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RESEARCH ARTICLE

Strategies to Minimise the Impact of COVID-19 on the Construction Industry: A Case Study of Construction Site Clusters in Malaysia

Farah Salwati Ibrahim¹, Muneera Esa^{2,*} Ernawati Mustafa Kamal³

¹Construction Project Management, School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 Gelugor, Penang, Malaysia, farahsalwati@gmail.com

²Construction Project Management, School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 Gelugor, Penang, Malaysia, muneera_esa@usm.my

³Construction Project Management, School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 Gelugor, Penang, Malaysia, ernamustafa@usm.my

Corresponding author: Muneera Esa, Construction Project Management, School of Housing, Building and Planning, Universiti Sains Malaysia, 11800 Gelugor, Penang, Malaysia, muneera_esa@usm.my

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Abstract

Malaysia has seen the third wave of infection since the start of the global COVID-19 pandemic, with approximately 103 construction sites involving over 14,677 workers reported from April 2020 to February 2021. This has led to limited progress in construction projects or a complete halt, resulting in late project delivery. The purpose of this paper is to investigate the factors influencing the spread of COVID-19 and the strategies taken by the affected construction sites to mitigate the spread of the outbreak. The researchers adopted a case study approach with a multiple-case design and discusses the use of an in-depth interviewing method to collect rich data on the studied phenomenon. Data collected from three construction sites. The sites were mixed development projects in nature and provided in-depth, rigorous, and robust information. Based on the results, two categories of factors influencing the spread of COVID-19 were established. These are primary and secondary factors, such as workers' mobilisation, uncontrolled movement of workers, and the limited practice of social distancing. Furthermore, evidence suggests that the strategies adopted to control the effects of the pandemic were a combination of

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government enforcement and initiatives taken by construction companies. This paper concludes that an early identification of the causes of the spread will enable appropriate implementation strategies to control the outbreak. This study is an attempt to present the experiences of one developing country as an example of a means of dealing with unexpected pandemics or other intractable diseases that can affect project delivery.

Keywords

COVID-19; Malaysian Construction Industry; Construction Site; Influencing Factors; Strategies

Introduction

Approximately a year after the global struggle against the COVID-19 pandemic began, its impact on the world has grown increasingly significant, not only from the perspective of health and safety but also in terms of the global key economic indicators. During this study period (April 2020–February 2021), there have been 115 million confirmed COVID-19 cases and nearly 2.55 million people have died due to the outbreak, and these numbers continue to grow every day ([WHO, 2021](#)). Due to the threat posed by the pandemic, governments throughout the world have imposed lockdowns to prevent the spread of the virus. During the lockdown period, most businesses were forced to close; international travel became very limited; and individuals faced restrictions on performing their normal working, physical, and social activities. These containment measures have resulted in severe economic disruptions. As reported by the World Economic Outlook ([IMF, 2020](#)), the unprecedented pandemic has negatively impacted global health and the economy, particularly in the second quarter of 2020 ([IMF, 2020](#)).

Similar to many other industries, the construction industry has also been adversely affected ([Vitner, Dougherty and Honnold, 2020](#); [Raoufi and Fayek, 2021](#)). The pandemic has impacted the industry in many aspects of its operations and also the construction work environment ([Raoufi and Fayek, 2021](#)). Most construction activities face suspension and cancellation due to shortages of construction materials, labour, equipment, and machinery components due to the lockdowns, which have impeded the progress of construction activities, making it impossible to meet project deadlines ([Vitner, Dougherty and Honnold, 2020](#)). Additionally, governments are obligated to enact new regulations and Site Operating Procedures or Standard Operating Procedures (SOP) as needed. The SOP and new regulations must be implemented to lessen the impact and spread of COVID-19 in the construction industry. In most countries, there are six main aspects emphasised in the SOP for the construction industry, namely health screening for workers, providing hygienic facilities for workers (workers' residential, toilets, rest areas, cafeterias, etc.), physical distancing by minimising the number of workers, transportation for workers, regularly sanitising the work areas, and performing COVID-19 tests ([MITI and CIDB, 2020](#); [KPMG, 2020](#); [CLC, 2021](#); [Stiles, Golightly and Ryan, 2021](#)). There are some other aspects of the SOP that vary slightly based on each country's policy and construction environment. China and India, for example, used technology intervention to combat the COVID-19 pandemic ([KPMG, 2020](#); [Apec, 2021](#)). The technology intervention consists of the implementation of Artificial Intelligent (AI), the Internet of Things (IoT), and other digital technologies ([Javaid, et al., 2020](#); [Ebekozi and Aigbavboa, 2021](#)). Building Information Modelling (BIM), drones, GPS, real-time virtual reality, and remote cameras are all examples of technological interventions that can be used to reduce physical interaction among construction workers during a pandemic. However, their application has been limited due to inadequate awareness and expertise ([KPMG, 2020](#); [Apec, 2021](#); [Tang, et al., 2019](#); [Ibrahim, Esa and Rahman, 2021](#)).

The Malaysian government has made compliance with the SOP compulsory for all construction sites. However, the transmission of the virus at construction sites still occurs. The number of cases involving construction sites in Malaysia has been rising, with more than 100 construction sites affected and more

than 14,000 construction workers having tested positive for COVID-19 ([MOH, 2021b](#)). Due to the gravity of the situation, many construction sites have been directed to close for disinfection and quarantine ([MOWorks, 2020](#)). Thus, project timelines are disrupted and impeded as a longer period of shutdown inevitably leads to more delays and an increment in the construction cost ([Gamil and Alhagar, 2020](#)). To reduce the negative effects, construction companies should manage the pandemic situation effectively and resume operations as usual.

Numerous studies have discussed COVID-19 from the perspective of the construction industry, most of them focusing on the impact of COVID-19 on the economy, health and safety, standards of operation, construction activities, and worker's on-site activities during the pandemic ([Al Amri and Marey-Pérez, 2020](#); [Al-Deen Bsisu, 2020](#); [Umar, 2022](#); [Ebekozién and Aigbavboa, 2021](#); [Apec, 2021](#); [Alsharaf, et al., 2021](#); [Gamil and Alhagar, 2020](#)). To the author's best knowledge, no studies were reported during that critical period on the factors influencing the spread of COVID-19 and the strategies taken by the affected construction sites to mitigate the spread of the outbreak. Therefore, two research questions are raised in the present study. These are as follows:

- What are the factors influencing the spread of COVID-19 at construction sites and how do these factors affect project delivery?
- How are the mitigation strategies performed to control the outbreak during the peak time of this viral infection?

This study is significant as it examines the precautionary principle in managing infectious diseases and links it to the identified strategies. The following sections provide more extensive insights on the factors influencing the spread of COVID-19 and strategies implemented by affected construction sites when operating in current circumstances. In accordance with this issue, the following sections describe the construction industry's current scenario faced in the midst of the pandemic, followed by the methodology adopted, findings, discussions, and conclusions.

Literature Review

THE IMPLICATIONS OF THE PANDEMIC FOR THE CONSTRUCTION INDUSTRY WORLDWIDE

Since December 2019, industries worldwide, including the construction industry, have been facing adversities due to the breakout of the COVID-19 pandemic. The economy in most countries deteriorated in the second quarter of 2020, with many countries' Gross Domestic Product (GDP) falling as key economic indicators failed to create profits. Global economic growth declined by 4.9% in 2020, falling short of the World Economic Outlook's April 2020 prediction ([IMF, 2020](#)). Due to reduced and postponed building spending during the pandemic crisis, the construction sector in several developed and developing countries saw a drop in GDP in the second quarter of 2020 ([Schober, 2021](#); [BEA, 2020](#); [IHS Markit, 2020](#); [May, 2020](#)). Based on the 2020 global economic report, the main causes of the contraction in the global economy were directly attributed to the COVID-19 pandemic, which saw most countries impose lockdowns, community quarantines, stay-at-home orders, temporary business closures, and travel restrictions or prohibitions in order to stop the spread of the virus ([IMF, 2020](#); [DOSM, 2021](#)). In the next paragraph, discussions are centred on the examples of countries that fall into the top ten economies in which the pandemic has severely affected the construction industry.

For example, in the United States of America (USA), GDP dropped by 5% in the first quarter of 2020 and deteriorated even further in the second quarter of 2020 to -31.4%, following the government's issuance of a "stay at home" order in March 2020 to curb the spread of COVID-19. The construction industry is one

of twenty-two key economic indicators that contribute to the GDP of the USA. Fortunately, due to a large number of key economic indicators that contribute to the GDP, the impact on the construction industry was slightly lower at -0.08%, and was found to be the GDP's second-lowest impacted indicator ([Bureau of Economic Analysis, 2021](#)). Meanwhile, in the United Kingdom (UK), the contraction in annual GDP growth was recorded at 9.8%, the worst in UK history after the economic recession in 2009. The pandemic has greatly impacted the construction industry, where the GDP value for the construction sector was shown to have decreased by 64.9% in the second quarter of 2020 ([Mayrick, 2021](#)).

Turning to Asia, COVID-19 has also affected world-leading economies such as China. The pandemic has slowed China's construction development, but the market has shown signs of a slow recovery since [May 2020](#) ([Congressional Research Service, 2021](#)). China has forced its economy, especially the construction industry, to shift into digital technology in order to make way for economic growth despite the pandemic. China is focusing on digitalising the construction industry by incorporating advanced construction technology into its infrastructure projects. These technologies include Building Information Modelling (BIM), 3D printing, green concrete, modular construction technologies, and Bcore CTS technology, as part of the efforts to push the construction sector to contribute to the country's GDP growth ([Rudykh, Shilova and Khomich, 2021](#)).

From the above discussion, it is clear that the global construction industry has been greatly impacted by the COVID-19 pandemic. In the first and second quarters of 2020, the industry clearly experienced great challenges. However, the strategies to overcome the situation during the pandemic are significant to ensure that the outbreak can be contained and that the industry will be allowed to operate. There are clearly lessons to be learned from the pandemic and China's construction industry; improvements in construction technology will help to reduce the number of people on site during the pandemic while allowing construction work to continue as usual in order to minimise losses.

THE SCENARIO OF THE MALAYSIAN CONSTRUCTION INDUSTRY (MCI) DURING THE PANDEMIC

In Malaysia, from March 2020 to date, two phases of lockdown (i.e., Movement Control Order (MCO)) have been implemented. Within this MCO period, the government has imposed a tight SOP on all industries, inclusive of the construction industry. The [Department of Statistics Malaysia \(2021\)](#) stated that the GDP of Malaysia decreased by 5.6% compared to by 4.3% in 2019, with the construction industry recording a 19.4% contraction. In MCO 1.0, all construction sites were directed to close for approximately six weeks, and only critical projects were allowed to continue work. The MCO also disrupted project timelines, which in turn affected the availability of suppliers, materials, machinery, and skilled personnel, while also delaying project progress ([Esa, Ibrahim and Mustafa Kamal, 2020](#)). Meanwhile, during MCO 2.0, all types of construction work were permitted to operate upon obtaining approval from the Ministry of International Trade and Industry (MITI), subject to strict implementation of the SOP on site ([MOWorks, 2021](#)).

According to data reported on the COVID-19 website by the Ministry of Health Malaysia ([MOH, 2021b](#)), only five construction sites were affected in the first half of 2020, with only 150 cases recorded. However, starting in November 2020, there was a massive jump in the number of cases at various construction sites, which formed a large number of COVID-19 "construction site clusters." Subsequently, an additional ninety-eight construction site clusters were identified, where 14,677 workers (both local and foreign) were found to have been infected. [Table 1](#) shows the tabulation of the construction site clusters in Malaysia from April 2020 to February 2021.

Table 1. Tabulation of Construction Site Clusters in Malaysia from April 2020 to February 2021.

No.	Month	No. of Construction Site Clusters	Positive Cases (Site Workers)
1	April 2020	1	28
2	May 2020	3	119
3	June 2020	1	3
4	July 2020	1	3
5	November 2020	6	3,728
6	December 2020	33	5,461
7	January 2021	26	2,536
8	February 2021	32	2,799
TOTAL		103	14, 677

Source: Information retrieved from the Ministry of Health Malaysia ([MOH, 2021b](#))

Due to the significant increase in the number of cases related to construction sites, the government collaborated with the Construction Industry Development Board (CIDB) and the Malaysian National Security Council (NSC) to introduce a tightened SOP and conduct regular site inspections at all registered construction sites within Malaysia. As recorded through the CIDB Telegram Channel, from 13th January to 22nd February 2021, 99% or 1,261 construction sites were found to have complied with the SOP, while 1% or 10 construction sites were instructed to close due to non-compliance with the SOP.

However, cases related to construction sites are still being reported despite the imposition of a strict SOP and regular inspection of construction sites conducted by the government. Thus, to minimise the exacerbation of COVID-19 cases at construction sites, the government and relevant agencies should holistically investigate the root causes of the spread of the pandemic at construction sites, taking into account both explicit and implicit factors. By addressing the root of the problem, the influencing factors and the risks can be managed more effectively.

FACTORS INFLUENCING THE SPREAD OF COVID-19 AT CONSTRUCTION SITES

COVID-19 has been widely transmitted on construction sites due to several causes. The Ministry of Health (MOH) identified elements such as crowded and cramped workers' housing facilities, lack of physical distancing practices, and unsatisfactory personal and environmental hygiene practices among construction workers, especially foreign workers ([MOH, 2019](#); [MOWorks, 2021](#)). As of 30th June 2019, most of the construction workers at construction sites in Malaysia are from countries such as Indonesia, Myanmar, Bangladesh, Nepal, India, Pakistan, Philippines, Vietnam, China, Thailand, Sri Lanka, Cambodia, and Laos, with a total number of employees estimated at 435,002; it is also noted that the level of hygiene practices among them is very low ([Hassan, et al., 2018](#); [Arif Shah, 2020](#); [Wahab, 2020](#)). The situation becomes worse when the workers are placed in temporary shelters made up of small cabins with minimal facilities and utilities, each of which houses more than ten workers. As a result, good hygiene and social distancing practices are difficult for workers to adopt, contributing to the faster virus transmission. These areas need to be sanitised every day, while commonly used areas are recommended to be sanitised at least three times per day. Additionally, there is a need to limit the number of workers in one place at any given time ([CIDB, 2020](#)).

Another factor identified is the mobilisation of construction workers from one site to another upon the completion of a project ([Hasnan, 2020](#); [MOWorks, 2021](#)). As mentioned by the CEO of CIDB, Datuk Ir. Ahmad Asri Abdul Hamid, in a press conference regarding the Damanlela construction site cluster in Klang Valley, it was affirmed that asymptomatic workers had been unconsciously carrying around and spreading the virus when they were mobilised from one site to another, and this had caused more than 2,000 workers to be infected ([Krishnan, 2020](#)). According to the chronology of these cases, the main transmitter would be a foreign worker showing no symptoms, but the fact that he had been infected would have been detected only after undergoing a COVID-19 health screening at the construction site ([Krishnan, 2020](#)).

Furthermore, ineffective implementation of the SOP at construction sites has also contributed to the widespread transmission of the virus ([MOWorks, 2021](#)). This reflects a lack of awareness and understanding regarding the importance of complying with the SOP, which can be attributed to the language barrier and lack of knowledge. Another contributing factor is the contractors' failure to monitor and enforce SOP compliance on-site during working hours. Among the SOP breaches recorded include not wearing face masks, failure to maintain good hygiene, body temperature not being monitored, and not practising physical distancing ([Alagesh, 2020](#)).

It is also noted that direct contact with infected people has also contributed to the spread of COVID-19 ([Bernama, 2021](#)). Evidence shows that transmission can happen either consciously or unconsciously. To explain, transmission can happen consciously when workers are directly exposed to a "Person Under Investigation (PUI)." On the other hand, the workers may get infected unconsciously during their outing days when they meet friends or acquaintances who are not in the construction industry.

STRATEGIES TO CURB THE SPREAD OF COVID-19 AT CONSTRUCTION SITES

The government has created numerous strategies to serve as preventive measures in order to limit COVID-19 transmission at construction sites. These strategies have been tabled and approved with the consensus of various parties, including the MOH, the NSC, and the MOWorks ([MOWorks and CIDB, 2020](#)). A total of 15 protocols are listed as the main strategies in the SOP ([NSC, 2021](#)). Due to the huge rise in the number of construction site clusters, the government has tightened the SOP by amending several protocols to require strict control and monitoring based on factors identified by the MOH and the MOWorks ([NSC, 2021](#)).

Failure to comply with the strategies and the SOP can cause contractors to be held liable under Section 34 (B)(c) and Section 34 (c) of the Malaysian Construction Industry Development Act 1994 (Act 520) ([Zainuddin, 2020](#)). Meanwhile, under the amended Workers' Minimum Standards of Housing and Amenities Act 1990 (Act 446), the government has also tightened the regulations regarding workers' housing facilities by making it compulsory for contractors to provide safe, comfortable, and clean accommodation. Thus, this should enable physical distancing to be practiced. Disciplinary action such as suspension or cancellation of the contractor's registration will be imposed by the CIDB upon those who fail to comply with these rules ([MOWorks, 2020b](#); [CIDB, 2020](#)). In addition, the MOH develops and updates the COVID-19 Management Guidelines in Malaysia No.5/2020 from time to time ([MOH, 2021a](#)). With these steps in place, contractors will suffer losses if their site is ordered to be shut down until it is declared safe for operation. Moreover, contractors or developers will also have to bear the cost of the workers' medical bills, including the cost of swab tests and quarantine fees ([Krishnan, 2020](#)). In addition, if proven guilty of violating the SOP, contractors will have to face serious consequences such as license termination and no allowance for extension of time.

Meanwhile, regular checking and on-site monitoring by the contractors and safety and health officers are compulsory to ensure that the workers and staff strictly adhere to the SOP ([Sulaiman, 2021](#)). Wearing face masks, practising self-hygiene (washing hands with soap), tracking workers' body temperatures, minimising

the number of workers on site for physical distance, and controlling the movement of workers in and out of site are all important SOPs that must be monitored for compliance. The contractor must also regularly supervise the sanitation process to ensure that the site is fully sanitised according to schedule. The workers' facilities and commonly used areas also need to be regularly monitored and checked as the hygiene level of site workers is typically very low, particularly when involving foreign workers ([Hassan, et al., 2018](#)).

The banning of workers' mobilisation from one site to another is another strategy imposed by the CIDB to control the COVID-19 outbreak ([CIDB, 2021](#)). Furthermore, controlling the movement of workers on-site, namely from the construction site to the Centralised Labour Quarters (CLQ) and then from the CLQ back to the construction site, must also be carefully planned for execution. For example, if a 7-seater vehicle is used, only five workers should be travelling in it at any one time, whilst a 40-seater bus can only load up to half or two-thirds of the number of seats to promote social distancing among the workers. All the workers' movements must be recorded for future reference.

Research Methodology

This section offers an explanation of how the study was conducted and the mechanism to ensure the validity and reliability of the study.

RESEARCH APPROACH AND STRATEGIES

A qualitative research approach was adopted in this study. A qualitative approach is commonly used to explore and acquire an in-depth understanding as well as to develop a better interpretation of the issue at hand from the perspective of the people involved and as understood by them ([Saunders, Lewis and Thornhill, 2019](#)). As a research strategy, a case study was adopted to achieve the objectives of this study. According to [Yin \(2018\)](#), a case study is typically used when the boundaries between the phenomena being studied and the context in which they are studied are blurred. Therefore, it is rational for this study to use this strategy in order to have a broad overview of the unpredictable phenomenon of COVID-19 in the context of MCI, by having an in-depth study of a real-life case.

SELECTION OF CASE STUDIES

The case study is a suitable method to attentively observe data in a specific context in a small geographic area, with a small number of individuals as study participants ([Zainal, 2007](#)). In a case study, there are usually two designs used by the researchers. However, in this study, the multiple-case design was adopted because it involves real-life situations that consist of evidence through replication. By replicating the case, pattern matching is utilised as a technique that links some information from the same case to some theoretical proposition, which can enhance and support the research outcome ([Campbell, 1975](#)). Besides, the use of multiple-case design is often considered more compelling, so it should be more robust in identifying the influencing factors of the spread and the strategies taken. The chosen cases are the COVID-19 construction site cluster cases, which is the unit of analysis in this study.

The case studies were chosen from a list of 103 construction site clusters reported by the MOH. Several criteria were considered when selecting the case studies. The selection was based on the criteria such as mixed development, located in Kuala Lumpur, a large number of workers affected, and repeat cases. To explain further, the construction site cluster should be determined by the following: it should be currently active, with new daily cases recorded as of 28th February 2021; it should be located in Kuala Lumpur; it should be classified as a workplace infection; it has the highest numbers and percentage of workers who have tested positive for COVID-19; it has the highest numbers of current screened workers; the timeline of the outbreak must be more than two months; and the construction site should still be closed due to cases

being continuously recorded. Hence, the progress and delivery of the projects are significantly affected by the closure of the construction site, and most workers are still under the surveillance of the MOH. From among these 103 construction site clusters, only three sites fulfilled the criteria that had been set and were selected as the potential case studies in this study. Below are the summarised respondent selection criteria.

- It is located in Kuala Lumpur.
- The construction project is limited to mixed development, which involves a large capacity of workers.
- It is classified as a workplace infection.
- It affects a large number of workers—more than eight hundred workers.
- It involves repeat cases or clusters of outbreaks.
- The timeline of the outbreak must be more than two months.

According to [Yin \(2018\)](#), in a multiple-case design that uses replicating cases, the researcher can use two or more cases that are believed to be literal replications, and the “how” and “why” objectives have been implemented smoothly. Furthermore, the selection of the case study is also based on the availability and willingness of participants to participate in this study. The three selected case studies fulfil all the criteria that have been mentioned above. [Table 2](#) shows the details of the construction site clusters selected for the purposes of this study.

Table 2. Background of Selected Case Studies

	Cluster A	Cluster B	Cluster C
Location	Kuala Lumpur	Kuala Lumpur	Kuala Lumpur
Type of Development	Mixed development		
Cluster Type	Workplace	Workplace	Workplace
First Outbreak Start	7 th November 2020	4 th December 2020	18 th December 2020
First Outbreak End	13 th March 2021	3 rd April 2021	19 th March 2021
Second Outbreak Start	6 th July 2021	8 th June 2021	25 th June 2021
Second Outbreak End		No record	
Positive COVID-19 Workers (1 st Outbreak)	2,785 workers	2,323 workers	817 workers
Positive COVID-19 Workers (2 nd Outbreak)	630 workers	33 workers	28 workers
No. of Screened Workers (Until 28 th February 2021)	4,525 workers	5,761 workers	1,008 workers
Percentage of workers found to be positive for COVID-19	61.35%	40.15%	81.1%

Source: Information retrieved from the Ministry of Health Malaysia ([MOH, 2021b](#))

PARTICIPANTS

The participants in this study were divided into two groups. They were chosen based on their position (person in charge) and their first-hand experience dealing with the issue. The first group was made up

of representatives from the Ministry of Health (MOH) and government agencies, namely the Crisis Preparedness and Response Centre (CPRC), which is responsible for recording the daily COVID-19 cases, investigating the factors influencing the COVID-19 spread and tracing PUI, and the Construction Industry Development Board (CIDB), the party responsible for checking the compliance with the SOP at construction sites. Thus, these three entities are responsible for investigating the factors influencing the spread of COVID-19 at the construction site clusters.

The second group consists of the project managers from the three (3) affected construction site clusters. They are interviewed in order to explore the strategies taken by the affected organisations to curb the spread of COVID-19 at their respective construction sites.

[Table 3](#) and [Table 4](#) set out the profiles of participants taking part in the interview sessions for Phase One and Phase Two, respectively, while ensuring that their anonymity is preserved (upon request by the said participants). Five (5) participants from phase one and three (3) participants from phase two were interviewed using a semi-structured format, bringing the total number of interviews to eight (8).

Table 3. Profile of participants taking part in Phase One interviews (Government Entities)

Government Entities	Code	Position	Roles and Responsibilities
Ministry of Health (MOH)	GA1 GA2	Doctors (In-charge of treating the COVID-19 patients)	<ul style="list-style-type: none"> • Manage and treat COVID-19 patients (including from the construction site clusters) • Conduct swab tests and update the results • Update daily reports of COVID-19 cases
Crisis Preparedness and Response Centre (CPRC)	GA3	CPRC Representative	<ul style="list-style-type: none"> • Placed under the Surveillance Section of the Disease Control Division, Ministry of Health Malaysia • Manage disasters, outbreaks, crises, and emergencies (DOCE) related to health • Monitor the identified DOCE in active surveillances, including COVID-19 clusters. • Trace close contacts in existing and new COVID-19 clusters
Construction Industry Development Board (CIDB)	GA4 GA5	CIDB Enforcement Officers	<ul style="list-style-type: none"> • An agency under the Ministry of Works, responsible for managing, controlling, and monitoring the performance and activities of the construction industry • Responsible for checking the on-site SOP compliance and workers' facilities • Conduct site inspections • Issue notices of closure for construction sites that do not comply with the SOP

In terms of data validation, the information obtained from the second group was verified by the CIDB enforcement officers. This is to ensure that the strategies taken by the affected construction site clusters are valid. The CIDB enforcement officers were selected as the expert validators because once the affected construction site has recovered and is allowed to operate again, CIDB will closely monitor compliance with

Table 4. Profile of participants taking part in Phase Two interviews (Affected Construction Site Clusters)

Case Study	Code	Type of Organisation	Position	Years of Experience
Cluster A	CA	Main contractor	Project Manager	12
Cluster B	CB	Main contractor	Project Manager	10
Cluster C	CC	Main contractor	Project Manager	15

the SOP and any additional strategies taken by the construction site will be recorded. Thus, the validation from these agencies can be trusted as the process is exhaustive.

Data Collection and Analysis

As the case study protocol is a wide data collection plan, a multi-method data collection technique was used in this study, which included document analysis and semi-structured interviews. These strategies are important to synchronise beneficial information for this study. There are two categories of relevant documents examined. The first category comprises the government's announcements regarding regulations, SOP, initiatives, and lockdowns. The second category of documents involves analysis of the statistics on daily COVID-19 cases, consisting of the number of workers affected, newly listed construction site clusters, the current status of the existing construction site clusters (still active or recovered), the number of sites allowed to operate, and the number of sites ordered to be closed (including the reasons).

Next, the semi-structured interviews were conducted to retrieve actual information from the three selected case studies. The interviews sought to identify the key factors influencing the spread at each site and the strategies taken by each of the affected construction site clusters. The effectiveness of the different strategies taken by the construction site clusters to reduce the number of affected workers at each site was compared. Due to the COVID-19 situation, the researcher was not allowed to travel; therefore, the interviews had to be conducted over the telephone, as requested by the participants. All the information from the interviews was transcribed and analysed using NVivo 12 plus software. The "*thematic analysis*" was used to discover the frequency of a theme in the interview transcript as well as to assess its flexibility and ability to be applied in a wide variety of theoretical frameworks and research interests that would be useful for this research (Clarke and Braun, 2013; Alhojailan, 2012; Salman, et al., 2021). Additionally, this study has placed emphasis on the abductive approach, which allows the researcher to inductively explore the factors influencing the spread of COVID-19 and strategies taken according to the emerging themes and compare the trend of the constructs found deductively during the literature review.

Results and Findings

In this section, the relevant themes that are considered important to this research outcome have been identified and analysed. [Table 5](#) shows the themes that have been generated from the interviews.

FACTORS INFLUENCING THE SPREAD OF COVID-19

Based on [Table 6](#), the factors influencing the spread can be divided into two categories: primary and secondary. The factors influencing the spread in the primary category are caused by the main transmission of COVID-19, as recorded by the MOH. Meanwhile, in the secondary category, the factors influencing the spread are identified from the input given by the CIDB and the project managers.

Table 5. Themes generated from the interviews

Themes	Categories	Government					Affected Construction Site Clusters		
		GA1	GA2	GA3	GA4	GA5	CA	CB	CC
Factors influencing the spread of COVID-19	Workers' mobilisation			/	/	/	/	/	
	Uncontrolled movements of workers			/	/	/			/
	Non-compliance with the SOPs			/	/	/	/	/	/
	Unhygienic housing facilities/dormitories	/	/	/	/	/	/	/	/
	Crowded and cramped housing areas	/	/	/	/	/	/	/	/
	Workers' lack of awareness and inadequate knowledge of COVID-19	/	/	/	/	/	/	/	/
	Language barriers (for SOP compliance)				/	/	/	/	
	The attitudes of the workers	/	/	/	/	/	/	/	
	Unavailability of COVID-19 health coordinators				/	/		/	
	Unscheduled disinfection in common areas				/	/	/	/	/
Limited isolation centres	/	/	/	/	/	/	/	/	
Strategies taken by the affected construction site clusters (To ensure they can resume the work at the site again)	SOP compliance	/	/	/	/	/	/	/	/
	Initiative Budget (for COVID-19 tests)	/	/	/	/	/	/	/	/
	Providing adequate and proper Centralised Labour Quarters (CLQ)				/	/	/	/	/
	Special isolation centres				/	/	/	/	/
	Work arrangements				/	/	/	/	/
	Human resource/workers management				/	/	/	/	/
	Appointing a language translator among the workers (for foreign workers)						/	/	/
	Appointing a COVID-19 Health Supervisor						/	/	/

Primary Category

The factors influencing the spread in the primary category of virus transmission at construction sites (as explained by the GA1, GA2, GA3, GA4, and GA5) are listed in the MOH and the CIDB records. These factors are workers' mobilisation, uncontrolled movement of workers, and non-compliance with the SOP. The problem with workers' mobility occurs when foreign workers who work under subcontractors are transferred from one site to another, skipping COVID-19 screening tests and quarantine procedures. This lack of monitoring has resulted in a higher number of asymptomatic carrier cases being recorded at the construction sites. Consequently, the late detection and assessment of the COVID-19 infection caused the spread of the virus to a larger group of people, especially at the workers' dormitories.

Subsequently, the participants also stated that the uncontrolled movement of workers in and out of the construction site and the failure to record the workers' movements became among the factors influencing the spread on site. An episode recorded in Cluster C illustrated how a worker who had been affected by the virus during an outing unintentionally transmitted the virus to his dorm mates as well as other close contacts at the construction site, which resulted in a significantly high number of positive cases being recorded, affecting 817 workers. As such, this finding is proof that stricter movement control is necessary to curb the spread of COVID-19.

It can be said that the root cause of the spread can chiefly be attributed to a lack of compliance with the SOP imposed for the construction sites. The affected construction site clusters failed to adequately keep track of workers' movements, either manually or through the MySejahtera application. Furthermore, it is noted that the workers' daily body temperature readings were also not appropriately recorded.

“As what we found in these construction sites, they do not properly comply with the SOP, especially the worker's movement, where most of them do not record their movement even manually, in addition to poor housing facilities, unhygienic construction areas, and so on. If we use a scale, these three construction sites only get 3 to 4 points out of ten points in terms of compliance with the SOP. So, it is not surprising to see the large number of workers affected by COVID-19 here” [GA3, GA4, GA5]

Secondary Category

In the secondary category, five factors which contributed to the higher number of construction site clusters have been identified. Among them are poor living conditions, with overcrowded and stuffed workers, and limited practice of social distancing. The situation is also made worse by poor hygiene practices, as mentioned earlier.

“The housing conditions are really bad. Sometimes we feel sad looking at their houses, with bad smells, a lot of rubbish, cramped, and with limited water supply.” [GA3, GA4, GA5]

In addition, a lack of knowledge and awareness among the construction workers about COVID-19 has contributed to the low implementation of SOP. According to the project managers, it was a difficult process to educate the foreign workers on the SOP and COVID-19 as they were unfamiliar with the procedures, leading to undisciplined attitudes. The language barrier also posed a serious problem. Furthermore, the participants also highlighted the need for a COVID-19 health coordinator to be available on site to impart knowledge and create awareness regarding the SOP.

“We have problems with the foreign workers regarding compliance with the SOP because they do not understand the situation and they are also stubborn, which means that sometimes we need to force them to wear the face mask, to keep the area clean, to practice physical distancing and many more.” [GA4, GA5, CA1, CA2]

“..... some of the workers do not understand what we are talking about during the toolbox meeting when we try to explain about the SOP and the dangers of COVID-19, this is due to the different language...we do have a Safety and Health Officer (SHO) on site but not specifically as a COVID-19 SHO.” [GA4, GA5, CA2]

Other than that, the unscheduled disinfection at the construction sites, commonly used areas, and workers' facilities has also contributed to the spread of COVID-19 at the construction sites. Meanwhile, isolation centres are limited and sometimes even unavailable at the construction sites.

“We admit that in the early days of the pandemic situation, we did not regularly sanitise our site. That is due to our carelessness.” [CA1, CA2, CA3]

“The isolation centres are only available when we transfer the workers to CLQ. Before this, we did not provide any isolation centres and it was a new requirement imposed by the government.” [CA1, CA2, CA3]

Based on the findings, greater involvement of all parties, especially the top management, can contribute to minimising the effects of COVID-19 through strict adherence to the SOP. [Table 6](#) shows the summary of the findings.

Table 6. The primary and secondary categories

Case Studies	Primary Category	Secondary Category
Cluster A	<p>The initial case was reported following the workers' screening at the workplace, where the infected worker worked under a subcontractor and was transferred from one site to another after a project had been completed.</p> <p>Initial case: *15 workers infected * All were foreign workers</p>	<ul style="list-style-type: none"> • Social contact with infected workers. • Crowded and cramped conditions in workers' housing facilities resulted in the inability to practise physical distancing. • Lack of understanding of COVID-19 and SOP. • Lack of hygiene (both in housing and site areas). • Uncontrolled workers' movements (inside and outside). • The workers did not undergo COVID-19 screening before entering the construction site – some are illegal workers. • Self-isolation was not implemented for new workers. • Sanitation was not regularly implemented.
Cluster B	<p>Transmission of workers from one site to another site after the project is completed.</p> <p>Initial case: *11 workers infected * All were foreign workers</p>	<ul style="list-style-type: none"> • Social contact with infected workers. • Crowded and cramped conditions in workers' housing facilities resulted in the inability to practise physical distancing. • The workers did not undergo COVID-19 screening before entering the construction site. • Self-isolation was not implemented for new workers before working on-site. • Lack of awareness and knowledge about the SOP. • Difficulty in getting workers accustomed to the SOP, especially in wearing face masks, sanitising hands regularly, and practising physical distancing.

Table 6. continued

Case Studies	Primary Category	Secondary Category
Cluster C	<p>A worker was infected during an outing to buy groceries, and in turn he infected close contacts in the dormitories.</p> <p>Initial case: * 20 workers infected * All were foreign workers</p>	<ul style="list-style-type: none"> • Social contact with infected workers. • Crowded and cramped conditions in workers' housing facilities resulted in the inability to practise physical distancing. • Lack of awareness and knowledge about the SOP. • Lack of understanding of COVID-19 (foreign workers). • Lack of hygiene (both in housing and site areas). • Undisciplined attitude (i.e., not wearing face mask during working hours).

STRATEGIES TO CURB THE SPREADING OF COVID-19

The strategies taken by the affected construction site clusters to minimise the spread of COVID-19 were categorised into two groups. The first group consists of strategies based on government enforcement, and the second group sets out the initiatives taken by the affected construction companies.

Government enforcement

From the perspective of government enforcement, all the participants (namely GA1, GA2, GA3, GA4, and GA5) have explained that the implementation of all the protocols in the SOP and regulations is compulsory. Most of the construction projects implement the SOP and regulations imposed on them by the government to ensure that their projects can run smoothly without any suspension due to breach of the SOP. The government has initiated a special task force to monitor the level of SOP compliance at construction sites. By conducting site inspections, the government identified several factors that cause the spread of COVID-19 in such places, as discussed in the previous section. In response, the government has to tighten the SOP and regulations based on the factors that have been identified.

“For the CIDB, it is our responsibility to conduct site inspections for all registered construction sites. Currently, we have conducted 15,985 inspections involving 9,049 construction sites, with 99% appearing to comply well with the SOP and only 1% found to be non-compliant with the SOP, and these sites were consequently ordered to be closed.” [GA4, GA5]

“CPRC works closely with MOH to identify active cases, new cases, and clusters, as well as to identify the close contacts and PUIs for the recorded cases.” [GA3]

“Besides treating the COVID-19 patients, the MOH is also responsible for updating the patients' data to the CPRC and top management for the daily cases, updating information on the new variant if detected, doing the swab tests and site inspection if a big cluster is detected, like in construction sites and prisons.” [GA1 and GA2]

At the same time, the government has also granted several initiative funds to facilitate and lessen the burden among the construction companies and employees under the Protection of the Economy and the People of Malaysia (Perlindungan Ekonomi and Rakyat Malaysia, PERMAI) assistance package. This is intended to combat the COVID-19 outbreak, safeguard the welfare of the people, and support business continuity. Apart from providing free screening tests to local workers, the government also initiated the COVID-19

Screening Programme for all registered foreign workers under the Social Security Organisation (SOCSO), whereby the cost of the test kits will be fully borne by the SOCSO. Similarly, the CIDB also subsidised RM7 million for the COVID-19 screening test for registered foreign workers under the CIDB construction personnel. This test is important to identify COVID-19 clusters in the workplace, especially in high-risk zones. For local workers, the screening test is free and can be done at government hospitals if requested by the contractors or the developers.

Initiatives taken by affected construction site clusters

The second group of strategies consists of the initiatives taken by the affected construction site clusters to overcome the spread of COVID-19 at their construction sites after they were severely hit by the pandemic. The initiatives had been created and implemented during the closure to convince the authorities to allow them to continue construction work on site. From the case studies, three self-initiatives have been identified as important strategies that can be applied to improve the level of security and protection of their construction sites against COVID-19. The three strategies are to raise awareness and understanding regarding COVID-19 and the SOP among the construction site workers; to build a proper CLQ or a proper housing facility with adequate utilities and comfort for construction site workers, complete with an isolation centre; and to rearrange the work schedule and workers on-site (work planning and human resource management). [Table 7](#) shows the strategies taken by the affected construction site clusters in these three case studies. Although the construction sites are closed to date, in accordance with the CIDB's orders, the workers are directed to clean the site, complete critical parts of the current project, and make small repairs to their housing facilities within the construction site compound.

To increase awareness and understanding of the SOP during the pandemic, a COVID-19 Health Supervisor was appointed at the construction sites, assisted by two or three language translators among the workers, who are normally chosen based on the language mainly spoken by the workers. The language translator was chosen based on their understanding of English or the Malay language to ensure that they could accurately convey and explain the information to their team. This initiative was taken to guarantee that the workers are able to comprehend the pertinent issues.

“We used one of our workers as the translator to translate the SOP and other important information to their team using their native language because they could understand it better. Yes, we still appointed an SHO for our site to monitor the COVID-19 situation, but it is very helpful to also utilise the language translator.” [CA1, CA3].

Additionally, the sites also utilised speakers to amplify any reminder announcements to the workers as part of the efforts to ensure that they comply with the SOP. The announcements reminded them to wear their face masks, wash their hands, avoid gathering, and maintain physical distance.

“It's difficult to monitor all the workers on site, so what we do is, we will play a recording of SOP using a speaker that we place in selected areas every 2 to 3 hours to make sure they are always alert and remember their responsibilities to prioritise their safety and health.” [CA1, CA2, CA3].

As for housing facilities, the contractors and developers have taken the initiative to move some of their workers to more appropriate housing facilities either on site or outside the construction area. A construction company with enough budget would move its workers into a paid facility like the CLQ. However, contractors with a tight budget would attempt to manage the existing workers' housing facilities by reducing the number of workers working on-site in the same shift. The contractors rearranged and rescheduled the workload according to the availability of the skilled and unskilled workers. This can reduce the number of workers working in the same shift, promoting physical distancing.

“We manage our housing facilities by minimising the number of workers staying at the facility and designating an area to provide an isolation room. The number of workers at the site is limited according to the work schedule because we don’t have the budget to rent another place.” [CA2, CA3].

“... most of our workers are staying outside the construction area with a proper CLQ, and we hired a contractor to manage the CLQ and isolation room for our workers.... we also provide transportation for our workers to travel from site to CLQ and so on with a tight SOP in place.... Yes, we minimise the number of workers as required by the SOP in order to promote physical distancing.” [CA1]

In this section, it is evident that the government’s tight enforcement and monitoring are extremely significant in ensuring that the SOP and regulations are adhered to by the construction players. Contractors and developers should, however, take additional steps to prevent virus transmission on construction sites and, as a result, reduce the number of construction site clusters. [Table 7](#) shows a summary of the findings.

Table 7. The strategies implemented by the affected construction sites

Case Studies	Strategies implemented by the affected construction sites
Cluster A	<ul style="list-style-type: none"> • Site sanitations are scheduled (daily, weekly, and monthly). • Workers’ dormitories are upgraded to CLQ and daily sanitisation is performed. • Workers’ shifts are rearranged without overlapping the previous team’s shift. • All the workers, including the ones under subcontractors, must be tested for COVID-19 before being allowed to work on-site. • The regular rapid test is carried out for all staff and workers, including those of subcontractors. • Workers are always reminded about the risks and the preventive measures that should be practiced. • Workers who show symptoms are isolated.
Cluster B	<ul style="list-style-type: none"> • All workers must take the COVID-19 test and must be certified negative; the test is to be repeated every 2 weeks. • Transportation is provided for workers to travel from the site to their housing facilities. • All workers are relocated to a proper CLQ. • An on-site COVID-19 health supervisor is hired. • A self-isolation centre is provided for new workers before allowing them to work on-site, as well as for infected workers and their close contacts. • The working areas are regularly sanitised. • The number of workers in one working area is minimised. • Hygiene around the construction site and CLQ is improved. • Awareness and knowledge about COVID-19 and its preventive measures are promoted to the workers every day.

Table 7. continued

Case Studies	Strategies implemented by the affected construction sites
Cluster C	<ul style="list-style-type: none"> • All on-site workers are monitored by health supervisors and the MOH. • Sanitation is done regularly. • The COVID-19 test is made compulsory for all workers, especially foreign workers. • The number of on-site workers is minimised. • An isolation room is provided for infected workers and their close contacts. • Awareness and understanding regarding the SOP and prevention of COVID-19 infection are promoted to the workers.

Discussion

COVID-19 is potentially the worst global pandemic in world history. It has not only caused grave harm from the perspective of health and safety, but it has also crippled many sectors in the global economy, including the construction sector. Most of the construction companies are facing losses due to the temporary closure of construction sites following the lockdowns and stay-at-home orders, where only a limited number of workers are allowed on-site to prevent the spread of the virus ([IMF, 2020](#); [IMF, 2020](#); [DOSM, 2021](#)). Such circumstances have contributed to the suspension and delay of projects while also affecting project operation costs. In Malaysia, after the first lockdown ended and the economic sectors began to open up again, the second and third waves of COVID-19 occurred. During the first wave, the number of cases related to construction sites was quite low, but the numbers increased tremendously during the second and third waves of the pandemic.

As humans become the main agents of the spread of COVID-19 ([Araya, 2021](#)), it is important to explore the factors influencing the spread that increase the transmission and analyse how the impact on the affected construction companies can be reduced. Information from the right parties involved in the situation is important to ensure the authenticity of the information and to give a bigger picture regarding the real situation at the construction sites. The use of two entities in this study, from different backgrounds and which play different roles in managing the pandemic situation, is seen to be relevant. From the perspective of the government entities, they are responsible for ensuring that every rule and instruction set out in the SOP are properly adhered to at the construction sites in order to curb the spread of COVID-19. Meanwhile, the affected construction sites are being used as case studies to see how they deal with the scenario that arose due to non-compliance with the SOP and inadequate management of the COVID-19 risk at the construction site. Based on the study conducted, most of the factors influencing the spread have to do with poor construction-site planning and management, lack of awareness and knowledge, and poor human resource management by the construction companies.

Construction site planning management does not only involve planning the project life cycle itself but also the planning of the entire construction site, including site management, site planning, site cleanliness (i.e., waste management), risk management, logistics management, compliance with regulations, health and safety, and others ([Jimoh, 2012](#)). Proper management and planning are crucial, especially in a pandemic situation, to ensure that the construction site remains a safe environment and that construction activities can be performed with a minimum risk of spreading COVID-19 ([Araya, 2021](#)). Effective site management planning is important to ensure continuity of the project life cycle ([Mohd Zain, et al., 2018](#)) and promote sustainable construction ([Ochieng, et al., 2014](#)). Poor site planning and management have contributed to the high number of COVID-19 infections on construction sites due to the lack of a proper schedule for disinfection, no physical distancing, and the absence of proper hygienic on-site accommodation for the workers.

Furthermore, from the perspective of awareness and knowledge, communication is the most important element, because without a clear understanding of COVID-19, how it can be transmitted, and how it can be avoided, construction companies will not be able to effectively curb the spread of COVID-19 at construction sites. Therefore, the role of a Health Officer or Health Supervisor is an important one and having a trusted translator from among the workers will ensure that the correct information about COVID-19 reaches all the workers and they are able to properly understand the information as well as the SOP that must be strictly followed. A two-way communication with the management at the site is also important to ensure SOP compliance, and the top management must be made aware if the site is not effectively managed or if elements in the SOP are left unaddressed. The attitude of the workers can also be managed once they understand the impact and consequences they will face should the SOP be ignored.

The third perspective related to the main outcome of this study is human resource management. Human resource management concerns the management of workers, and this includes the arrangement of workers in performing construction activities based on their skills, working hours/shift, accommodation, welfare, and mental healthcare. Improper housing facilities, which are crowded and cramped, and workers' unhygienic living conditions portray the construction company's irresponsibility as an employer which fails to protect the welfare of its employees, especially foreign workers. The construction company should provide a proper CLQ with comfortable housing, adequate utilities, and facilities. The government has subsidised some of the initiatives for the foreign workers, such as bearing the cost of the COVID-19 swab tests and treatment, to help the construction companies reduce their financial burden during challenging times. Construction companies are more likely to take COVID-19 risk management and SOP compliance seriously if they have to deal with strict enforcement and hefty fines.

It can be concluded that SOP compliance is the key to curbing the spread of COVID-19 on construction sites. According to [Esa, Ibrahim, and Mustafa Kamal \(2020\)](#), the SOP has already included all the important elements that need to be prioritised during the construction activities, such as guidelines for workers' movement, workers' accommodation, workers' travel, and so on. All these elements are covered in order to minimise the factors influencing the spread. Somehow, lack of discipline and carelessness on the part of both employers and employees have led to construction sites forming the biggest cluster of COVID-19 infections, hence contributing to the high number of cases in Malaysia. As time goes on, strict adherence to the SOP and a number of actions taken by the construction companies can help other construction sites create a risk management plan that can be used to reduce the risk of COVID-19 infection at construction sites.

Conclusion

First, it is important to identify all the potential factors, both internal and external, that resulted in the spread of COVID-19 at construction sites. In essence, early identification of the factors influencing the spread enables the right strategies to be implemented by the government entities and the construction company itself to manage the cases effectively and prevent any further infection. Apart from government enforcement, contractors and developers should conduct their own initiatives to curb the spread of the virus. Therefore, this is the right time for the MCI to improve and create a better construction environment through the following recommendations: (1) providing adequate housing and improved health care for workers; (2) investing in ongoing education and training on effective construction site management; and (3) implementing new technologies on construction sites in tandem with Construction 4.0. One limitation of this study pertains to the data collected between April 2020 and February 2021, which was the peak of the pandemic. The central aim of this study is to document the factors influencing the spread of COVID-19 and strategies adopted by a developing country as an example of a means of dealing with unexpected

pandemics or other intractable diseases (in the future) that affect project delivery during the peak of a pandemic. This study does not cover the post-pandemic period.

Further work can be done to continue additional investigation in this research area, such as exploring the implications of introducing new construction technologies as a new norm to minimise open social interaction within the construction industry. Additionally, cross-sectional studies can also be conducted in other countries to analyse other applicable strategies to overcome the exacerbation of COVID-19 cases in the construction industry of the respective countries. Moreover, a longitudinal study of changes in combating viral pandemics may enrich theory and guide prevention and intervention strategies for the construction industry. It is hoped that this will encourage the construction industry to devise a workable strategic framework that can effectively manage the work at construction sites, even when COVID-19 has become endemic.

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