy in hospitals across the country increased to 63.4% (Salim, 2022). At the current stage, the number of COVID-19 patient admissions in public hospitals per 100,000 population increased by 4% in June 2020. It makes the percentage of hospital bed occupancy of COVID-19 increase with non-critical bed occupancy increased by 1%.

Meanwhile, the number of patients who need breathing aids increased by 40.2%. Furthermore, the COVID-19 assessment centre (CAC) also showed an increase of 22.1%, nationwide. Among that, the number of patients undergoing home monitoring increased by 37.6% and the number of COVID-19 cases referred to hospitals increased by 11.4% (Sulaiman, 2022).

4.1.3 ICU Management Crisis

With an average of 3,000 new cases daily, the number of critically ill patients has risen to new heights after the first post-COVID-19 was announced. The current percentage of ICU utilisation is 63% in Johor and 50% in Kuala Lumpur and if no precautions are taken place, it is not impossible that it will increase (CodeBlue, 2022). As of June 2022, ICU bed occupancy has increased by 2% (Sulaiman, 2022). According to a recent announcement made by the Malaysian Health Minister, a new wave of COVID-19 infections may be earlier than expected. He stressed that the new cases also increased with two new clusters namely education and higher education clusters. With the newly identified clusters, most of the states showed an increase in cases. He added, that in the development of the smallpox virus, the citizen is reminded to be more sensitive in handling COVID-19 and try to live with it (Hamzah, 2022).

4.1.4 Shortage of Healthcare Professionals

During the early stage of COVID-19, Malaysia's public health system is continuously struggling with a shortage of healthcare professionals (doctors and nurses). The doctor-to-population ratio is 1:656, which is below the aim of 1:400 (Ahmad, 2019). It became worsened in cases when healthcare personnel have contaminated with COVID-19 and had their responsibilities halted (CDCP, 2021a). The same situation might be recurrent if the number of COVID-19 cases increases due to the new clusters announced by the MOH. It is well known that nurses are the backbone of the healthcare system. They spend more time with patients than doctors do in hospitals, and they are crucial to keeping an eye on the well-being of the individuals they are caring for. However, in the current condition, Malaysia faces a shortage of nurses because most of the nurses are being assigned to multiple tasks with considerably low salaries and their contribution is unacknowledged (Gan, 2022).

4.1.5 Non-COVID-19 Patients' Treatment Delay

As COVID-19 is transmitted mainly through respiratory secretions, healthcare workers who deal with patients of the aerodigestive tract are among the most vulnerable to infection. These include dentists, otolaryngologists, head and neck surgeons, gastroenterologists, pulmonologists, respiratory therapists, speech therapists, infectious disease physicians or ophthalmologists, and doctors of screening and critical care units (Abdullah *et al.*, 2020; Lai *et al.*, 2020). Furthermore, as the number of COVID-19 patients grows, hospital bed shortages have emerged as a major concern (Ayamany, 2021). Therefore, to avoid transmission and provide additional bed support to COVID patients, many non-urgent procedures and general and non-emergency surgeries have been cancelled or postponed in several hospitals (CSO, 2020). These circumstances not only generate uncertainties and delays in the treatment of non-COVID patients but also indicates that a significant backlog of patients may grow in the future, perhaps resulting in chaos.

4.1.6 PPE Shortage

Malaysians were likewise unprepared to combat the pandemic in the early stages, owing to the concurrent political instability and the assurance that the virus would not spread readily in the country. Consequently, with the growing number of COVID-19 cases, PPE equipment has been in limited supply (Shah *et al.*, 2020). Although MOH Malaysia claims to have resolved the issue of PPE shortages, the problem of PPE distribution to the hospitals, particularly in Sabah and Sarawak still be an issue (Zainul, 2020). Top Glove, the largest Malaysian producer of medical gloves in the world, highlighted the issue of the possibility of COVID-19's new waves in 2023. The situation might repeat the year-end 2021 history where employees from four factories tested positive and forced the company to halt half of its production capacity for more than a month (Idris, 2021). Therefore, precautions in the post-COVID-19 pandemic should be taken seriously, especially by the MOH.

4.1.7 Occupational Burnout and Mental Health Issues

Healthcare professionals across the world are playing a critical role in the battle against the COVID-19 pandemic. Healthcare workers in Malaysia are assisting the nation in a variety of tasks including surveillance, screening, diagnosis, and treatment (Zakaria *et al.*, 2021). However, they confront immense challenges including a high risk of infection, insufficient contamination protection, overwork, frustration, and tiredness (Mohd Noor *et al.*, 2021). Multiple studies have indicated that Malaysian healthcare professionals frequently experience feelings of stress, exhaustion, burnout, and anxiety which majority of them were nurses. These situations frequently have a detrimental influence on physical, occupational, psychological, and social well-being (Ramli *et al.*, 2022). Furthermore, they are at an increased risk of developing post-traumatic stress disorder (PTSD) or posttraumatic symptoms (Abas *et al.*, 2018). Hence, implementing necessary measures to offer psychological support and counselling to healthcare professionals has become a serious concern for the healthcare system.

4.1.8 Blood Supply Management Issues

Malaysian health system's blood supply is primarily reliant on unpaid volunteers (Wooi Seong, 2017). Due to the standard operating procedures (SOP) implemented by the Malaysian Government, the blood donors faced difficulties in travelling to the mobile sites and blood banks during MCO Movement Control Order (MCO). In the current state, a former patient can only donate blood 14 days after recovering from COVID-19. This situation has reduced the number of blood donation campaigns significantly (Muttaqin, 2022). Consequently, blood supply at the National Blood Centre and other blood banks in the nation reported a significant 28% decline. Blood demand, on the other hand, increased once the MCO was replaced by relaxation measures. It is due to the resumption of elective procedures and the increased number of automobile

accidents (Jr, 2020). As a result, maintaining an optimal level of blood inventory to support surgical procedures and emergency blood transfusions has become a challenge for Malaysian hospitals during the COVID-19 outbreak.

4.1.9 Challenges Concerning Treatment

One of the major challenges is to identify an acceptable variety of evidence-based drugs, including repurposed medicines that can be used use in Malaysia. According to the COVID-19 management guideline by MOH, chloroquine and hydroxychloroquine including or excluding other antiviral drugs were proposed to treat various clinical phases of the COVID-19 infection (MOH, 2022b). But in June 2020, Malaysia revoked the use of these medications based on a study showing the ineffectiveness of these drugs among 500 COVID-19 patients (Ying, 2020). Another research, undertaken in collaboration with the WHO in nine COVID-19-affected hospitals, investigated the efficacy of four different treatment regimens that included redeliver, lopinavir/ritonavir, interferon beta, chloroquine, and hydroxychloroquine. However, the result of this Solidarity Therapeutics Trial reveals nil or low efficacy of the regimen on 28-day mortality or the in-hospital course of COVID-19 among hospitalized patients (WHO, 2020c). The absence of a standard drug regimen and frequent changes in treatment protocols create additional challenges for healthcare professionals to maintain a sustainable treatment plan.

4.1.10 Challenges Concerning Vaccination

In terms of immunization, the government of Malaysia explored several initiatives to ensure the availability of the COVID-19 vaccine from numerous international resources. According to a statistic by MOH, 83.6% of the total population has been fully vaccinated till July 6, 2022. Around 27 million population received at least two doses with 16.1 million with boosters. On the same note, a total of 1.3 million children (5 to 11 years old) have received the second dose which seems a bit slow (MOH, 2022c). Delays in vaccine rollout impede the process of developing herd immunity. The new wave which is expected in September 2022 might be observing a huge spike in COVID-19 infections, posing new challenges to the healthcare system. With the newly identified education and higher education clusters, it is important to ensure parents send their kids for vaccination as a precautionary step. Figure 2 presents the current challenges confronted by the Malaysian healthcare supply chain system.

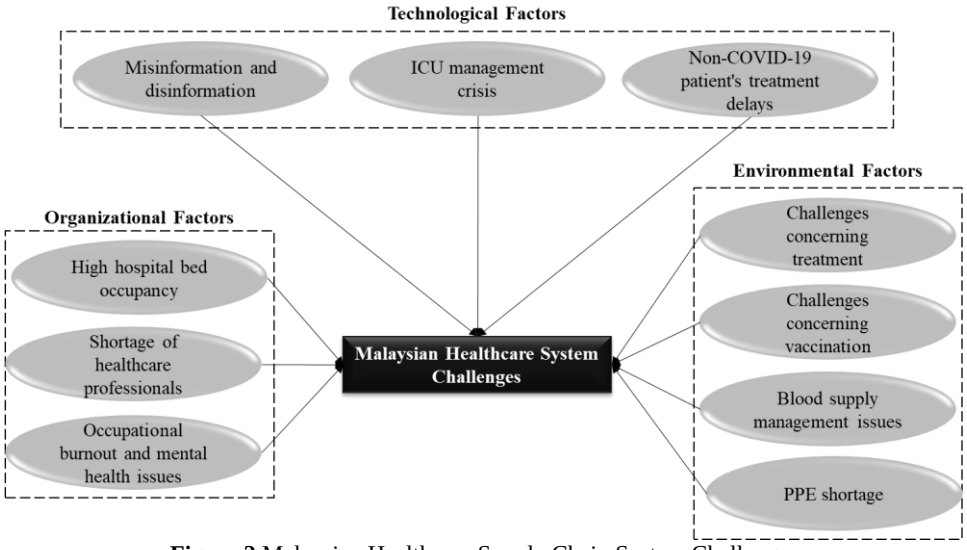

Figure 2 Malaysian Healthcare Supply Chain System Challenges

4.2 Mitigation Measures

4.2.1 Misinformation and Disinformation

To minimize misinterpretation and misunderstanding, only evidence-based facts should be provided to the general population in a clear and common style. Doctors should specifically convey this information to increase its reliability (Tagliabue *et al.*, 2020). In addition, the inoculation concept can also be used to educate citizens on how misinformation is created, disseminated, and propagated. The development and implementation of the online game Go Viral! is an example of such an application. It's a game created in partnership with the UK government and the WHO. It trains the players on how to avoid three common methods (fearmongering, the use of phoney experts, and conspiracy theories) of disseminating misinformation about the coronavirus (van der Linden *et al.*, 2020). Another option is to create a web app like "CoVerifi", which assesses the trustworthiness of news by combining the power of machine learning with the power of human feedback (Sarsam *et al.*, 2022a). Finally, strong collaboration among the medical community, government, and the media is required, restricting the transmission of fake news, and therefore better engaging the general population to follow accurate rules (Tagliabue *et al.*, 2020).

4.2.2 High Hospital Bed Occupancy

The use of a remote monitoring system and patient support can help to alleviate overcrowding in hospitals. Accordingly, the admission rate may be reduced, resulting in low bed occupancy. Some effective techniques to implement a system of remote patient assistance include the Internet of Things (IoT) platform supported mobile healthcare (Chen *et al.*, 2016), distant constant monitoring of patients based on radio frequency identification devices

(RFID), wearable sensor technology, telemedicine, and cloud computing infrastructure (Dong *et al.*, 2020). On the other hand, the establishment of mobile health clinics (Attipoe-Dorcoo *et al.*, 2020), e-pharmacy (Singh *et al.*, 2020), and e-grocery services (Dannenberg *et al.*, 2020) for the worst-hit clusters can be some effective efforts to stop physical movement and curb the transmission of infection.

4.2.3 ICU Management Crisis

To overcome it, management should investigate short-term and long-term strategies. For the short-term strategies, since ICUs in hospitals have limited space and bed capacity, converting less sophisticated units, such as recovery rooms, coronary care units, stroke units, hallways, or other locations into ICUs is a good way to deal with a crisis quickly. Other possible measures are triaging ICU admissions and treatment, transfer of appropriate patients to other units, non-admission of patients with a poor prognosis, additional medical assistance from other sectors, increased logistical support, and hiring of reserve-trained ICU nursing/medical personnel (Vincent & Creteur, 2020). Meanwhile, for long-term strategies, although it is an expensive and time-consuming operation, the development of offshore medical rigs can aid a country's long-term preparedness for pandemics and other emergencies. Hybrid testing labs, research facilities, PPE storage warehouses, specialized medic dorms, secure logistical channels, and patient beds will all be available on these offshore rigs (Abideen *et al.*, 2020).

4.2.4 Shortage of Healthcare Professionals

The management should introduce the healthcare worker's (HCWs) surveillance program. This is because, the increased risk of infection and intra-hospital transmission among HCWs has been recognized as an important element that poses an occupational health risk and disrupts healthcare operations during the COVID-19 pandemic (Muthuri *et al.*, 2020). Moreover, a healthcare organization may use a variety of tactics, ranging from typical occupational surveillance programs to more adaptable and resource-intensive measures such as periodic or intermittent testing (CDCP, 2021a). Alike, management should also practice the Centres for Disease Control and Prevention (CDC) guidelines to curb the shortage by following the contingency and crisis capacity strategies measures including, staffing schedules adjustment, job rotation of HCWs and a few other strategies. Consideration of permitting the infected HCWs should be the last resort if the shortages persist despite other mitigating methods (CDCP, 2021b).

4.2.5 Non-COVID-19 Patients' Treatment Delay

The top management should implement digital health solutions for the treatment of non-COVID patients. Digital health solutions like telemedicine and eHealth services might be a feasible choice for treating non-COVID patients. Furthermore, restricting face-to-face visits and patient social mobility, limits transmission among medical practitioners and patients (Bokolo, 2021). Accordingly, the application of healthcare 4.0 can enhance the effectiveness and efficiency of healthcare services while also offering patients with better, more value-added, and more affordable healthcare services. Some of the eHealth innovations that could improve patients' experiences include real-time telemedicine, mobile health applications, and online patient monitoring (Asadzadeh & Kalankesh, 2021).

4.2.6 PPE Shortage

Following the operational guidelines of the CDC, enabling efficient usage and disposal of PPE while conserving resources is the best way to mitigate the PPE shortage. On the other hand, the need for contingency planning for PPE stock shortages cannot be overstated. Therefore, the government needs to introduce smart communication channels to enhance the supply chain, customized PPE manufacture, and PPE reprocessing to address the shortages (Rowan & Laffey, 2020). Government can also promote local companies to make manufacturing transitions to produce this equipment (Ranney *et al.*, 2020). Alike, according to Tarfaoui *et al.* (2020), 3D printing can act as the solution to the PPE shortage. The disparity between the availability and demand of PPE able to be solved using 3D printing technology. During the post-COVID-19 period, the printing of face shields, goggles, medical accessories, surgical masks, and ventilator parts increased significantly.

4.2.7 Occupational Burnout and Mental Health Issues

Mitigation and amelioration of these issues require a multifaceted strategy that includes organizational involvement and policy-level approaches (Nishimura *et al.*, 2021). It is important to ensure medical personnel have enough nourishment, maintain work schedules, and avoid potentially overloading and practice a work-life balance (Restauri & Sheridan, 2020). Alike, leadership, organizational support, and organizational justice should be offered to them (Walton *et al.*, 2020). Additionally, medical personnel must be adequately equipped with PPEs and be fully vaccinated (Chew *et al.*, 2021). Accordingly, using positive coping techniques, such as good religious coping strategies cannot be denied (Chow *et al.*, 2021). Moreover, peer support programs, financial counselling, online counselling services, and psychoeducational training module are also important. Inclusion of a psychoeducational training module in a national SOP for healthcare crisis management, psychoeducational seminars, psych emotional self-care activities, and psychological micro-practices can be useful for this purpose (Bao *et al.*, 2020; Greenberg *et al.*, 2020).

4.2.8 Blood Supply Management Issues

To facilitate the available blood supply, the blood donation system in all hospitals needs to be modified and systematized. More blood donation programs should be arranged along with online promotions on different platforms such as the use of social including Facebook, Twitter, Pinterest, and the official page of MOH to encourage people to blood donations (Sarsam *et al.*, 2022b). Furthermore, introducing the “DONOR APP” by MOH will enable to make the donation process more efficient, enabling users to conveniently locate and arrange appointments for donation centres. It will inform donors that enough time has elapsed to donate again, along with sending blood supply alerts to let people know when there is an imminent need for blood. It will also be reducing the waiting period before donors arrive at a hospital for blood

donation (Holtkamp, 2019). Alike, reducing donation fears through different programs, article sharing, advertisements and well-designed education activities will much be helped (Elzamly *et al.*, 2016).

4.2.9 Challenges Concerning Treatment

Currently, the function of WHO is viewed as a custodian of global health. It has a considerable impact on international health policy, including laws, operational choices, and treatment procedures. Therefore, the WHO committee in charge of current trials must be more watchful in terms of data analysis and clinical management recommendations to reduce confusion and maintain treatment homogeneity (WHO, 2020c). Alike, technology plays a critical role in enabling widespread and accessible digital health services during pandemics as well as protecting against the "re-emergence" of COVID-19 disease after a pandemic. Therefore, the importance of 5G systems and 5G-enabled e-health solutions cannot be overstated (Siriwardhana *et al.*, 2021). Additionally, it is crucial to integrate technology to connect, coordinate, and support numerous stakeholders including governments, top IT companies and health organisations. Standardised protocols must be created to make communication between stakeholders easier while maintaining data security in designing the protocols, standards, data types and formats for better treatment management (Kritchanchai, 2014).

4.2.10 Challenges Concerning Vaccination

To achieve a high vaccination rate and establish herd immunity, all rational hurdles are required to be removed. It includes vaccine scarcities, PPE shortage, remoteness of vaccine centres, restricted operating hours, and a cumbersome registration process (Mouser, 2021). It is essential to maintain a continual procurement process to secure vaccine availability (Lim, 2021). Other efforts to boost vaccination include improving vaccine confidence and making vaccination a societal norm, as well as doing situation-based research. The efficacy of COVID-19 immunization programs can be safeguarded through community engagement and excellent communication (WHOd, 2020). Similarly, increasing accessibility to immunisation programmes in locations like pharmacies and workplaces will raise vaccination awareness. Top management may also perform internal audits of practice immunization rates and reminder-recall systems for their employees who refused to get vaccinated. **Table 1** summarizes the challenges and mitigation measures for the Malaysian healthcare system that can be used as a guideline.

Table 1 Challenges and Mitigation Measures Summary

Challenges	Mitigation measures	Source
Misinformation and disinformation	▪ Provision of evidence-based facts by doctors ▪ Application of "Inoculation Theory" ▪ Creation of a web app like "CoVerifi" ▪ Strong stakeholders' collaboration (medical community, government, media)	(Farr *et al.*, 2021; Miah *et al.*, 2014; Sarsam *et al.*, 2022a; Tagliabue *et al.*, 2020; van der Linden *et al.*, 2020; WHO, 2020b)
High hospital bed occupancy	▪ IoT, RFID-based remote medical assistance ▪ Continuation of MCO ▪ Establishment of mobile health clinics ▪ Using e-pharmacy service and e-grocery service ▪ Introducing "DONOR APP" by MOH ▪ Reducing donation fears through different programs, articles and advertisements well-designed education activities	(Attipoe-Dorcoo *et al.*, 2020; Chen *et al.*, 2016; CodeBlue, 2022; Dannenberg *et al.*, 2020; Dong *et al.*, 2020; Salim, 2022; Singh *et al.*, 2020; Sulaiman, 2022)
ICU management crisis	▪ Conversion of less sophisticated areas to ICU ▪ Triaging ICU admissions and treatment ▪ Transfer of appropriate patients to other units ▪ Non-admission of patients with a poor prognosis ▪ Additional medical assistance from other sectors ▪ Increased logistical support ▪ The hiring of reserve-trained ICU nursing/medical personnel ▪ Development of offshore medical rigs	(Abideen *et al.*, 2020; CodeBlue, 2022; Hamzah, 2022; Sulaiman, 2022; Vincent & Creteur, 2020)
Shortage of healthcare professionals	▪ Introduction of an HCW surveillance program ▪ Following CDC guidelines to curb the shortage	(Ahmad, 2019; CDCP, 2021a; CDCP, 2021b; Gan, 2022; Muthuri *et al.*, 2020)
Non-COVID-19 patient's treatment delays	▪ Digital health solutions (telehealth, eHealth, mobile health applications, online patient monitoring)	(Abdullah *et al.*, 2020; Asadzadeh & Kalankesh, 2021; Ayamany, 2021; Bokolo, 2021; CSO, 2020; Lai *et al.*, 2020)
PPE shortage	▪ Following the operational guidelines of the CDC ▪ Introduce smart communication channels ▪ Customized PPE manufacture ▪ PPE reprocessing ▪ Promote local companies to produce PPE ▪ Understand the present PPE inventory, supply chain, and utilization rate ▪ Create a robust PPE supply chain via a supply chain visibility platform ▪ Putting just-in-time fit testing into practice	(Finkenstadt & Handfield, 2021; Idris, 2021; Nagel *et al.*, 2021; Ranney *et al.*, 2020; Rowan & Laffey, 2020; Shah *et al.*, 2020; Tarfaoui *et al.*, 2020; Zainul, 2020)

Table 1 Challenges and Mitigation Measures Summary (con't)

Challenges	Mitigation measures	Source
Occupational burnout and mental health issues	▪ Fulfil basic physiological needs. Offer Leadership, organizational support, and organizational justice. ▪ Equipped with PPEs, Ensure vaccination. ▪ Encourage to use positive coping techniques ▪ Peer support programs ▪ Staff support hotlines for financial counselling and the right to reimbursement ▪ Introducing psychoeducational training module, psychoeducational seminars, psych-emotional self-care activities, and psychological micro-practices	(Abas *et al.*, 2018; Bao *et al.*, 2020; Chew *et al.*, 2021; Chow *et al.*, 2021; Greenberg *et al.*, 2020; Mohd Noor *et al.*, 2021; Nishimura *et al.*, 2021; Ramli *et al.*, 2022; Restauri & Sheridan, 2020; Walton *et al.*, 2020; Zakaria *et al.*, 2021)
Blood supply management issues	▪ Use of social media in the blood donation process ▪ Introducing "DONOR APP" by MOH ▪ Introducing different programs, articles, advertisements and, well-designed education activities	(Elzamly *et al.*, 2016; Holtkamp, 2019; Jr, 2020; Muttaqin, 2022; Sarsam *et al.*, 2022b; Wooi Seong, 2017)
Challenges concerning treatment	▪ Become more watchful in terms of data analysis and clinical management recommendations. ▪ 5G systems and 5G-enabled e-health solutions ▪ Strong stakeholders' collaboration (governments, top IT companies and health organisations)	(He *et al.*, 2021; MOH, 2022b; Siriwardhana *et al.*, 2021; WHO, 2020c; Ying, 2020)
Challenges concerning vaccination	▪ The continual procurement process of vaccine ▪ Improving vaccine confidence ▪ Making vaccination a societal norm ▪ Doing situation-based research.	(Lim, 2021; MOH, 2022c; Mouser, 2021; WHO, 2020d)

5. DISCUSSION AND CONCLUSION

5.1 Discussion

Even though the number of fatalities in Malaysia is not increasing at an exponential rate, the country's death toll cannot be ignored. At the end of July 2022, there have been around 3,561 confirmed COVID-19 cases and 60.3% ICU utilisation in Malaysia (MOH, 2022a). Within the current legislation and new initiatives, the National Institute of Forensic Medicine Malaysia has innovated protocols and recommendations for the handling of the deceased. However, if the mortality rate continues to climb, future issues with storage and decomposition, labour shortages, the paucity of properly equipped mortuaries, and other limited resources may arise. As a result of poor death management, it might result in a pile-up of a corpse (Khoo *et al.*, 2020).

Furthermore, clinical waste, radioactive waste, chemical waste, pressurised containers, and general garbage are the five primary forms of healthcare waste in Malaysia. Clinical waste includes human or animal tissue, blood or bodily fluids, excretions, medications, pharmaceutical goods, contaminated swabs or dressings, syringes, needles, and sharps instruments (NRE, 2009). Following the COVID-19 pandemic, the MOH in Malaysia recorded a 27% (by weight) rise in clinical waste. The rise is mostly due to medical personnel's enhanced use of disposable gloves, face masks, and PPE (Muhamad, 2020). Additionally, there has been widespread use and incorrect disposal of face masks and disposable gloves by the public (Agamuthu & Barasarathi, 2021). Although the plants are operating at full capacity, there is a pressing need to expand treatment and disposal capabilities.

To deal with the mounting pressure of clinical waste collected from hospitals and clinics, the Malaysian Department of Environment has already raised concerns about the need for more effective equipment and storage spaces, particularly in locations like Sabah and the East Coast of Peninsular Malaysia (Meikeng, 2021). To minimize undesired infection and negative health and environmental consequences, proper treatment and disposal of clinical waste generated by hospitals and other healthcare organizations and facilities are necessary. Therefore, if adequate measures are not undertaken, clinical waste management might become a serious challenge for the healthcare system in the future.

5.2 Research Implications

This study emphasizes that the challenges found could lead to a fresher understanding of the challenges and opportunities affecting Malaysia's healthcare system. This study may establish the foundation for future scholarly investigation of Malaysia's healthcare system. The outcome from this study also adds to the overall healthcare business discipline which may enhance knowledge of the healthcare system. Furthermore, the study's findings will also help practitioners to understand the challenges facing Malaysia's healthcare industry and possible mitigation measures that might be useful to remain competitive. Alike, this paper's findings will help top management whether in the public or private healthcare sectors to carry out or develop a strategic initiative.

5.3 Limitations and Recommendations

This study's subjective results have a drawback because it is one of the first to examine the Malaysian healthcare system's challenges. The author's observations of the industry provide the basis for the emphasised strategies. Future investigations should perform a quantitative study. An empirical analysis would demonstrate the importance and support of the arbitrary aspects that were addressed in this paper. Additionally, this paper highlighted existing and ongoing challenges that could change in the future, the results should be regarded as guidelines as the healthcare industry continues to advance. Therefore, more organised and in-depth empirical studies should be the main emphasis of future studies. Further research is required to completely identify and comprehend any additional pertinent or hidden

challenges affecting Malaysia's healthcare system. Therefore, conducting focus groups or panel interviews as part of future empirical research to produce more insightful findings about the whole healthcare system in Malaysia should take place. The qualitative nature and methodology used in this work, despite the paper's limitations and the paucity of healthcare research in Malaysia, further support the suitability and relevance of the content analysis for exploratory research.

5.4 Conclusion

The study contributes to the current literature on the healthcare supply chain by exploring and identifying the various challenges that Malaysia's healthcare system confronted in responding to the post-COVID-19 pandemic situation. The observation and content analysis's findings showed that misinformation and disinformation, high hospital bed occupancy, ICU management crisis, shortage of healthcare professionals, non-COVID-19 patients treatment delays, PPE shortage, occupational burnout and mental health issues, blood supply management issues, challenges concerning treatment and challenges concerning vaccination are the challenges of Malaysia's healthcare system in Malaysia. Additionally, death management and waste management are the ongoing challenges confronted by the Malaysian healthcare system.

Although COVID-19 disease is no longer being treated as a serious illness, the number of patients around the world is increasing. Data generated from WHO (2023) as of May 2023 shows that the number of people who were positively infected with COVID-19 in Malaysia had reached 5.07 million, 37,020 people died, 14,291 people were still being treated (positively active), and 5,020,529 patients were declared cured. Thus, this study provides several mitigation measures that might be useful for the Malaysian healthcare industry to remain competitive, particularly during the post-COVID-19. Alike, this paper's findings will help top management whether in the public or private healthcare sectors to carry out or develop a strategic initiative. Besides, the findings from this study promote efficiencies such as reduction in healthcare and clinical wastes and energy consumption and allow the industry to propel itself towards sustainable development.

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