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Ramifications of the COVID-19 pandemic on construction operations in developing countries: Malaysian experience

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Abstract

Purpose – This study explored the ramifications of COVID-19 on construction operations in Malaysia.
Design/methodology/approach – Following a detailed literature review, 37 ramifications are identified and divided into nine aspects. A self-designed survey is then employed to seek the perceptions of construction practitioners around the Klang Valley region regarding the significance of the ramifications. A total of 203 valid responses are subjected to statistical analyses to prioritise the ramifications.
Findings – All the potential ramifications are perceived to be significant, with the five utmost critical ramifications being rescheduling the project timeline, compliance with government SOP, delay in the handover project, compulsory COVID-19 test for all workers and the extra cost incurred to provide COVID-19 test for workers.
Practical implications – This study highlights the ramifications of COVID-19 on construction operations and deliberately informs construction organizations regarding the shortcomings of recent construction management. Besides, the insights suggested that industry practitioners devise corresponding strategies for project sustainability in future similar crises.
Originality/value – The findings serve as a valuable reference and are benign to industry professionals and researchers from developing nations, especially nations that share similar characteristics to Malaysia.

Keywords Construction industry, Construction operations, COVID-19 pandemic, COVID-19 ramifications, Developing countries

Paper type Research paper

Introduction

Construction is among the most significant patrons of the global economy, accounting for considerable total gross domestic production (GDP) in most nations (Alaloul *et al.*, 2021). Therefore, countries, especially those in developing economies, have involved the

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construction industry in sustainable development. Unfortunately, the alarming health crisis of COVID-19 has set a predicament globally, creating chaos and devastating effects on all economic activities, including the construction sector. According to The World Bank (2020), the global economy has shrunk by about 5.2% due to the COVID-19 crisis, which is reported as the deepest recession since the Second World War. Furthermore, millions of people around the world are unemployed amid the COVID-19 fallout (Gamil and Alhagar, 2020).

Given the diversity of the construction sector, which encompasses constructing new buildings, renovating and maintaining existing buildings and other projects related to civil works such as roads, public utilities, maritime, transportation, energy and waste management facilities, construction is indeed playing a prominent role in revitalising the economy (Husien *et al.*, 2021). Therefore, immediately reforming the industry is necessary, as the industry has suffered from myriad COVID-19 impacts that have interrupted construction operations. Nonetheless, it is suggested that gaining exhaustive insights into the ramifications of COVID-19 is the predominant step in enhancing construction management. Hence, this study aimed to provide an overview of the significant ramifications of COVID-19 on construction operations. Several studies investigated the early impacts of the COVID-19 pandemic on the construction industry, but little attempt has been made in developing countries, which perceive the construction business as one of the significant economic pillars. This leads to a shortage of information regarding the major threats of COVID-19 in developing built environments, thereby causing inappropriate remedies to be taken. Notably, the construction sector contributed approximately 4–10% annually to the GDP in developing nations such as Malaysia, Lebanon, Jordan and Cambodia (Alaloul *et al.*, 2021; Alkilani *et al.*, 2013; Awwad *et al.*, 2016; Durdyev *et al.*, 2017). Moreover, the containment measures of COVID-19 implied higher costs in developing countries, which commonly lack healthcare capacity and fiscal space, higher informality, shallower financial markets and poorer governance (Loayza and Pennings, 2020). In essence, the impacts of COVID-19 will be more severe and long-lasting in the developing world, especially without proper implementation of COVID-19 recovery strategies.

To deepen the knowledge, this paper explored the ramifications of COVID-19 on construction operations in developing countries, providing Malaysia as a base of study. According to the Department of Statistics Malaysia (2023), the GDP of construction has been reduced by 44.3% during the COVID-19 crisis, which is among the hardest-hit sectors in Malaysia. Hence, this study is significant to uncover the significant impacts of COVID-19, which recently undermined construction operations, thereby assisting the construction stakeholders to develop appropriate and effective construction practices for the COVID-19 pandemic and future similar crises.

Literature review

Malaysian construction industry in COVID-19 crisis

COVID-19 is a contagious disease caused by the SARS-CoV-2 virus that originated in China. According to the Centers for Disease Control and Prevention (2022), the virus is highly transmittable through droplets and particles, which causes infected people to experience respiratory illness. Until 2020, this infectious disease had affected more than 200 countries and territories, with a minimum of 600 m confirmed cases and over six million deaths reported (Dao *et al.*, 2020). To curb the contagious disease, WHO (2023) suggested several key preventive measures, such as practicing social distancing, avoiding 3C (crowded, confined and close contact) places, wearing a properly fitted face mask, getting vaccinated, regularly cleaning and sanitising hands and being self-isolated. In Malaysia, a nationwide lockdown is imposed to contain the spread of the COVID-19 disease. This policy has completely restricted the movement of the community, including banning all unessential businesses. However, this

decision has caused the construction industry to incur losses of RM18.5 bn in the first three phases of the lockdown (King *et al.*, 2021). Being one of the major productive sectors, it is indispensable to reopen the construction of building-related projects, notwithstanding that the contagious disease has not been eliminated. In this regard, the government suggested incorporating COVID-19 measures into the built environment to curb the transmission of disease whilst sustaining the construction work.

Unlike other sectors, the work from home (WFH) policy is quixotic in construction. Instead, construction work often demands close interactions and consistent supervision on site to ensure the construction operations are aligned with the client's requirements (time, cost and quality) (Harari, 2020). Despite COVID-19 measures, mass infection is still enduring in the construction industry due to several critical challenges during implementation, such as ignorance and incompliance behaviours (Amoah and Simpeh, 2021). Moreover, Yap *et al.* (2022) revealed that conventional project delivery, which is labour-intensive, has an immense correlation with a high rate of incidence on site. For instance, the Ministry of Health (MoH) revealed that 11.56% of COVID-19 cases originated from construction sites. According to Malaysiakini (2020), Damanlela Construction Site Cluster is one of the biggest workplace-related clusters with a 56.9% high infectivity rate. Concerning the surge of COVID-19 cases, the Construction Industry Development Board (CIDB) responded that it is due to workers under subcontractors travelling across multiple sites to complete assigned tasks. Furthermore, the high transmission rate among the construction workforce is attributed to cramped worksite and crowded living conditions, which deter social distancing practices along with poor hygiene practices and the living environment (Chan, 2020). Amos *et al.* (2021) corroborated that the built environment expedited disease transmission, whilst the circumstances in developing countries were more damaging. Consequently, construction projects with severe mass infections will be temporarily suspended to contain the transmission on disease across the industry. As validated by Deep *et al.* (2022), workers' H&S is a major constraint of project success. Indeed, over 90% of the construction projects around the globe are disrupted with protracted delays and disorganized cash flow due to the COVID-19 outbreak (Alsharef *et al.*, 2021; Esa *et al.*, 2020; Hatoum *et al.*, 2021; Ogunnusi *et al.*, 2020).

Conspicuously, immediate recovery strategies are demanded to improve construction management for the contagious built environment. According to Sospeter *et al.* (2022), every post-disaster environment delivers unique intricacies and dynamics that inspire transformed management to be implemented for project sustainability and success. Hence, a comprehensive study of the relevant ramifications of COVID-19 shall be prioritized to devise coping strategies that can effectively rehabilitate the industry. In line with this, a literature review is widely conducted to include various aspects of the ramifications of COVID-19. As summarized in Table 1, a total of 37 ramifications are identified and divided into nine aspects: overarching time, financial, human resources, resource availability and accessibility, health and safety prevention, regulatory compliance, contractual issues and the psychological health of employees.

Ramifications of COVID-19 on construction operations

Generally, the ramifications of COVID-19 vary from contract to contract and nation to nation; however, induced significant effects on construction operations. Time is perceived as one of the most prevalent impacts in most countries, like Malaysia, the USA, India, Kuwait and Nigeria (Gamil and Alhagar, 2020; Hatoum *et al.*, 2021). Esa *et al.* (2020) from Malaysia, who conducted interview sessions with eight contractors listed on the Construction Industry Development Board (CIDB), asserted that the lockdown policy imposed to contain the spread of COVID-19 unexpectedly caused project delays, late delivery of building materials and rearrangement of the project schedule.

No.	Ramifications	References
	Time	
T1	Delay in handover project	Adhikari and Poudyal (2021), Shibani (2020), Esa *et al.* (2020), Gamil and Alhagar (2020), Ogunnusi *et al.* (2020), Alsharef *et al.* (2021), Umar (2021), Zamani *et al.* (2021), Ebekozien *et al.* (2021), Hatoum *et al.* (2021), Kaushal (2021), Majumder and Biswas (2021), Pamidimukkala and Kermanshachi (2021)
T2	Delay in material supply	Esa *et al.* (2020), Gamil and Alhagar (2020), Alsharef *et al.* (2021), Biswas *et al.* (2021), Hatoum *et al.* (2021), King *et al.* (2021), Umar (2021), Zamani *et al.* (2021)
T3	Rescheduling project timeline	Esa *et al.* (2020), Gamil and Alhagar (2020), Ebekozien *et al.* (2021), Hatoum *et al.* (2021), Kaushal (2021)
T4	Delay in inspections and securing permits	Alsharef *et al.* (2021), Hatoum *et al.* (2021), Kaushal (2021)
	Financial	
F1	Additional cost in providing personal protective equipment (PPE)	Adhikari and Poudyal (2021), Esa *et al.* (2020), Alsharef *et al.* (2021), King *et al.* (2021)
F2	Provide COVID-19 test for workers	Esa *et al.* (2020), King *et al.* (2021), Zamani *et al.* (2021)
F3	Cost in appointing COVID-19 health supervisor	Esa *et al.* (2020)
F4	Cost in providing transportation for workers	Esa *et al.* (2020), King *et al.* (2021)
F5	Cash flow problem/late payment	Ogunnusi *et al.* (2020), Osuizugbo (2020), Alsharef *et al.* (2021), Biswas *et al.* (2021), Ebekozien *et al.* (2021), Hatoum *et al.* (2021), King *et al.* (2021), Majumder and Biswas (2021), Pamidimukkala and Kermanshachi (2021), Zamani *et al.* (2021)
F6	Increase in material cost	Osuizugbo (2020), Alsharef *et al.* (2021), Ebekozien *et al.* (2021), Hatoum *et al.* (2021), Majumder and Biswas (2021), Zamani *et al.* (2021)
F7	Suspension of projects/reduced number of planned projects	Gamil and Alhagar (2020), Osuizugbo (2020), Alsharef *et al.* (2021), Ebekozien *et al.* (2021), Hatoum *et al.* (2021), Majumder and Biswas (2021), Zamani *et al.* (2021)
	Human resources	
H1	Reallocation of human resource	Esa *et al.* (2020), Gamil and Alhagar (2020), Hatoum *et al.* (2021), Iqbal *et al.* (2021), Stiles *et al.* (2021)
H2	Low productivity	Esa *et al.* (2020), Ogunnusi *et al.* (2020), Alsharef *et al.* (2021), Kaushal (2021), Stiles *et al.* (2021)
H3	Termination of workers	Esa *et al.* (2020), Gamil and Alhagar (2020), Biswas *et al.* (2021), Ebekozien *et al.* (2021), Hatoum *et al.* (2021), Husien *et al.* (2021), Majumder and Biswas (2021), Umar (2021)
H4	Work from home challenges	Gamil and Alhagar (2020), Alsharef *et al.* (2021), Lingard *et al.* (2021), Pamidimukkala and Kermanshachi (2021)
H5	Limited access to construction site	Iqbal *et al.* (2021), Stiles *et al.* (2021)
	Resource availability and accessibility	
R1	Material shortage	Adhikari and Poudyal (2021), Ogunnusi *et al.* (2020), Osuizugbo (2020), Shibani (2020), Esa *et al.* (2020), Gamil and Alhagar (2020), Alsharef *et al.* (2021), Umar (2021), Zamani *et al.* (2021), Biswas *et al.* (2021), Choi and Staley (2021), Ebekozien *et al.* (2021), Hatoum *et al.* (2021), Husien *et al.* (2021), Majumder and Biswas (2021)

Table 1.
Ramifications of COVID-19

(*continued*)

No.	Ramifications	References
R2	Tools and equipment unavailable	Esa *et al.* (2020), Ogunnusi *et al.* (2020), Choi and Staley (2021), Hatoum *et al.* (2021), Kaushal (2021), Pamidimukkala and Kermanshachi (2021)
R3	Lack of labour	Adhikari and Poudyal (2021), Esa *et al.* (2020), Gamil and Alhagar (2020), Osuizugbo (2020), Alsharef *et al.* (2021), Biswas *et al.* (2021), King *et al.* (2021), Majumder and Biswas (2021), Zamani *et al.* (2021)
	Health and safety prevention	
S1	Compulsory body temperature checking	Esa *et al.* (2020), Shibani (2020), Alsharef *et al.* (2021), Umar (2021)
S2	Practice social distancing	Esa *et al.* (2020), Shibani (2020), Alsharef *et al.* (2021), Iqbal *et al.* (2021), Kaushal (2021), Umar (2021)
S3	Compulsory COVID-19 test for all workers	Esa *et al.* (2020), Stiles *et al.* (2021), Umar (2021)
S4	Extra management for workers' accommodation and working schedule as well as site sanitation	Esa *et al.* (2020),Shibani (2020), Alsharef *et al.* (2021), Iqbal *et al.* (2021), Zamani *et al.* (2021)
S5	Contact tracing	Adhikari and Poudyal (2021), Esa *et al.* (2020), Iqbal *et al.* (2021), Kaushal (2021), Umar (2021), Zamani *et al.* (2021)
S6	Provide health and safety education for all workers	Esa *et al.* (2020), Alsharef *et al.* (2021), Iqbal *et al.* (2021), Umar (2021), Zamani *et al.* (2021)
	Regulatory compliance	
RC1	Comply with government SOP	Esa *et al.* (2020), King *et al.* (2021), Stiles *et al.* (2021)
RC2	Regulatory confusion	Alsharef *et al.* (2021), Choi and Staley (2021), King *et al.* (2021)
	Contractual issues	
C1	Issues and interruptions in contractual terms	Gamil and Alhagar (2020), Ogunnusi *et al.* (2020), Alsharef *et al.* (2021), Biswas *et al.* (2021), Ebekozien *et al.* (2021), Hatoum *et al.* (2021), Kaushal (2021), Salami *et al.* (2021)
C2	Increase in disputes, litigation and claims	Alsharef *et al.* (2021), Hatoum *et al.* (2021), Husien *et al.* (2021), Salami *et al.* (2021), Umar (2021)
	Psychological health of employees	
P1	Social isolation	Lingard *et al.* (2021), Pamidimukkala *et al.* (2021), Umar (2021)
P2	Stress about possibility of exposure to virus	Hatoum *et al.* (2021), Pamidimukkala and Kermanshachi (2021), Pamidimukkala *et al.* (2021), Stiles *et al.* (2021)
P3	Job stress and burnout	Hatoum *et al.* (2021), Lingard *et al.* (2021), Pamidimukkala *et al.* (2021), Stiles *et al.* (2021), Umar (2021)
P4	Financial distress	Hatoum *et al.* (2021), Lingard *et al.* (2021), Pamidimukkala and Kermanshachi (2021)
P5	Personal needs and family conflict	Hatoum *et al.* (2021), Lingard *et al.* (2021), Pamidimukkala and Kermanshachi (2021), Pamidimukkala *et al.* (2021), Stiles *et al.* (2021), Umar (2021)
	Others	
O1	Adoption of new technology	Adhikari and Poudyal (2021), Gamil and Alhagar (2020), Alsharef *et al.* (2021), Hatoum *et al.* (2021), Lingard *et al.* (2021), Pamidimukkala and Kermanshachi (2021), Stiles *et al.* (2021)
O2	Ability to secure loans at low interest	Alsharef *et al.* (2021), Hatoum *et al.* (2021)
O3	Review on improving existing system	Alsharef *et al.* (2021), Hatoum *et al.* (2021), Stiles *et al.* (2021)

Source(s): Table by authors

Table 1.

Financial is another noteworthy impact of COVID-19, which gathered considerable attention in the global construction industry. In the USA, Alsharef *et al.* (2021) revealed that the COVID-19 crisis has induced unappealing financial impacts such as deferred payment due to cash flow problems, suspension of ongoing projects and delay in commencement of projects, the extra cost to secure necessary personal protective equipment (PPE) and an upsurge in material costs. Moreover, Kaklauskas *et al.* (2021) observed that investment in construction-related projects has been reduced by 13–30% due to the unpredictable context of the pandemic.

Notably, human resources are valuable in the construction industry, given its labour-intensive nature. Nonetheless, Stiles *et al.* (2021) elucidated that the preventive measures implemented to contain the spread of disease affected the reduction of the workforce, low productivity and restriction of nonessential site visits in the UK construction industry. Indeed, Esa *et al.* (2020) corroborated that productivity has slid down by approximately 20% during the COVID-19 fallout. Moreover, Ogunnusi *et al.* (2020) revealed that the UK construction industry is facing a shortage in construction material supply, tools and equipment since the border between Indonesia and China is inaccessible to restrict the spread of COVID-19 disease. Likewise, the labour shortage issue is encountered in Malaysia due to the fact that foreign workers have returned to their respective countries, whilst the government has stipulated a more rigorous ordinance to restrict the entry of foreign workers during the pandemic (Zamani *et al.*, 2021).

To combat the infectious disease, corresponding H&S preventions are alertly introduced as standard operating procedures (SOPs) in most nations, such as distancing practices, one task for one worker policies, site surveillance and providing COVID-19 H&S education to the workers (Iqbal *et al.*, 2021). By conducting quality interviews with 23 construction experts, Umar (2021) discovered that regular health checks, providing screening tests and promoting H&S practices among workers are encouraged in Gulf Cooperation Council (GCC) countries. However, some industry professionals treated regulatory compliance as having a detrimental impact in terms of management and control of labour (King *et al.*, 2021). This may give rise to the unclear SOP guidelines announced by the authority, which often lead to interruptions to construction operations. Given their unexpected nature, most construction professionals in the US construction industry have suffered plenty of significant contractual issues. For instance, issues and interruptions in contractual terms and increases in disputes, litigation and claims due to nonperformance and delay (Alsharef *et al.*, 2021). Industry experts raised a discussion over the legal interpretation of the implications of the COVID-19 outbreak on construction projects (Husien *et al.*, 2021). A notable question emerged: Can the contractor include COVID-19 as a "force majeure", which represents an unforeseeable event to be exempt from compensation whilst granting the construction projects an extension of time (Biswas *et al.*, 2021; Ogunnusi *et al.*, 2020)? Since none of the construction parties would like to endure the losses resulting from the pandemic, conflict arises when there is a disagreement regarding the claim and interpretation of certain legal terms.

Meanwhile, studies have conceded that the psychological health of employees is another paramount aspect to be concerned about during the COVID-19 pandemic. Findings from Lingard *et al.* (2021) reported that the construction workforce is suffering mental anguish due to several reasons. Heeding the call of "teleworking", industry personnel are socially isolated, which causes them to have minimal interaction with family members, friends and colleagues (Hallin, 2020). As such, negative emotions derived from job burnout have no way to be expressed, thus leading to psychological distress. Financial distress has been reported as a critical factor in poor mental health due to the pandemic (Dawel *et al.*, 2020). Construction employees are afraid to be laid off, furloughed or have their salaries cut off, which will cause them to suffer from income loss. Indeed, more than 50% of the construction workforce has experienced elevated mental distress, depression, anxiety and stress from financial concerns

due to the deadly disease (Newby *et al.*, 2020). Certainly, construction practitioners with poor psychological health will thus disrupt the overall construction operations.

Despite myriad studies deliberating about the impacts of COVID-19, limited studies have focused on the context of a developing world in which the construction business plays a vital role in national economic growth. In bridging the knowledge gap, this study explored the ramifications of COVID-19 on construction operations, providing Malaysia as the base of the study. The findings are expected to present an overview of the construction issues in recent years, thereby supporting the project team to reform the industry.

Research methodology

The exploratory direction is embraced due to the scarcity of knowledge about the COVID-19 fallout. This study relied on a quantitative approach to uncover the most prominent ramifications of COVID-19 on construction operations. According to Naoum (2019), this technique is well-suited to establish reliable theories from the results. To recognize the prevailing impacts plaguing the building industry, a thorough literature review is initiated to examine a preliminary list. Pertinent studies regarding the construction industry during the COVID-19 outbreak were discovered using relevant keywords to search in research databases such as Google Scholar, Web of Science and Scopus. To capture the perceptions of the targeted respondents on the significance of ramifications, a questionnaire survey is engaged as the research instrument, given its benefit of gathering a satisfactory amount of responses in a limited time (Yap and Lee, 2019). The survey contained two parts. The first part is engaged to gather the background information of the respondents, whilst the second part accesses the viewpoints of respondents on the ramifications of COVID-19. For each ramification, the respondents are asked to rate the significance level based on a five-point Likert scale (with 1 = extremely insignificant, 2 = insignificant, 3 = neutral, 4 = significant and 5 = extremely significant).

Sampling and data collection

To ascertain the comprehensibility and appropriateness of the questionnaire, a pilot survey is first distributed to 30 experienced construction industry practitioners. Without necessary modifications, the questionnaire is further administered to targeted respondents through convenience, snowball and judgemental sampling techniques. Convenience sampling is engaged as the primary technique, which is convenient as it has limited prescribed characteristics (Etikan and Bala, 2017). The data collection process will be immediately suspended once sufficient responses are returned. Snowball sampling is embraced to accelerate the data collection process through a networking approach as well as to avoid missing out on any potential respondents, whilst judgemental sampling is considered to access respondents with the best information on COVID-19, such as the H&S officer (Fellow and Liu, 2015; Kumar, 2011). Moreover, the researchers were able to gather the opinions of the construction personnel in managerial positions who seemed to provide comprehensive data. Notably, the former sampling methods have been widely used for construction engineering and management-related survey research (Yap *et al.*, 2020), whilst the latter technique is suitable for describing the unknown knowledge of a phenomenon, like the COVID-19 crisis (Kumar, 2011). The sampling frame entails industry practitioners in the Klang Valley area, which is the central region with the highest gross output impelled by rapid construction activities in Malaysia (Department of Statistics Malaysia Official Portal, 2015). The targeted respondents encompassed the primary construction stakeholders, including the developer, consultant and contractor, to obtain a balanced view of perceptions. Despite the fact that the sample size was determined to be approximately 385, a total of 625 e-surveys designed by Google From were distributed to ensure sufficient responses were collected. Using the

platforms of LinkedIn and email, a total of 203 completed surveys were returned in a period of two and a half months. Overall, the response rate of 32.48% is beyond the common rate of survey (30%) for gaining feedback from construction personnel (Yap *et al.*, 2019). Although it is a self-voluntary participation survey, follow-up reminders are issued to nonrespondents to raise the response rate. It is also worth noting that ethics clearance are obtained from the university to conduct this meaningful survey.

The calculation of sample size is as follow:

Assumption:

$$\mathrm{P} = 50\%$$

$$\mathrm{Z-value} = 1.96\ (95\%\ \text{confidence level})$$

$$\mathrm{E} = 5\%$$

$$\mathrm{n} = \frac{0.5(1-0.5)1.96^2}{0.05^2}$$

$$= \frac{(0.5)(0.5)(3.8416)}{0.0025}$$

$$= 384.16 \approx 385$$

In the equation, P indicates the characteristics of the targeted respondents in this study and is recommended to be 50% of the population. According to Bartlett *et al.* (2001), researchers are suggested to engage 50% as the estimated value of P to maximize the variance and allow the largest sample size to be included. From the equation, the Z – value describes the confidence level in the accuracy of the results produced by the survey findings. As for this study, the typical confidence level for management research involved is 95% with a Z-value of 1.96 (Bartlett *et al.*, 2001). Besides, the E value, which revealed the risk level able to be liable, is assumed to be 5%.

Statistical analysis approach

Statistical Package for Social Sciences (SPSS) Version 26 software is used to perform quantitative data analysis. Descriptive statistics for the demographic information of respondents are obtained, whereby the relative ranking of the ramifications is determined based on the mean scores by considering the viewpoints of the respondent groups. Ramifications achieved with a higher mean value will therefore be regarded as more significant. If two or more yields achieve the identical mean value, the yield with a lower SD will be prioritized with a higher ranking (Yap *et al.*, 2020). To further evaluate the collected data, a nonparametric ANOVA test known as Kruskal–Wallis is applied to ascertain if there are any statistically significant differences between the three respondent groups. Variables obtained with a significance value (p-value) above 0.05 denoted that the respondents in all groups shared similar viewpoints on the ramifications, whilst p-values below 0.05 showed significant differences in perceptions among the respondent group (Shafiq and Afzal, 2020). However, the Shapiro–Wilk test is suggested to study the normality of the data, indicating the suitability of the Kruskal–Wallis test (Yap and Sim, 2011).

Analysis and discussion of results

Demographic profile of respondents

Table 2 provided detailed information regarding the background of respondents, broadly including representatives from developers (47), consultants (37) and contractor (119) firms.

Parameter	Category	Respondents group Developer	Consultant	Contractor	Total	Frequency (%)
Designation	Executive	24	24	63	111	54.7
	Manager	14	3	32	49	24.1
	Senior manager	3	5	14	22	10.8
	Director	6	5	10	21	10.3
Years of experience	X ≤ 5 years	10	18	39	67	33.0
	5 years > X ≤ 10 years	18	5	40	63	31.0
	10 years > X ≤ 15 years	10	4	16	30	14.8
	15 years > X ≤ 20 years	5	3	3	11	5.4
	X > 20 years	4	7	21	32	15.8
Education level	Postgraduate degree (Ph.D., Master's degree)	19	12	19	50	24.6
	Bachelor's degree	27	24	92	143	70.4
	Diploma, Certificate	1	0	7	8	3.9
	High school	0	1	1	2	1.0

Source(s): Table by authors

Table 2. Demographic profile of respondents

A majority (60%) had at least ten years of working experience in this sector, whilst at least 44% of the participants held a manager position or above in their respective organizations. In this context, the respondents are considered adequate to make informed judgements (Yap and Cheah, 2020). In addition, over 90% of the respondents are qualified with bachelor's or higher degrees. Thus highlighting that the skilled professionals are providing valid and noteworthy responses.

Questionnaire reliability

In this study, Cronbach's alpha coefficient parameter is employed to measure the reliability of the five-point Likert scale used in the survey. As a result, an alpha value of 0.965 is obtained, which represents satisfied internal consistency between the variables, and the measurement scale has attained a good measure of the yields (Deng *et al.*, 2018; Doloi, 2009).

Ranking of ramifications

Table 3 presents the mean, standard deviation and *p*-value of each variable according to the sample groups (developer, consultant and contractor). The ranking is assigned to each variable in ascending order based on the mean scores. Notably, all the ramifications of COVID-19 have obtained a significant mean value beyond 3.50. "Rescheduling project timeline" obtained the highest mean (4.36), which is therefore regarded as the most significant impact of COVID-19 on construction, whilst "Compliance of government SOP" is in second place with a mean value of 4.35. "Delay in handover project", which achieved a mean score of 4.34, is ranked as the third most critical ramification of COVID-19 on construction operations. Besides, "Compulsory COVID-19 test for all workers" is rated fourth place among all the ramifications measured (mean = 4.32), whilst "Extra cost in providing COVID-19 test for workers" is ranked fifth with a mean value of 4.28.

Meanwhile, the results of the Shapiro–Wilk test indicate that the data is not normally distributed with a *p*-value <0.05; therefore, the Kruskal–Wallis ANOVA test is further engaged to study the significance difference in the perceptions of respondent groups. Consequently, the Kruskal–Wallis ANOVA test provided that only the extra cost incurred to provide COVID-19 tests for workers (ranked more important by contractors), providing health and safety education for all workers (ranked more important by contractors) and the

Table 3.
Mean scores and ranking of ramifications

Ref	Ramifications	Overall (N = 203)			Developer (N = 47)			Consultant (N = 37)			Contractor (N = 119)			KW
		Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	p-value
T3	Rescheduling project timeline	4.36	0.904	1	4.36	0.965	2	4.27	0.804	4	4.39	0.913	3	0.306
RC1	Comply with government SOP	4.35	0.913	2	4.28	0.926	3	4.30	0.812	3	4.40	0.942	1	0.229
T1	Delay in hand over project	4.34	0.989	3	4.36	0.942	1	4.35	0.857	2	4.33	1.050	5	0.891
S3	Compulsory COVID-19 test for all workers	4.32	0.990	4	4.15	1.122	6	4.27	0.902	5	4.39	0.959	4	0.260
F2	Extra cost incurred to provide COVID-19 tests for workers	4.28	0.966	5	4.06	0.987	9	4.14	0.918	10	4.40	0.960	2	0.008**
R3	Lack of labour	4.26	1.008	6	4.19	1.035	5	4.19	0.845	7	4.31	1.048	6	0.278
S4	Extra management for workers' accommodation and working schedule as well as site sanitation	4.20	0.990	7	4.02	1.053	11	4.14	1.004	11	4.29	0.958	7	0.199
T2	Delay in material supply	4.20	1.034	8	4.15	1.142	7	4.14	0.887	9	4.24	1.039	8	0.480
T4	Delay in inspections and securing permits	4.15	0.955	9	4.19	0.970	4	4.00	0.882	16	4.18	0.974	11	0.264
F6	Increase in material cost	4.15	1.039	10	3.96	1.160	14	4.41	0.762	1	4.15	1.055	12	0.215
R1	Comply with government SOP	4.11	1.030	11	4.06	1.131	10	4.16	0.834	8	4.12	1.051	14	0.943
S6	Provide health and safety education for all workers	4.09	1.030	12	3.83	1.110	21	4.03	0.928	14	4.21	1.016	9	0.039*
F7	Suspension of projects/reduced number of planned projects	4.06	0.975	13	3.81	1.056	23	4.19	0.776	6	4.13	0.988	13	0.112
F1	Additional cost in providing personal protective equipment (PPE)	4.06	0.985	14	3.81	1.035	22	3.97	0.866	19	4.19	0.985	10	0.017*
P4	Financial distress	4.00	1.002	15	3.94	1.030	16	4.11	0.843	12	3.98	1.041	18	0.839
S2	Practice social distancing	3.99	1.101	16	3.77	1.127	27	3.97	0.928	20	4.08	1.136	15	0.091
S5	Contact tracing	3.96	1.031	17	3.70	1.140	31	4.00	0.782	15	4.04	1.045	16	0.135
P2	Stress about possibility of exposure of virus	3.94	0.958	18	3.96	0.908	13	3.97	0.799	18	3.92	1.026	20	0.978
H2	Low productivity	3.93	1.037	19	3.89	1.047	19	3.95	1.026	22	3.94	1.044	19	0.960
C1	Issues and interruptions in contractual terms	3.90	0.975	20	3.81	1.076	24	3.76	0.863	30	3.98	0.965	17	0.231
P3	Job stress and burnout	3.88	1.027	21	3.94	1.009	15	3.92	1.010	24	3.85	1.047	23	0.862
P1	Social isolation	3.87	0.937	22	3.96	0.884	12	3.84	0.898	26	3.84	0.974	25	0.810
H5	Limited access to construction site	3.86	1.072	23	3.94	1.111	17	4.00	0.913	16	3.79	1.104	28	0.546
F5	Cash flow problem/late payment	3.86	1.104	24	3.70	1.061	29	4.05	0.941	13	3.87	1.164	22	0.324
C2	Increase in disputes, litigation and claims	3.85	1.019	25	3.77	1.108	26	3.73	0.871	31	3.92	1.026	20	0.281

(*continued*)

Table 3.

Ref	Ramifications	Overall (N = 203) Mean	SD	Rank	Developer (N = 47) Mean	SD	Rank	Consultant (N = 37) Mean	SD	Rank	Contractor (N = 119) Mean	SD	Rank	KW p-value
O3	Review on improving existing system	3.84	0.974	26	3.83	0.940	20	3.95	1.026	22	3.81	0.977	26	0.588
P5	Personal needs and family conflict	3.81	0.992	27	3.89	0.914	18	3.78	0.947	27	3.79	1.040	27	0.852
S1	Compulsory body temperature checking	3.79	1.169	28	3.64	1.206	32	3.78	1.031	28	3.85	1.198	24	0.456
O1	Adoption of new technology	3.78	1.035	29	3.79	0.999	25	3.89	1.100	35	3.75	1.035	29	0.668
H1	Reallocation of human resource	3.76	0.942	30	3.70	0.907	28	3.97	0.957	21	3.71	0.949	30	0.335
RC2	Regulatory confusion	3.76	1.013	31	4.09	0.803	8	3.73	0.990	32	3.64	1.071	32	0.058
F4	Cost in providing transportation for workers	3.65	1.091	32	3.49	1.159	35	3.65	0.789	33	3.71	1.145	31	0.471
H4	Work from home challenges	3.63	1.146	33	3.70	1.061	29	3.78	1.031	28	3.55	1.212	33	0.671
F3	Extra cost in appointing COVID-19 health supervisor	3.48	1.114	34	3.40	1.210	37	3.65	0.949	34	3.46	1.126	34	0.625
R2	Tools and equipment unavailable	3.43	1.062	35	3.47	1.231	36	3.57	0.899	37	3.37	1.040	35	0.517
O2	Ability to secure loan at low interest	3.41	1.039	36	3.62	1.033	33	3.62	1.063	35	3.27	1.110	36	0.068
H3	Termination of workers	3.36	1.127	37	3.53	1.177	34	3.62	1.163	36	3.21	1.080	37	0.066

Note(s): SD denotes standard deviation, KW denotes Kruskal–Wallis, * and ** denote the mean is significant at 0.05 and 0.01, respectively
Source(s): Table by authors

additional cost in providing COVID-19 PPE (ranked more by contractors) had statistically significant differences between the three respondent groups (Table 2).

Discussion

The following discussion expounds on the five most critical ramifications of COVID-19 on construction operations. Scheduling is an important factor in determining project success. A good schedule allows a project to run smoothly and optimize the use of construction resources financially and operationally according to predetermined needs (Zakia and Febrianti, 2021). In the case of Malaysia, the government has enforced a national quarantine policy to restrict the movement of citizens in response to the COVID-19 outbreak. However, this policy put the construction businesses at a standstill for at least three months. Therefore, building activities that had been planned earlier are postponed, and the practitioners need to reschedule the project timeline (Gamil and Alhagar, 2020). When budget and time are limited for project completion, the project planner must carefully amend the work breakdown to avoid this inferior situation. Apparently, all unfulfilled construction tasks are being stressed in the remaining days to meet the date of completion as agreed by the parties initially. In line with these reasons, industry personnel claimed that the rearrangement of project schedules is the utmost ramification of the COVID-19 pandemic.

The government has decided to allow the reoperation of construction after the Cabinet realized that less than 40% of the budget allocated for the building sector in 2021 had been exploited to date (New Straits Times, 2021). Conditionally, all construction operations are implied by the strict SOP as specified by the Malaysian Ministry of Health. The enforcement of strict SOP in the construction sector is to ensure site safety, and it will be more practical to impose targeted lockdowns if any construction sites find an increasing number of infection cases. As highlighted by Esa *et al.* (2020), industry professionals treated this impact of COVID-19 as significant due to the tremendous effects of not adhering to the prescribed SOP. To limit the spread of disease, responsible authorities have conducted random investigations to confirm strict compliance with SOP is being adhered to on construction sites. Failing to comply with the stipulated SOP, the related practitioners will immediately get fined or warned. More imperatively, construction sites with immense disregard for SOP will be ordered to close until further notice. Around July 2021, 188 of the 810 operating jobsites investigated were forced to shut down due to non-compliance with SOP (PropertyGuru, 2021). In this situation, the construction projects will be further delayed, making no profits or more jeopardizing and the contractors will have to make compensation for noncompletion of work.

Before the COVID-19 fallout, a finding mentioned the notorious delay characteristic of the construction industry (Umar, 2021). Undoubtedly, the industry is facing a more advanced challenge of delay, which is aggravated by the pandemic. When projects are delayed, the party can either accelerate the building process or request an extension on time that is beyond the agreed completion date. However, none of these can be exempt from cost implications. Perhaps the additional expenses can be covered by the contingency sum, but most of the contingency allowances are unrealistic, especially when there are a plethora of prohibitive costs associated with COVID-19. Since the pandemic is an unexpected event, there is no extra contingency cost allocated in advance. Notably, whether the responsibilities will be borne by the contractors or equally distributed to all related parties is uncertain in this crisis. Relevant profound effects can be disputes and claims, arbitration and litigation and total abandonment (Alfakhri *et al.*, 2018). Expected disagreement shall result in dispute resolution; in addition, it is not free of charge. Additionally, the construction stakeholders will risk their public image when the project has a delayed handover. Precisely, none of these extended impacts is appealing for industry personnel; therefore, the delay in handover of the project has been rated as one of the top five ramifications of COVID-19.

COVID-19-infected people have different sicknesses. In this regard, even medical experts cannot determine if a person is infected by a contagious disease based on common symptoms such as fever and cough. With an upward trend of COVID-19 cases, the population around the globe has a high dependency on polymerase chain reaction (PCR) tests to help detect if a person has been exposed to the SARS-COV-2 virus before the COVID-19 rapid test kit was introduced. In Malaysia, the COVID-19 test was aimed at controlling the high infectivity rate when the vaccination programme had not been launched. Furthermore, all field workers needed to get screened before the resumption of work to ensure site safety (Esa *et al.*, 2020). The Malaysian construction industry is still very labour-intensive but there are limited slots provided for the health screening test, and the speed of getting results is relatively slow (Star Property, 2020). With these, a massive queue of foreign workers is found at a clinic to take the screening test with no compliance to distancing practice. This may turn into a terrible infection cluster if anyone from the crowd is detected positive for COVID-19. The surge in such high demand for COVID-19 tests was due to practitioners rushing to reshape their construction activities at the same time after a long haul of lockdown. As highlighted by Simpeh and Amoah (2021), screening is the only way to identify COVID-19 disease. Therefore, industry personnel must ensure all workers are screened before resuming building work.

The Ministry of Infrastructure and Port Development (MIDP) urged all industry employers to provide PCR tests for their workers to restrain the spread of disease. However, the cost of screening tests will not be abated by the authorities. Instead, the owners need to bear the cost of hundreds of construction employees in a company that is ill-afforded since the disease has unexpectedly plagued the industry. In this regards, construction practitioners revealed the prohibitive cost of complying with COVID-19 guidelines is unplanned (Simpeh *et al.*, 2021). During the pandemic, the estimated cost per PCR test is between RM 250 and RM350, which requires a minimum of three hours to get the result. Such costs will sum to a considerable amount of high expenses when the employers will have to be liable for all workers whilst facing financial distress from mobilization costs and profit losses since the initiation of the lockdown. In this vein, the construction practitioner will treat these as significant ramifications of COVID-19 in a beleaguered industry.

It is worth mentioning that all variables that are rated more important by contractors have labour-related impacts. As highlighted by Niroshana *et al.* (2022), managing the workforce is one of the most critical challenges in the COVID-19 era. Given that the contractors have an extensive number of workforces to sort out; it is unsurprising that the aforesaid ramifications, which involved high prohibitive costs, are ranked more significant by the contractor group.

Implications

Practical implications

By presenting an overview of the contemporary construction issues of COVID-19, this study reflected the severity of the COVID-19 crisis in dampening the construction industry. The outcome of the study highlighted that the most significant ramifications are majorly concerned with time, cost, H&S prevention and regulatory compliance. These implied that the construction practitioners would be more attentive in these aspects during unforeseen circumstances, particularly in a future similar crisis. For instance, the discussion suggested that industry practitioners should always reserve extra contingency funds to cover unexpected costs like purchasing COVID-19 PPE to contain the spread of the disease. Due to the extended impact of project delays, a backup schedule shall be prepared in advance to avoid further deferment. Also, there is a need to review the standard form of contract by elaborating on the contractual terms of "force majeure" or adding on extra conditions to

outline the responsibilities of parties during unforeseen circumstances. Additionally, the identified ramifications of COVID-19 can guide the construction stakeholders, including the client, suppliers, governments, consultants, contractor, etc. in confronting future similar crises by advancing the project delivery system whilst allocating sufficient resources.

Theoretical implications

This study provides a theoretical base for the significant ramifications of COVID-19 on project delivery, according to the experiences of the primary construction stakeholders. It is noteworthy that the sample size in this study is a paucity of similar studies that touch on the impacts of COVID-19. Moreover, this empirical study concerning developing countries is new to the construction management literature. The findings of this study suggest the most significant issues of COVID-19, which can serve as a guide for future studies intended to propose response strategies for unexpected events in the construction industry. Meanwhile, this paper highlighted that immediate studies are necessary to review the current project delivery system whilst developing a recovery plan to reform the industry from recession.

Conclusion

In recent years, the industry has been distressingly trapped in the COVID-19 crisis. Myriad consequences dreadfully dragged down construction progress, which is inextricably intertwined with the national economy. Hence, it is urgent to propose effective, sustainable and fulfilling responses to alleviate the impact of COVID-19 whilst sustaining construction operations. Nonetheless, it is suggested to well acknowledge the COVID-19 impacts to develop corresponding strategies. Previous studies focused on the early impacts of COVID-19 in the industry, but few have delved into the developing context. In bridging the knowledge gap, this study explored the ramifications of COVID-19 on construction operations in the Malaysian construction industry. A detailed review of the literature determined a list of potential ramifications, consisting of 37 variables, which are then divided into nine aspects. Following this, a questionnaire survey will be constructed and distributed to the construction practitioners to examine the significance of the ramifications of COVID-19. The participants have included 47 developers, 37 consultants and 119 contractors from the Klang Valley region. Prioritised using mean scores, the five most critical ramifications are rescheduling the project timeline, compliance with government SOP, delay in handover of the project, compulsory COVID-19 test for all workers and extra cost incurred to provide COVID-19 tests for workers. Besides, the result of the Kruskal–Wallis test indicated that the respondent groups have different views on several variables, including the extra cost incurred to provide COVID-19 tests for workers provide H&S education for all workers and provide COVID-19 PPE.

Limitations and future studies

A limitation of this study has been discovered to be that the data collection instrument used does not open up gateways to generate further explanations from the participants. Furthermore, the adoption of a five-point Likert scale has lacked reliability and validity, which does not provide more refined responses from the respondents (Dolnicar, 2021). As compared to mixed-method research, a mono-method research design is unable to provide a comprehensive outcome. Therefore, future studies have suggested including qualitative interviews or case studies to extract related information and knowledge from other developing countries in the Asia and Africa regions, which will be useful to corroborate the outcome of this study.

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