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Impacts of Covid-19 Outbreak on Civil Engineering Activities in The Malaysian Construction Industry: A Review

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ABSTRACT

The Covid-19 is a worldwide pandemic that has changed and disrupted the world's economic perspective. The construction industry, which is considered as one of the major growth engines for the economy, has been directly impacted. The pandemic is having a wide-ranging effect on construction and infrastructure projects globally. All developments and projects have been put on hold until further notice. Indeed, the current pandemic is a significant cause of project delays in Malaysia. The chain effects of the pandemic and its impact on the construction industry is extremely uncertain. In order to deal with this uncertainty, it is vital to determine and discuss the impact of Covid-19 on the construction industry since its early condition up until the current scenario in order to handle the potential risk and lessons that can be learnt for future planning. The aim of this research is to determine the impact of Covid-19 in civil engineering activities and the construction industry as a whole. In order to control the Covid-19 transmission, Malaysia has implemented Standard Operating Procedures (SOP) during the restriction period of the Conditional Movement Control Order (CMCO). In Malaysia, the entire construction and repair work progress that been subjected to Movement Control Order (MCO) were suspended and thus causes project suspension, delays, labour impact, work loss, time overrun, cost overrun, and other financial consequences. Therefore, it is recommended that the construction industry should utilize innovative construction technologies in order to overcome the problem that occurred due to Covid-19. It is also expected that the usage of construction technologies will assist in the development of a more sustainable infrastructure development as those technologies can be well adopted and implemented as a new norm in Malaysia.

Keywords: Covid-19; construction industry; MCO; CMCO; SOP; technologies; new norm

INTRODUCTION

The current Covid-19 crisis that has not been seen on this global scale has significantly impacted the industry's organization across all sectors and activities. In the terminology of scale, complexity, short-period, and long-period has an unprecedented circumstance that impacted on communities and organizations supporting local and global economies. Nearly every country's economic operation is in the hands of unexpected Covid-19 scenarios. Several businesses unintentionally flourish under the pandemic because of the intrinsic existence of the market operation, while some faced weather like a hurricane with considerable difficulties, but the construction industry is undoubtedly on the wrong end of the spectrum of the hardest impacted sector (Skanska 2018). Several members of the on-site sector, involving founders, contractors, clients, suppliers, and subcontractors have experienced various levels of impacts as the consequences of the coronavirus pandemic. The impact on both nature and scale relies on its particular area of organizations and the underlying projects to a large extent (Stiles et al. 2021).

During the pandemic, like many other nations, the Malaysian government had imposed a lockdown, from 18 March till 6 June 2020, which restricted the individual mobility and gatherings. However, owing to the restrictions levied by the authorities, all development operations and much of the industry activities around the country have been halted (Ray & Noah 2020). Not only that, the circumstances would obstruct the execution of the construction and engineering contract commitments and after the lifting of the existing constraints, this would lead to several legal conflicts for the business. In this paper, the coronavirus pandemic that have impacted the Malaysian construction industry is discussed. This would help to identify the problems that occur in the construction industry due to Covid-19 and to determine viable solutions to control and manage construction activities despite the outbreak of Covid-19. Thus, the

readiness of the community in adapting to the new norms of civil engineering practices in the construction industry should be highly considered. Further, it is recommended that the utilization of construction technologies to be extensively developed for a better future in terms of better economic performance in Malaysia.

IMPACT OF COVID-19 OUTBREAK ON CIVIL ENGINEERING ACTIVITIES IN THE CONSTRUCTION INDUSTRY

The coronavirus epidemic was proclaimed as an international public health emergency through the World Health Organization (WHO) by the end of January and announced as a pandemic on 11 March 2020 (Cucinotta & Vanelli 2020). In order to handle the epidemic, the restrictions of Movement Control Order (MCO) been implemented due to continuous and rapid growth in the cases of Covid-19. In general, the outbreak of Covid-19 and the MCO have triggered various and serious interruptions to commercial contracts and also to civil engineering sectors that involves infrastructure and construction contracts, particularly on failures to comply with the regulations and requirements of a contract. Typically, disruption to construction works that caused by Covid-19 has badly impacted the recent upcoming projects which have been cancelled during the MCO period. Approximately 19,077 of the total number of construction firms submitted to work under the MCO and those from the sector are recorded with an aggregate of 17,000 firms have been impacted despite their role as the construction industry's primary drivers (Ng 2020).

According to the Ministry of International Trade and Industry (MITI), there were 7,387 proposals denied and also 1,856 proposals were permitted to work. Number of the projects that had been given permission to proceed were advised to strictly follow the rules of project implementation for instance, the G1 and G2 categories of small construction firms were among those prioritised firms to begin construction work, including those project proposals that were lower than RM200,000 and those not achieving to RM500,000 (Kalbana & Nor 2020). Although if the Covid-19 comes to an end, construction works and progress are expected to be interrupted because according to Chelsey (2020), construction activities normally require a lot of time to be completed due to their nature and complexities. Precautionary measures of Covid-19 taken during the post-MCO are likely to delay the progress of construction work and thus, projects required the Extension of Time (EOT) (Esa et al. 2020). Besides, machinery such as bulldozers and lifts that were laid down for a certain duration had to be checked and examined by the authorities to ensure their safety aspects (Biswas et al. 2021).

Moreover, certain businesses in Malaysia were at risk as there was a strong reliance on the supply of industrial goods from China. Lockdowns were imposed by many states, triggering supply shortages due to transport bans or post-travel quarantines (Fadzlina et al. 2020). Manpower is also another major problem as due to travel limitations; many foreign workers were unable to reach Malaysia or leave their home countries. There were many construction firms and contractors had to deal with the shortage of workers due to restrictions imposed on the admission of foreign staffs. Therefore, construction firms had to pay the higher price of wages and salaries due to Covid-19 pandemic besides facing other issues with the introduction of the movement management order (Wahab 2020). Further, contractors had to deal with the postponements of contracts or increased expenses and, besides other amendments that had to be made. In many cases, plant and material shortages occur as a result of changes and delays in goods importations, site operations and supply chain matters (Zamani et al. 2021). Therefore, in order to handle the consequences of Covid-19 on the construction industry, employees need to adhere with the new standards enforced by the government of Malaysia.

NEW NORMS FOR CIVIL ENGINEERING PRACTICES IN THE MALAYSIAN CONSTRUCTION INDUSTRY

From 4th May 2020 onwards, the construction industry was resumed to its normal operations by adhering to the Standard Operating Procedures (SOPs) as outlined by the Government. Industrial workers are responsible in ensuring the compliance of all SOPs related to the MCO to safeguard the welfare of workers and deter the Covid-19 transmissions to building areas, construction sites and their nearby regions. Construction works can be stopped immediately and actions on the contractor can be taken if the contractor fails to comply with the required SOPs. Thus, SOPs must be strictly followed under this new norm and it must become part of society's life. Best practices in Standard Operating Procedure (SOP) could aid in the prevention of Covid-19 from spreading to on-site activities, particularly on construction workers, thus reducing the level of labour productivity that could affect Malaysia's economic development. The SOPs that all construction sites are required to comply must be clearly incorporated in its policies and operations and (Jocelyn et al. 2020).

TESTING AND HEALTH SCREENING OF WORKERS

The temperature screening tool that is known as thermal scanners used by the Ministry of Health (MOH) are widely adopted to measure the body temperature of employees. This protocol has been practiced throughout Malaysia and the health screening is required for staff with a body temperature greater than 38°C. For instance,

Sunway construction also implemented body scanning temperature as a preparatory step for admission to construction sites (Sude 2020). Besides this, it is also compulsory for all foreign and local employees to undergo Covid-19 health screening checks to ensure that they are infection-free before they perform their tasks and activities. In fact, supplying thermal scanners and screenings for workers at construction sites are among the standards and requirements that must be fulfilled by contractors and firms to commence with their work. There were 12,023 registered foreign workers in Penang's construction industry and 9,654 of them have gone through the process of mandatory coronavirus screening (Audrey 2020). In addition, 99 percent of overseas employees enrolled with the Penang Island City Council in order to go through screening process, while 90.2 percent of overseas employees enrolled with the Seberang Prai City Council (Jagdeep 2020). Thus, in the construction industry, the screening of workers' health is very critical due to a high number of foreign to fulfil the demand of manpower needs for continuous infrastructure development.

SOCIAL DISTANCING

In order to ensure social distancing among workers in the implementation or operations of construction activities, workers are divided into to a few areas according to their scope of work at the construction site. There was a case of 350 tested workers in Kuala Lumpur and only 44 of them were tested positive with Covid-19 (Dawn 2020). The significant number of more than 10% infected workers from a particular construction site, reflects that the practice of construction activities that limits social distancing, besides poor hygiene practices. In order to reduce the chances of Covid-19 spreads, employers must educate staffs and construction workers on the requirement of hygienic standards, healthy and safer work procedures and other preventative measures that must be taken to meet the Standard Operating Procedures (SOPs) at construction sites and living areas. The command and orders by the authorities of various departments to inspect the condition of foreign employees in Selangor and Kuala Lumpur is a preventative step to ensure workers' well-beings are best-fit for their working environment (Shah et al. 2020).

As the site operations of construction works were only approved during weekdays for about eight to nine hours of working time depending on the conditions of Covid-19, the manpower planning of construction activities is crucial. In addition, construction firms need to ensure that workers' mobility and logistics are properly arranged to enable safe movement among workers in performing their tasks, for instance the number of construction workers at sites is limited to a maximum of fifty percent as compared to normal days. The reduction of workers number is vital to allow social distancing and to ensure safe movements among them. According to Joseph and Rahimy (2020), the safe social distance of at least 1 metre is a compulsory procedure that must be followed at all workplaces. Accordingly, disinfection and decontamination exercises must be carried out routinely, especially in common public spaces. Besides on-site activities in the construction industry, organizations conduct virtual meetings due to travel restrictions and working from home orders during lockdown. Thus, it is important to ensure that virtual meetings are conducted effectively and comply with the company's policy. Moreover, mass gatherings are prohibited and this require organizations and associations to hold meetings online (Iksal 2020). Even if face-to-face meetings need to be conducted, for tracing purposes, each worker is required to use the MySejahtera programme to ensure a systematic recording of their health condition (ThinkCity 2020).

Besides the aspects of health and safety at work, workers' welfare is another priority in dealing with construction activities. Training and briefing sessions are held regularly to expose and train staffs on safer working practises to ensure that they follow safety and protection laws. In the light of the Covid-19 pandemic, it is important to conduct a safety briefing on a daily basis or once per week in order to increase workers' awareness and focus on health and safety issues (Jeschke et al. 2017). Construction projects need to continue with their activities and operations while maintaining health and safety standards and this could be challenging. Therefore, construction sites have to get going as they contribute to the economic growth of the country but it is vital to strictly follow the standard operating procedures with more stringent monitoring and control system to ensure the health and safety conditions of staff are able to cope with the threat of Covid-19 pandemic. Thus, it is important to practice social distancing at workplace or construction sites, and in any dangerous or hazardous condition, personal Protective Equipment (PPE) like mask, shield, safety boots, and safety helmet can be used.

ADOPTION OF TECHNOLOGIES IN THE CONSTRUCTION INDUSTRY

As discussed earlier, the new norms of maintaining social distance as practiced globally are essential to control the spread of Covid-19. At the beginning stage of Covid-19, the utilization of technology been implemented with the focus on healthcare systems, for instance, technology such as Makcik Kiah19 (MCK19) is the first Malaysian-made delivery robot for hospitals, designed to support healthcare frontline workers in delivering healthcare to Covid-19 patients (Al-Ogaili et al. 2020). Looking into the construction industry, in general, Malaysia is still focusing on the manual way of manpower efforts rather than the application of

technology in construction activities due to resources limitations. However, as things were getting chaos due to Covid-19 pandemic, there is an urgent need to utilise and adopt construction technologies to handle and overcome the site issues related to Covid-19 pandemic. Construction technologies include current innovative tools that are widely adopted throughout the world, especially in developed countries. Therefore, it is vital to consider the utilization of construction technologies in Malaysia in facing Covid-19 pandemic. As a general, basic and compulsory application or tool for health screening and documentation, namely MySejahtera (Tay 2020), other specific technologies related to Information and Communication (ICT) technologies are widely adopted in the construction industry. Although Covid-19 can be considered as a challenge to the industry, it opens up an opportunity for cutting-edge technologies to be adopted and implemented as new norms in Malaysia including Building Information Modeling (BIM), drones, virtual reality (VR), robotics, augmented reality (AR), and etc. These technologies can contribute towards the improvement of workers productivity, besides ensuring the health, well-being and safety aspects of workers in the construction industry as fewer human interactions are needed. These technologies are expected to stay and continue to evolve despite Covid-19 pandemic.

TRACING APPS

Generally, in relation to Covid-19 pandemic, authorities have launched many smartphone applications to assist the community, authorities and the industry in ensuring all entities in the economy can continue their operations and activities despite the movement control order (MCO) due to Covid-19 pandemic. Tracing application is one of essential applications that is adopted to ensure the compliance of standard operating procedures in handling Covid-19 pandemic. Malaysia has launched three smartphones' applications namely GerakMalaysia, MySejahtera, and MyTrace, which are used by the whole community in public areas and at work. The MySejahtera application for instance, was launched in April 2020 by the Malaysian government as a pilot programme. It aims to track the Covid-19 transmission through data collection from communities by self-physical evaluation using temperature recordings. This application is used to ensure communities registered themselves when entering a public place including offices and construction sites. The Malaysian government has agreed to make the use of this tracing application, MySejahtera as mandatory in all types of buildings. Communities are required to scan the MySejahtera application to record their presence with personal particulars especially body temperature and failure to do so, RM1,000 fine will be imposed (Alexander 2020). Construction employees are also required to use the MySejahtera application for the purpose of tracing and monitoring before entering construction sites. On 4th June 2020, Perak was the first state to mandate the public to use the MySejahtera as enforced by the local government authorities (Fadillah & Foo 2020).

BUILDING INFORMATION MODELING (BIM)

Building Information Modeling (BIM) is an application developed in promoting inter-organizational and wide-ranging coordination in the architectural, building sector and engineering in order to increase the quality and accuracy of building planning, renovation and repair operations. BIM is a modern construction management process, which allows users to create object-based multi-dimensional parametric models as a tool for construction project during their whole life cycle (Li et al. 2017). The utilization of this technology as a solution in the building sector resulted in improved job quality, improved work quality and competitiveness to control the overall budget of a building project besides efficient planning and effective building maintenance (Doumbouya et al. 2017). Related to BIM adoption in Malaysia, Construction Industry Development Board (CIDB) of Malaysia has established a roadmap for the construction industry on Industrial Revolution 4.0 (I.R. 4.0) which emphasizes on the adoption of BIM in the construction industry. With the challenge of Covid-19 pandemic, BIM plays its important role in the planning and communication of building project as it integrates project members in the planning, design, modelling etc. from different places, thus limiting physical movements and contacts. BIM adoption is able to reduce the amount of time spent on the preparation and development stages of building projects by 15-20 percent. The proposed planning and modification of the project in terms of the design and construction work for instance, can be assessed by all project members and other relevant parties for faster actions and more efficient decision-making process can be made (ARUP & thinkCITY 2020).

The utilization of BIM throughout a project lifecycle is optimised by various innovative technology-based elements of IR 4.0, such as Cyber-Physical Systems (CPS), Internet of Things (IoT), Internet of Services (IoS), Artificial Intelligence (AI), Big Data, and Smart Production which involves various types of computerisation software. BIM expands the tool functionality of information technology related applications to be adopted at construction site by controlling building design in terms of its structure, materials, manpower, and the overall performance of building projects. Thus, this kind of modelling can be linked to local authorities and council departments' that require information on the project's performance and progress (Diana 2020). Besides, it is encouraged to develop the cloud platforms for BIM model management

in order to create a monitoring and control framework for construction sites which can be performed on a virtual basis with the aim to reduce the risk of Covid-19 infection by reducing human interactions. Data and information are communicated based on a real time approach to the cloud network of an infrastructure project. the infrastructure. Therefore, BIM can be considered as an effective supporting mechanism for ensuring that project members and external parties deliver a construction project efficiently and effectively while fulfilling the requirements of a construction site's Safety Protocol and workers' health (Pavón et al. 2020).

DRONES

In Malaysia, the Department of Occupational Safety and Health (DOSH) has urged the construction industry to use drones and remote sensing devices to monitor construction sites (Bernama 2021). The adoption of drones involves technologies like are UAS (Unmanned Aircraft Systems) and UAV (Unmanned Aerial Vehicles), to perform various tasks on and above the work site such as monitoring and surveying. Technological advances and innovations have made drones become a cost-effective tool for construction sites. Construction projects of huge size and industrial scale around the world adopted drones for real-time site surveillance to ensure secure physical distances. Drones perform various tasks and construction activities related to inspection tasks, such as site appraisal, grading, earthworks, ground-breaking, security compliance, documentation of asset inventory, progress monitoring, safety, and identification of drone-conducted or aided hazards while maintaining a secure social distance for those who are involved in the project implementation (Elghaish et al. 2020). Even if, in the absence of site engineers or site supervisors, the utilization of drones can be used to track and improve the on-site construction work to make sure a good building progress as required by the project's specifications. For instance, drones can be used for site mapping based on a faster and more efficient workflows with less effort of human resources needed. Various secondary data products, such as shapefiles, contour lines, and tracer products can be obtained via drones, and then generated and interpreted by the Geographic Information System (GIS). The adoption of these technologies can assist construction firms and projects to improve their turnaround reporting by 25 percent and cut back on-site waste by 18.4 percent (Tkáč & Mésároš 2019).

According to Desa et al. (2019), resource tracking in the mining and aggregate industries has been revolutionized by aerial data from drones. Drone aerial data is used in image processing, cloud computing, and machine learning technology to ensure that inventory management become more effective in terms of its storage and retrieval. In the construction industry, as it involves various geographical locations and conditions, the adoption of drones can ease pre-construction tasks and efficiently monitor and control work progress. In this case, surveying works can be performed with minimum involvement of staffs, thus limiting inter-personal interactions in facing Covid-19 pandemic. Due to the hilly terrain of the survey region for instance, the use of drones will be of value. Obstacles in this particular area must be marked to ensure the smooth and safe operation of the drones. Surveyors, for instance, use aerial surveying technology using drones to assess stockpiles with a dense point cloud using photogrammetry processes, which is faster and simpler. Thus, by using drones, stockpile inventory tasks become more effective, with the improvements of financial forecasts manufacturing and supply chain management. Indeed, the adoption of drone technology contributes to time saving and manpower reduction in surveying tasks, but at the same time it ensures the precision of survey works. In comparison to conventional techniques, with the adoption of drone, surveying tasks will weigh up to 100 hectares in 12 hours, allowing for significant time savings and by using drone technology, the mining industry can improve the precision of whole stockpile component measurements and simulate the plant area in a 3D model (Faine et al. 2015).

VIRTUAL REALITY (VR) AND AUGMENTED REALITY (AR)

The Covid-19 pandemic has triggered construction companies and projects to reconsider their priorities in facing the economic challenges and uncertainties, since the slow take up of the construction industry to embrace emerging technologies. Therefore, new opportunities for a variety of innovations, including augmented reality (AR) and virtual reality (VR), which are expected to have an increasing impact in the coming years to remain competitive in the construction industry. It is imperative that the adoption of augmented reality (AR) and virtual reality (VR) technologies are recommended to be used in the construction industry especially in handling Covid-19 pandemic. As compared to the other developed countries like the United States, United Kingdom, Japan, etc. Malaysia is still at its infant stage when adopting more advances or innovative technologies such as these technologies and thus calls for the Malaysian construction industry to embark upon and invest in these technologies, as they can be considered valuable tools for a higher and better project performance. Generally, augmented reality (AR) and virtual reality (VR) can be of value in a project implementation as AR for instance, super-imposes computer-generated images and facts on real-world images, while VR generates an entirely virtual landscape. As a building project normally takes

months and years to be completed due to its complexities, the adoption of AR and VR can assist in the project implementation more efficient and effective. Thus, AR and VR make it physically possible for engineers to verify any details, during the design stage in particular and also throughout the project life-cycle. In a building project for instance, AR and VR technologies inspect every corner of the construction site, before laying the foundation, combining visual and physical views to help construction teams drive greater quality and precision in their projects' implementation (Ahmed et al. 2017).

Besides, virtual reality technology could enhance the experience of workforce in a building project with various simulation tools before a building is completed, thus allows for changes and, improvements. In addition to the convenient use of VR and AR in building projects, labour costs can also be minimised. In contrast to the actual needs and involvement of many workers in the construction industry to perform construction activities manually, the adoption of VR and AR enables work to be carried out off-site, from the workplace, thus reducing the risk of Covid-19. AR and VR also assist in the management of construction sites in terms of tracking and the assessments of the overall site surroundings and environment. This includes as assessment on the types and number of tasks that need to be performed in specific areas on a virtual basis first, rather than straight away assigning staffs on site to excavate the construction areas. In the planning phase of a project life cycle, it is essential to make sure the project plan is developed to meet the needs and wants of the clients. In this case, both developers and architecture firms for instance, could completely view and simulate realistic models by facilitating the use of virtual reality technologies in conjunction with BIM. Construction firms may create comprehensive, interactive models of construction projects in conjunction with 3D modelling software and BIM to visualize and show the outset and holistic view of a building project to a client. Based on this, clients are able to visualize, capture and comprehend the project's rationality, results or outcomes and make any desired improvements or corrections before a construction starts (Wang 2007).

For instance, the virtual reality application called Scaffold VR created by the United States, Avontus Software, has a special feature of a visual walk-through of prototypes created using the company's Scaffold Designer software. The software also allows the user to view and share building designs in a simulated 3D world. It allows team members to view the sketches from either venue, reducing mistakes and expensive reworks (Brian 2021). While traditional 3D models replaced the blueprints and rough mock-ups, virtual reality has a lot more to offer to project members and stakeholders as various tasks can be performed real-time on a remote and virtual basis. For instance, pouring concrete slab in an incorrect and inaccurate position is one of the most common error where the ground for the base can be destroyed, which inevitably requires subsequent works to replace or rework the misaligned base. If a technology such as AR and VR can be adopted, work procedures can be planned accordingly and real work implementation can be performed accurately. In addition, the adoption of virtual reality technology allows for a more convenient and safer working environment with less site visits and physical human interaction. In managing Covid-19 pandemic, workers, technical, and non-technical experience in projects implementation are of value, but knowledge and skills in adopting these technologies should be developed and supported with hands-on training before performing simulations based on the real site scenarios. Training on various construction activities can also be conducted using real-time simulation techniques and methods using AR and VR tools, before staffs can perform and deliver their tasks and responsibilities on-site after related training take place once workers have achieved a certain level of competencies. In relation to its usage in the training programs of construction firms or projects, VR serves as an important platform for the knowledge of health and safety aspects in a building (Woksepp 2007).

On the other hand, AR is designed to enable on-site staffs to automate any measurements related to the stage of projects' development. It has the potential to change the way humans collaborate with autonomous computers in a more interactive way. As for instance, the magic hat, known as the DAQRI Smart Helmet developed by headquartered in Los Angeles is a wearable augmented-reality platform being built for use in the industrial fabrication sector, particularly in the structure and site sector (Asgari and Rahimian, 2017). It enables architects, developers, and designers to wear their BIM models on their heads and view them as a full-scale 3D world on the construction site. The new version of DAQRI developed to revolutionize building construction, but it still depends on importing a static graphical model of a building and superimposing it on the actual condition of a project. It could identify components concealed from different views and automatically reflect them to users that push virtual reality to the brink of X-ray vision, and the construction industry into a world of material omniscience in real time (Zach 2017). The use of augmented reality (AR) is expected to expand rapidly, particularly because the access costs are lower than those of virtual reality (VR). Workers will be given AR units that will enable them to automatically calculate the building components and compare them to the model's specifications.

Meanwhile, augmented reality is used to determine a space's physical features, including its height, distance, and depth. Construction organisations transformed data into models, helping

these models to generate prototypes that are more accurate and offer a more holistic view of the project. In addition, AR provides specified working hours and materials that are required in a project in a more effective manner as it allows more precise measurements through the utilization of augmented reality. It has exact construction metrics that determine the duration of a project including productivity measurements and the precise labour requirements and materials available (Meža et al. 2015). In addition to the planning phase, augmented reality has been built to allow field workers during construction to automate measurements on-site. Workers will be able to determine and compare an automatic measurement of the built components with the measurements specified in the building models by wearing an AR unit. Staff were encouraged to detect and rapidly change any inconsistencies in the systems to reduce the increase in costs and delays of a particular project (Zhou et al. 2017).

ROBOTICS

Robotic is one of the primary focused technologies in the development of more productive, efficient, and effective operations in the construction sector. Robotics have the potential to overcome the shortcomings of building components production, for instance but the adoption rate is very low. Recently, due to Covid-19 pandemic, the adoption rate of robotics technology is higher as robotics offer an automation system with various advantages from their innovative features. Big scale and huge size building projects for instance, are more advanced in robotics adoption by using the power of robotics to perform repetitive and tedious tasks by the massive use of automated bulldozers, excavators, and other traditional on-site machinery. In this way, a huge amount of manpower is not required as human-skills have been substituted by machineries and automations.

With the existence of Covid-19 pandemic, it is important to ensure that the operations of construction projects are continuous to meet the demands of the construction industry. Therefore, in the adoption of robotic technologies, investments in this technology are viable, despite its high costs and price as robotics assist in the productivity and performance of construction activities in terms of cost savings, time reduction and work quality. In addition, the adoption of self-operating machines supports the lack of labour supply due to restricted travelling and movement of foreign workers during Covid-19 pandemic. Despite the lower supply of labour, construction sites are able to operate in a more effective manner based on a careful consideration on the cost and benefit of using robots in a particular project implementation (Lim 2020). The construction sector in Malaysia is on its way to invest this technology, and trends to sustain it in the future.

A team of robotics experts from the Faculty of Engineering, Universiti Putra Malaysia developed five robots to disinfect and avoid the transmission of Covid-19 as the use of this robot may be helpful to the hospital's Emergency Response Team (Zulita 2020). Although this robotic project is specifically developed for the healthcare industry, it can also be adopted and be used at construction sites and buildings. This opens up an opportunity that Malaysia has developed robots for health facilities which have the potential to be applied in the construction industry. For instance, in the United States, a collaboration between Boston Dynamics and Trimble has developed the use of Spot, a dog-robot which performs activities such as site surveying, scanning, and progress reports. Spot was tested in pilot projects on building sites with difficult conditions, such as solar farms (Bouffanais & Lim 2020).

Besides, the advantages of using robots in the construction industry, the huge costs of initial investment for robotic adoption must be highly considered. In the long run, the adoption of robot appears to be more efficient, effective, reliable and less costly as opposed to manual labour, but the adoption should be outweighed with the benefits and advantages of construction performance. Although there is a possibility of manpower reduction with the adoption of robotics, it can overcome the issue of skilled manpower supply while generating precision in craftmanship, higher outputs and competitiveness that bring additional dimensions of values to construction projects. Moreover, with the introduction of cobots or collaborative robots which developed and produced to function with human equivalents. Cobots help to improve and raise productivity by committing tasks that are perceived as repetitive, tedious and boring by workers. Cobots can also decrease running costs substantially by reducing the amount of manpower required for a project (Delgado et al. 2019). Despite the need for repairs or other forms of malfunction, robots are able to perform various tasks with less human interaction on a continuous basis to handle the challenges of Covid-19 pandemic in a progressive manner.

CONCLUSION

This article explores the impacts of Covid-19 pandemic on civil engineering activities in the Malaysian construction industry. From the reviews, it is discovered that some of the issues related to Covid-19 pandemic are time delay, shortage of supplies, lack of manpower, postponements of contracts and financial impacts. Despite technological innovations and advancements, it is still not a normal and common practice in the Malaysian construction industry to adopt various technologies in the construction industry due to various barriers such as cost, price, culture and technology

know-how itself. However, the adoption of construction technologies with real-world applications and advantages is of value in handling Covid-19 pandemic. In this case, the Malaysian construction industry will remain competitive by integrating new approaches into their strategies and workflows. Since the Covid-19 pandemic gives challenging impacts to the construction industry as a whole, it is highly recommended to consider technology adoptions in the implementation of construction projects in order to achieve higher project and work performance, enhance coordination, and projects completion on time and within budget, which will result in higher profit margins.

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None.

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