Rebuilding the Construction Industry: A Strategic SCM Framework for Overcoming Pandemic Challenges

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ABSTRACT

The COVID-19 pandemic has posed great challenges globally as well as to the construction industry, leading to organizations having to re-examine their response mechanism to remain competitive. In Malaysia, private housing projects have been among the most severely affected, with 539 classified as sick projects. However, despite being among the worst hit, the number of research focused on holistically addressing the pandemic challenges are lacking, while existing initiative in Malaysia lacks innovative approaches. Poor performance by the industry has led to calls for change and SCM has been promoted a strategic path forward however, past SCM studies have also lacked holistic approaches, resulting in underutilized SCM strategies. This paper, which is part of a university research grant, therefore explores the significant pandemic challenges confronted by the construction industry in Malaysia, with specific attention to private housing projects, and the potential of SCM as the way forward. Pathogen, which refers to dormant conditions, will be employed as a means for classifying the significant pandemic challenges, enabling resolution from their roots. Through a mixed-method approach involving Fuzzy Delphi Method (FDM) questionnaires and Semi-structured Interview on industry experts, this research aims to tackle the pandemic challenges systematically and propose a Holistic SCM-Based Framework to facilitate improvements. The findings are expected to make a significant contribution to empirical studies on SCM by devising a framework that leverages on SCM instruments to overcome the key determinants of pandemic challenges. Moreover, the framework is expected to offer practical insights for policymakers and industry stakeholders, potentially serving as a model for other countries to emulate in handling similar challenges in the future.

Keywords: COVID-19, Malaysia, Pandemic Challenges, Private housing projects, Supply Chain Management (SCM)

INTRODUCTION

The COVID-19 pandemic has affected operational conditions and severely affected many organizations and their supply chains, including the construction industry, at an unprecedented scale (Alsharef et al., 2021; Ivanov, 2022). The pandemic has led to construction projects facing issues such as suspensions, lack of resources leading to cancellation, suppliers shutting down their businesses, suppliers failing to deliver materials timely (Esa et al., 2020), loss of time, increased cost, and worker layoffs (AGC, 2020). The consequences of COVID-19 in Malaysia were similar, whereby practitioners suffered due to the various negative impacts on their businesses and projects. Among the effects of the pandemic on the Malaysian construction industry were safety issues, multiple regulatory compliance requirements, issues with human resource allocations, loss of productivity, lack of some expertise, issues with working time and terminations,

problems with resource availability in the market and site (Esa et al., 2020), suspension of projects, workforce shortage, delays in project handover and cost overruns (Gamil & Alahagar, 2020). Consequently, worldwide supply chains have been impacted significantly (Sharma et al., 2020; Xu et al., 2020; Chowdhury et al., 2021).

Academics have seriously discussed the effects of the COVID-19 pandemic since 2020. The consequences were mainly due to the need to change the usual way of working to a new way, also known as the "new normal", which occurs worldwide, including in Malaysia. The new normal has forced many on-site activities to be moved off-site, except for certain critical works. Restrictions placed by the Malaysian government caused many developments works to be halted (Ray & Noah, 2020). It led to the obstruction of many construction activities, including contract commitments, leading to litigation risks for businesses after the bans were lifted (Zakaria & Singh, 2021).

Adapting to the new normal has proven to be an uphill task for the Malaysian construction industry, as evident from the many failures recorded thus far (i.e., Sman, 2020; Esa et al., 2020; Gamil & Alahagar, 2020; The Edge, 2021; Rahim, 2022). With consideration that the World Health Organization (WHO) identified 1400 epidemic outbreaks from 2011 to 2018 (Hudecheck et al., 2020), learning to adapt to the new normal is ever more critical. Towards creating a path to recovery, organizations need to identify the challenges they face; however, there is a lack of information and readily available literature on this matter (Paul et al., 2021). COVID has been described as by Koonin (2020) as a rare but highly impactful event which surpasses the scale of major disruptions in the past twenty years, including SARS and H1N1. Towards effective mitigation, operative recovery management strategies are vital (Paul et al., 2021) as it is the fundamental need for good supply chain disaster management. Since the COVID-19 pandemic affects large numbers of supply chains and over an unpredictable time frame; there is a necessity for novel ways of handling supply chains to face "extreme conditions" (Sodhi & Chris, 2019). It will also address the uncertainty of demand and supply, geopolitical stability, labor availability, supply chain visibility, permanence, and financial flow.

Over the years, many have mooted SCM as the way ahead in construction industry worldwide (e.g., Egan Report, 1998; Love et al., 2004), and even for Malaysia (Riazi et al., 2019; Riazi et al., 2020). SCM has been shown to boost the industry's ability to continue operating smoothly and be best positioned during a pandemic and other shocks and unexpected scenarios (Yu & Rehman Khan, 2021) while SCM has also been linked to many qualities that are vital for project success and critical in challenging times (Cheng et al., 2010; Riazi et al., 2019). For construction companies to effectively deal with COVID-19 pandemic and recover after that, it is vital to recognize the trends in construction supply chain management in the upcoming years and determine the suitable practices to improve the strategy, tactic, and operations of construction activities (Le et al., 2020).

Therefore, there is a measured hope in SCM's prospect of remedying the current conundrum of Malaysian construction industry, i.e., overcoming pandemic challenges. SCM also offers many applicable instruments that would facilitate construction industry enhancements (Cheng et al., 2001; Mehdi Riazi, 2014; Riazi et al., 2019) hence, helping the industry players cope with changing circumstances. This paper therefore aims to delve into the potential of SCM of being the post-pandemic savior for the Malaysian construction industry. Coverage will be made on the effects of pandemics on the construction industry, challenges faced, and SCM as the way forward to better equip the country to face future pandemics with resilience.

LITERATURE REVIEWS

The COVID-19 Pandemic and Its Disruptive Impact on the Construction Industry: Global and Malaysia Perspective

Worldwide Context

The COVID-19 pandemic has badly affected many industries and; challenges have been wide-ranging across

sectors (Kawmudi et al., 2020) such as changes in demand, interrupted supply of goods, halt of businesses such as export and imports, and attainability of raw material due to lock-downs worldwide (Bartik et al., 2020) and the construction supply chain was of no exception (Yu et al., 2021). Being a major source for economic

and nation development worldwide, its contribution to economy comes directly and indirectly (Dlamini, 2012). The COVID-19 pandemic has posed drastic effects on the construction sector worldwide; evident from the International Monetary Fund (IMF) GDP reports, which indicated an approximate 3% decline in 2020 compared to 2019 (Kawmudi et al., 2020).

Past research has pointed out the drastic effects of COVID-19 on the construction industry. Among them being a study in the United Kingdom that pointed significant GDP loss by the industry in early 2020 and was projected to shrink by 25% in the same year (Preston, 2020). Meanwhile, in Australia, 76,500 people became jobless between March and May 2020 (Bleby, 2020) while health and safety issues forced suspension of work in New Zealand (Day, 2020). Countries like Nepal and the Maldives were also not left out to suffer negative consequences of the pandemic as pointed out in Ramesh et al. (2020) and Huaxia (2020) respectively.

Shift to online working to avoid contracting the virus has risked millions of jobs due to the on-field nature of many construction activities. Many stakeholders were left unprepared for the change (Laing, 2020), including both public and private sectors (Hamid & Huam, 2020), hence a heavy blow to the global economy (Chopra & Nagar, 2020). COVID-19 lock-down and recovery periods were among the major blows posed by the pandemic. This was due to reduced inputs and workers movement which forces delay in project, while the increased need to ensure staff safety, providing food, water and sanitation adds onto the cost bared by organizations (Chopra & Nagar, 2020). Limited capital has worsened the situation worldwide (Chohan, 2020), further intensifying the burden, underscoring the critical issue of COVID-19's unpredictable impact on the construction industry (Kawmudi et al., 2020).

Malaysia Context

Similar to global trends, the Malaysian construction industry was also significantly affected by the impacts of the COVID-19 pandemic. As part of the government's initiative to control widespread viruses, several Movement Control Orders (MCOs) were enforced under the Control and Prevention of Infectious Disease Act 1988 and the Police Act 1967 (PMO, 2020a) which left costly consequences to the nation's economy. As such, the first to third MCO phases, government loses averaged at RM2.4 billion per day, amounting to RM63 billion loss in approximately four weeks (PMO, 2020b). While the construction industry was allowed to resume operation from 4th May 2020 onward, strict SOPs were enacted by the government – which was made a new normal in Malaysia (Zakaria & Singh, 2021), made compulsory to all project sites (Jocelyn & Rachel, 2020) with hefty penalties upon incompliance.

Project performance in the country was also severely affected due to unfamiliarity with new-normal working habits, forcing the industry to undergo a steep learning curve and resulting in productivity losses. Many projects suffered delays (see Chandra, 2021) including three major projects in Limbang, Sarawak (see Sman, 2020) as well as projects undertaken by mega companies like PETRONAS (Das, 2021). On top of that, a major loss of efficiency was suffered by the private housing sector as evident from results of a survey by the Real Estate and Housing Developers Association Malaysia (REHDA). Out of 121 members that they surveyed, 75% of them faced a decline in work efficiency, 81% of them had cash flow issues, while 78% had negative views on their future reinvestment plans on land banking and other projects (The Edge, 2021). Furthermore, statistics from the National Housing Department reported 539 sick private housing projects as of 30 April 2022 - a 64.33% increase compared to 30 April 2019 (Sinar Harian, 2022). Sick projects refer to projects that are critically delayed, behind schedule, or facing serious financial or operational issues, potentially leading to project failure or abandonment. Performance issues also affected the most recent inaugural Malaysia Plan, namely the 12th Malaysia Plan which covers nation development period from years 2021 to 2025. As such, Rahim (2022) highlighted the emergence of 92 sick 12th Malaysia plan projects as of February 2022. All these factors further underscore the severe impact the pandemic has had on Malaysia and its construction industry, highlighting the need for comprehensive solutions to better equip the country to face future pandemics with resilience.

Construction Industry Challenges in the COVID-19 Era

In recognition of the pandemic's impact, researchers worldwide have begun to examine the challenges it has posed to the construction industry, with the aim of developing improvement mechanisms. Among them being a study by Kawmudi et al. (2020) who focused on Sri Lanka and came up with a total of 14 challenges, whereby top 5 was :- "*Delay of completion of the project*", "*Damage the Supply Chain with shortage & delay materials*", "*Change the public perception on site & less confident and laziness among labours*", "*Global uncertainty, market condition & economic challenge*", and "*Temporary suspension & termination of contracts*". On the other hand, Salami et al. (2022), in their study also highlighted several challenges. Their findings generally indicated that many of the challenges were a direct result of the pandemic such as increasing costs, reduced productivity, problems with increasing use of technology and innovative solutions, reduced workers interference, the need to cope if working from home, coping with continuous containment strategies, the need to develop of new working procedures, extra safety procedure requirements and the need to modify construction execution schedules.

According to Kawmudi et al. (2020), it was logical that project delays were the most prevalent challenge due to absenteeism, which was evident during the pandemic. Lock-downs and the fear of contracting the virus shy workers away from sites, and since projects are very sensitive to time issues, delays were inevitable. If pandemics become a recurring scenario, it is thought to cause people to move away from urban areas, affecting workers' supply and time to get new ones (Davis, 2020). Delays and material shortages would also be challenging (Chohan, 2020) since the pandemic would affect the project's critical paths, which are essential for planning material procurement. Other than that, public perceptions, labor confidence and people's mental condition would also pose a challenge in getting people back to work on project sites (Kawmudi et al., 2020), which as a result, may lead to project suspension or termination due to inability to meet expectations. External situations are known to have a chain reaction on other activities (Lewis, 1988); hence, legal issues and disputes could occur due to claims for a time extension, increased costs, suspensions, and terminations (Kawmudi et al., 2020) as construction works are always tied to some form of contract requirements. Beyond that, poor economic states of countries will also increase regression risks (Chopra & Nagar, 2020), thus affecting future project funding.

On top of that, other research has also directly or indirectly pointed out the potential challenges posed by the COVID-19 pandemic. Among them were the risks of supply chain stakeholders collapsing financially (Choi, 2020), job cuts (Chowdhury et al., 2020), challenges to uptake emerging technologies and their application as well as adapting to evolving practices in work and management (Gurbuz & Ozkan, 2020), shortage of resources to perform fast recovery plan (Leite et al., 2020) as well as the declining demand in the long run, harmonizing economic growth with social sustainability (Lalon, 2020).

Applying the Pathogen Concept to Mitigate COVID-19 Challenges

The construction industry's inter-connected, multi-disciplinary and multi-entity nature means that any problem within the industry should be viewed from a "system perspective" rather than merely looking into individual factors so that any strategies to overcome problems can affect the overall aspect of the industry. For this reason, pathogen, a concept introduced by Busby and Hughes (2004), avoids repeating similar mistakes/problems and enables them to be tackled right from their roots. According to Love et al. (2010), the pathogen concept allows for better understanding on the fundamental source of the problem which makes their deterrence more feasible. AlSehaimi et al. (2013) stressed on the importance of properly scrutinizing sources of problems/failure to stop future incidences. The pathogen approach has been recognized as suitable for all problem-related studies (Busby & Hughes 2004; Ahmad, 2022) hence, it could serve as a potential solution in this study, as similar initiatives have been used to solve other issues, such as – delays (Riazi & Nawi, 2018) and disputes (Love et al., 2008; Ahmad, 2022). As a matter of fact, from the context of this study, pandemic challenges involve problems that surface due to the pandemic and require proper mitigation plans.

Busby and Hughes (2004) defined pathogens by several qualities, which includes them being, a rather stable condition that has been around for a long time before the problem even started, people would not have recognized it as warning signs before a problem shows up and that they have a close connection to the problem

and could be seen as the principal cause of the problem when it happens. Moreover, the authors also proposed eight main categories of pathogen in their study which were: "*Practice - Pathogens arising from people's deliberate practices*", "*Task - Pathogen arising from the nature of the task being performed*", "*Circumstance - Pathogens arising from the situation or environment the project was operating in*", "*Convention - Pathogen arising from conventions, standards, routines and codes of practice*", "*Organization - Pathogens arising from organizational structure or operation*", "*System - Pathogens arising from an organizational system*", "*Industry - Pathogens arising from the structural property of the industry*", and "*Tool - Pathogens arising from the technical characteristic of the tool*".

This approach groups a long list of factors (i.e., pandemic challenges) into a smaller set of underlying conditions, making them easier to manage and avoid similar problems that arise from the same pathogen to surface in future due to the very roots of it has been addressed. Despite being a generally novel concept in construction research, it has been effectively applied in several studies (i.e., Love et al., 2008; Love et al., 2010; Love et al., 2012; Busby & Zhang, 2008; Riazi & Nawi, 2018; Nur Hidayah, 2022) and thus, is viewed as an effective approach in dealing with various pandemic challenges that the industry is facing. Rather than looking at individual challenges, taking the pathogen approach allows the issues to be addressed right from the core, leading to more effective mitigations.

Supply Chain Management: A Strategic Avenue to Recovery

The COVID-19 pandemic has severely reconfigured the workplace dynamics of many organizations and their supply chains (Ivanov, 2022), including the ones from construction sector (Alsharef et al., 2021) as supply chain disruptions causing companies to struggle to maintain operations (see Frederico, 2021). Most disturbance to supply chains were found to be due to poor management of risk, resource, suppliers and transparency (see Kutzner & Rajal, 2020) all of which highlights a significant gap in SCM knowledge, inspiring both practitioners and researchers to make further considerations on the way they shape supply chain strategies to better withstand future disruptions (Frederico, 2021). There are many challenges associated with formulating recovery strategies to face disruptions (DuHadway et al., 2019) hence, further research into "new normal" practices is vital to for effective adaptation, response, and transformation of organizations; enabling timely and well-informed decision-making. Failure for organizations to act decisively may risk companies losing competitiveness in the market (Ajmal et al., 2022).

The need to revolutionize the construction industry stems from the multiple deficiencies of the conventional practices - often linked to fragmentation, adversarial relationships, lack of innovation, poor time-cost performance, low satisfaction of clients, etc. (Egan, 1998; Latham, 1994), which necessitates systemic change and revolution towards being more streamlined and efficient. There is an urgent need to elevate project performance which was described by Riazi et al. (2020) as being at a substandard level.

Over the years, many have mooted SCM as the way ahead in construction industry worldwide (e.g., Egan Report, 1998; Love et al., 2004), and even for Malaysia (Riazi et al., 2019; Riazi et al., 2020). SCM has been shown to boost the industry's ability to continue operating smoothly and be best positioned during a pandemic and other shocks and unexpected scenarios (Yu & Rehman Khan, 2021) while SCM has also been l

SCM is one philosophy that over the years, have been actively mooted as the future path for the industry (e.g., Egan, 1998; Love et al., 2004), including for Malaysia (Riazi et al., 2019; Riazi et al., 2020) given the intricate dynamics of current industry, requiring an enhanced level of collaboration and teamwork, and that self-sufficiency is not feasible anymore (Love et al., 2004). This has paved way for the promotion of SCM as a strategic means of boosting performance and adaptability in face of unexpected events (Mehdi Riazi, 2014) such as COVID-19 and other pandemics. With collaboration as its key quality trait (Riazi et al., 2019), SCM has proven its potential to drive improvement and address weaknesses in current industry practices via attributes that improve the relationship between parties. SCM's working philosophy and instruments have the potential to overcome industry's problems from many perspectives (Riazi et al., 2019), and continuous improvement have been among its primary agenda (Mehdi Riazi, 2014).

There have been many past applications of SCM in real-world projects which have led to significant success in time optimization and minimizing delays (e.g., Brady et al., 2006; Potts, 2009) as well as instruments to boost industry performances such as - Champion/Driving Personalities (Kumarsawamy et al., 2007), Joint Agreed Goals (Maqsood et al., 2003), Building Information Modelling (Holness, 2008), Joint Risk Management (Potts, 2009), Profit Sharing and Risk Sharing arrangements (Eriksson & Pesa¨maa, 2007), etc.. SCM has also proven effective at assisting better collaboration and teamwork (Riazi et al., 2019) all of which are essential elements of successfully working in a "new normal" fashion. Project failures typically occur because of numerous interconnected events which further reinforce the need to effectively tackle each one of them, using multiple effective approaches (Riazi et al., 2020) which in this case, can significantly leverage from wide range of instruments available within SCM. This therefore creates a measured hope and optimism in the potential of SCM to be the savior for the Malaysian construction industry.

Research Conceptual Framework

This research aims to develop a Holistic SCM-Based Framework to overcome the distinctive Pathogens of pandemic challenges in Malaysian private housing project. Figure 1 illustrates the conceptual framework of this research.

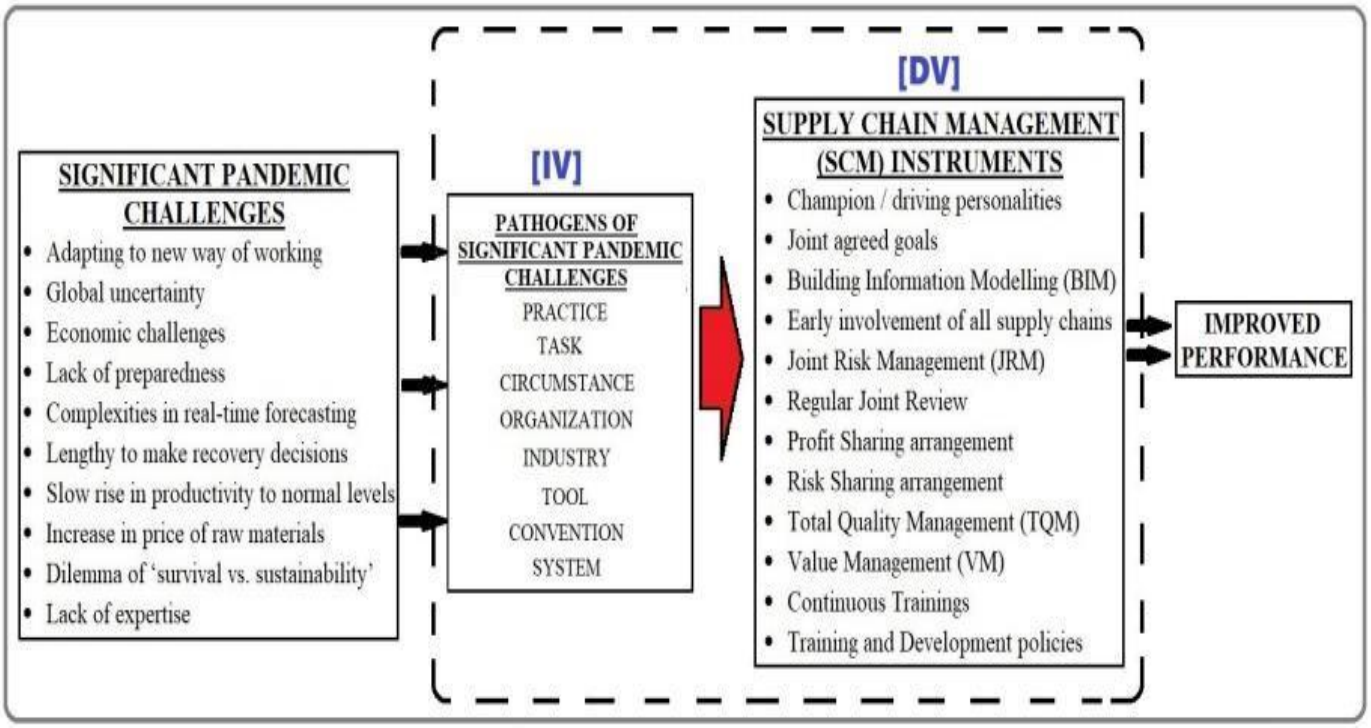

Figure 1: Research Conceptual Framework

With reference to Figure 1, firstly this research will establish the significant pandemic challenges which are then classified into pathogens, also known as the latent conditions. Pathogens in Figure 1 were extracted from studies by Busby and Hughes (2004); Love et al. (2008), Riazi and Nawi (2018), and Riazi et al. (2019) who used similar concepts in their respective work. These pathogens may change as this research takes place as some of them may be relevant, while others may not, and there are also possibilities for new pathogens arising as findings are concluded. Finally, beneficial SCM instruments will be matched to overcome each pathogen, thus producing the final research framework. SCM instruments that are presented in Figure 1 represent only a fraction of many, recommended or applied in the past (e.g., Maqsood et al., 2003; Kumarsawamy et al., 2007; Eriksson & Pesa¨maa, 2007; Holness, 2008; Potts, 2009). In the same way as the challenges, more SCM instruments are also foreseen to emerge as the study progresses, and their inclusion in the framework will depend on the pathogen list concluded later. Different SCM instruments may benefit different pathogens, and this research will elucidate them. After developing the final research framework, they will go through the validation process before being finalized.

The Research Route

This research aims to develop a Holistic SCM-Based Framework to overcome the distinctive Pathogens of pandemic challenges in Malaysian construction Industry with particular focus made on private housing projects impact during the pandemic period (i.e., from 2020 to 2023). This study targets the main construction industry supply chains (i.e., client/developer, consultant and Class G7 contractors) for data collection. The population for this study will be identified from several sources. For the developers, who are clients of private housing projects, will be identified from developers lists registered with Real Estate and Housing Developer (REHDA) Malaysia. Consultant group can be identified from relevant professional bodies such as the Board of Architect Malaysia (BAM), Board of Engineers Malaysia (BEM) and Board of Quantity Surveyors Malaysia (BQSM). Meanwhile, the contractor list can be accessed via the Malaysian Construction Industry Development Board (CIDB) database.

Sampling-wise, nonprobability sampling in the form of criterion sampling will be adopted throughout this study since only experts from the industry will be targeted because this method suits situations when a specific group of people are sought. According to Honigmann (1982), nonprobability sampling suits problem-solving that seeks to discover occurrences or implications of occurrences while Ahmad (2022) supports the use of criterion sampling when samples are not drawn at random and did not represent the population.

The research design will harness guidelines from Fellows and Liu (2008) which supports the combination of quantitative and qualitative approaches to produce accurate and reliable outcomes, as follows:

Establishing the Significant Pandemic Challenges

Towards developing the framework, firstly, there is a need to identify the pandemic challenges faced by Malaysia construction industry. Due to the lack of information and literature on construction-related pandemic challenges (Paul et al., 2021), this study will target six (6) industry experts with a minimum of ten (10) years of experience to perform preliminary interviews on them. All interviewees should also be experienced taking part in private housing projects between the years 2020 to 2023. Considering that Malaysia may have disparities with other countries in terms of locality, culture, and governance, the interview is essential to gain expert insights. This ensures that all pandemic challenges unique to Malaysia are addressed and captured accurately, without undue reliance on reports from other countries. Criteria used to select experts here follows the ones determined by Pill (1971), Berliner (2004), and Cha and Lee (2018) that they should have continuous field working experience of more than 5 years and have experience in the specified field; while the number of responses meets the requirement as per Ismail et al. (2013) and Riazi et al. (2020) for reliable outcomes in interviews involving expert respondents. Consequently, “Content Analysis” will be used as a means of analyzing responses based upon recommendation by Fellows and Liu (2008) and findings will be based on the majority’s responses (see Mehdi Riazi, 2014).

Once all pandemic challenges are gathered, they will be used for the preparation of Fuzzy Delphi Method (FDM) questionnaires. Experts’ criteria here will also follow benchmarks set by Pill (1971), Berliner (2004), and Cha and Lee (2018), while the number of responses will correspond to Adler and Ziglio (1996) and Ahmad (2022)’s benchmark of 10 to 15 experts to achieve a high degree of uniformity. Using Fellows and Liu (2008) as well as Ahmad (2022) as reference, close-ended questionnaires with a “7 Point Linguistic Variable” - which is a conversion from “Likert Scale” to “Fuzzy Scale” - will be used to measure the significance of each pandemic challenges towards ranking them and establishing the significant ones. Data analysis will follow a similar approach by Ahmad (2022) which involves fuzzification of responses, aggregating the fuzzy numbers, defuzzification process, performing threshold analysis, and ranking the variables according to their defuzzified values. FDM is selected because it allows for decision-making based on expert and consensus opinions (Manakandan et al., 2017), ranking of variables (Tseng et al., 2016), and for respondents to fully express their opinion which is a plus point when covering new research topics that crave feedback from highly knowledgeable people (Ahmad, 2022). This reduces misinterpretation of opinions thus offering higher validity in results.

Organizing Significant Pandemic Challenges into Pathogens

Once establishing significant pandemic challenges, this study will proceed with classifying them into pathogens which according to Busby and Hughes (2004), allows for solving problems right from their roots. This way, long list of significant pandemic challenges are classified into a more specific category of latent conditions, making the problem more manageable, thereby preventing future issues related to a specific pathogen, since the underlying cause of the problem has been tackled. For this purpose, semi-structured interviews will be conducted with experts from the industry - experts' criteria follow the ones used for FDM. The sample size will be determined based on the concept of saturation, ensuring that data collection does not result in repetitive or unnecessary information that does not contribute to the research (Morse, 2000), meaning that interviews can be stopped at as early as six (i.e., Guest et al., 2006) or up to ten (i.e., Atran et al., 2005), fifteen (i.e., Mehdi Riazi, 2014) or even more interviews, depending on the consistency and richness of data obtained. Nevertheless, there is consensus that saturation typically arrives early in research (see Guest et al., 2006; Romney et al., 1986) thus, the saturation point in this study is expected to be not far from figures achieved by past researchers. Approach to data analysis here will adopt similar approach as the preliminary interview – using content analysis and concluding outcomes based upon the majority's responses.

Developing a Validated Research Framework

This stage will involve a minimum of two semi-structured interview sessions – the first to develop and second one to validate the framework. The number of experts and their criteria will be the same as those used for grouping pandemic challenges into pathogens. Using fundamental SCM instruments gathered from extensive literature reviews, they will be matched with pathogens they are able to tackle, thereby developing the final research framework. After that, a second interview will be undertaken to validate the framework and following that, should two sessions proof insufficient to validate the framework, additional sessions will be done until a consensus is achieved. Just like the other interviews in this study, similar approach to data analysis will apply here.

Contribution To Body of Knowledge

The outcome of this research is expected to contribute towards enriching the body of knowledge in several areas. Primarily, the establishment of significant pandemic challenges adds to the body of literature that have been short of information on this matter (see Paul et a., 2021) with many initiatives being rather partial (e.g., Salami et al. 2022; Sutterby et al., 2023) and missing the Malaysian context, particularly on private housing projects.

On top of that, considering the effectiveness of pathogen approach as evident in few studies (i.e., Love et al., 2008; Love et al., 2010; Riazi & Nawi, 2018; Ahmad, 2022), it remains a relatively new concept in construction research and has yet to be adapted for use to tackle pandemic challenges, hence further establishing contribution that can be made via this research.

Lastly, with respect to SCM studies and framework development; past SCM initiatives have been quite limited (e.g., Hoxley, 2001; Riazi et al., 2019; Wuni & Shen, 2023), while proposed models and frameworks lacked exhaustiveness (e.g., Le et al., 2020; Osunsami et al., 2022; Le & Nguyen, 2022). Nobody has yet to holistically apply SCM to surmount pandemic obstacles. Even the ones focusing on COVID-19 lacked inclusiveness (e.g., Osunsanmi et al., 2022; Sutterby et al., 2023) and no one covered the Malaysian context. Even previously proposed SCM instruments (e.g., Brady et al., 2006; Kumarsawamy et al., 2007; Holness, 2008; Potts, 2009) did not specifically target pandemic challenges. For that reason, development of a holistic framework - an outcome of this research - is expected to contribute significantly to the advancement of knowledge in SCM, particularly in the context of framework development that addresses industry-specific challenges during pandemics. By using a holistic approach, it would systematically address all sub-issues related to pandemic disruptions, right from their very roots - an aspect often overlooked in previous studies.

SUMMARY

In overall, the COVID-19 pandemic has affected the construction industry, at an unprecedented scale, leading to worldwide suffering in terms of loss of productivity, lack of resources, loss of time, increased cost, worker layoffs, etc. Similarly, Malaysia has suffered a fair share of the impact, with private housing projects being among the worst hit, evident from multiple failure and delay cases during the COVID-19 pandemic period. Among the woes faced were issues related to safety, human resources, resource availability, working time, terminations, the need to comply with multiple regulations, loss of productivity, workforce shortage, and many more. Many of these issues were mainly due to the need to adapt with "new normal" concept, forcing on-site activities to off-site, hence affecting productivity and operation cost. Considering the vast occurrence of epidemics (i.e., 1400 times in 8 years according to WHO), learning to deal with future pandemics is vital for organizations to adapt, survive and thrive; hence, operative recovery management strategies are vital. However, the number of research holistically addressing pandemic challenges are lacking, including in Malaysia with many local studies not being exhaustive enough and lack innovative approaches. This has led to calls for transformation towards more revolutionary ways of handling the industry, to remain functional and competitive in the face of future disruption. Past calls for change worldwide have promoted SCM as a means for transforming the old-fashioned industry into a more efficient and productive one. SCM has been linked with numerous positives for the construction industry such as improved teamwork, productivity, adaptability, resilience, innovation, etc., all of which are vital for progressing in positive direction. However, lack of holistic approach in past studies has resulted in underutilized SCM strategies hence, this research, which is part of a university research grant, highlights SCM as a strategic approach to overcome pandemic challenges in the Malaysian construction industry, with particular focus on private housing projects, to hopefully create a pathway to face of future commotion. The vast instruments available within SCM could significantly improve Malaysian industry by reforming many of the inefficient practices via various practical and impactful solution it has to offer, towards an all-round enhancement in efficiency; proven possible in few past applications on real projects. Through a mixed-method approach involving Fuzzy Delphi Method (FDM) questionnaires and Semi-structured Interview on industry experts, the outcome of this research - "A Holistic SCM-Based Framework to Overcome Pandemic Challenges in Malaysian Construction Industry" – is expected to provide a pathway for tackling challenges of future pandemic in the construction industry with optimism and upbeat mindset. The findings are anticipated to make a substantial contribution to the body of knowledge in SCM, while also providing actionable insights for industry decision-makers. They may serve as a model for other countries addressing similar challenges in the future.

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