SOCIO-CULTURAL FACTORS OF MALAYSIA'S CONSTRUCTION INDUSTRY THAT PROCRASTINATE THE IMPLEMENTATION OF CONSTRUCTION 4.0 – A CONCEPTUAL FRAMEWORK

[1]Liong Chee Gin, [2]Dr. HJ Kamal Adb Razak
School of Business of the Malaysia University of Science and Technology

---

ABSTRACT

Construction 4.0 that adopted industrial revolution ("IR") 4.0's concept and framework is unfolding several benefits to Malaysia's construction industry. Nevertheless, construction industry is notorious for its conservative approach towards novel technology or technology advancement, resulted immensely lags behind other industries in terms of automation processes and level of digitalization amidst cumbersome its productivity. Scholars identified that socio-cultural has the greatest influence towards the successful implementation of construction 4.0, wherein impeding the engagement of construction 4.0 that resulted dawdle productivity improvement. The purpose of this paper is enumerating and examining the influence of socio-cultural in Malaysia's construction industry in enabling country policy makers and organization decision makers possess the perspicuous insights that impeding the implementation of construction 4.0 in Malaysia. However, there are other factors contributing to the successful implementation of construction 4.0 require further research in the future such as i) Political, economic, technological, environment, and legal factors, ii) Ethical issues, iii) Management process for overall project life cycle, and iv) Operation and tactical and strategic planning.

Keywords – Construction 4.0, Malaysia Construction Industry, Socio-Cultural.

I. INTRODUCTION

The first three industrial revolution through mechanical (1700s), electrical (1870s), and information/digital technology (1970s) were intended for productivity improvement of operational processes and business procedures (Alaloul W. S., Liew, Zawawi, & Mohanned, 2018). Similarly, the prevailing advancement of information and communications technology ("ICT") featuring by the vogue of digitalization and automation are supporting the "Industrie 4.0" or IR 4.0 in enhancing productivity and efficiency (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020). "Industrie 4.0" – the fourth industrial revolution was published by the German Government in 2011, to create a coherent policy scheme to maintain its industrial competitiveness in the context of global marketplace (Nowotarski & Paslawski, 2017). Klaus Schwab (2016), founder and executive chairman of World Economic Forum, advocates that "Industrie 4.0" is blurring the lines between the physical, digital, and biological spheres. This advance technology digital transformation enhances communication networks, efficiency of organization and management, and production and processes across industries (Zabidin, Belayutham, & Ibrahim, 2019) amidst contributing to sustainable economic, environmental, and social development (Ghobakhloo, 2019) as well as global ecological system.

IR 4.0 forged construction 4.0, changing the apparatus of design, construction, operation and maintenance of assets / edifice (Sawhney, Riley, Irizarry, & Perez, 2020), in soaring product quality, decreasing time-to-market, enhancing operation performances and improving health and safety (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020). Construction 4.0 is the adoption and adaptation of the "Industrie 4.0" or Industrial Revolution ("IR") 4.0 scheme into the construction industry (Sawhney, Riley, Irizarry, & Perez, 2020). Construction 4.0 unfolds several benefits consisting high efficiency and productivity, accuracy and quality-centred, collaboration, sustainability, and safety, as well as recover the eroded image of construction industry (Sawhney, Riley, Irizarry, & Perez, 2020) (Kozlovska, Klosova, & Strukova, 2021). Despite of the stupendous benefits,

construction 4.0 subsists its infancy stage, eminently lags behind other industries in terms of automation processes and level of digitalization (Alaloul W. S., Liew, Zawawi, & Mohanned, 2018), especially in developing countries that imitate traditional labor-intensive industry practices (Kozlovska, Klosova, & Strukova, 2021), for example, Malaysia. Construction industry hesitant in capitalizing these innovative technologies into its common practices due to resistance to change, barriers to innovation, unpredictability, profits, and skilled workforce recruitment, resulted exiguous improvement and productivity stagnation in the construction industry for decades (Sawhney, Riley, Irizarry, & Perez, 2020).

Several factors contributed to this adversity as explicit by Oesterreich and Teuteberg (2016) such as complexity, uncertainty, fragmented supply chain, short-term thinking, and culture. The nature of construction industry is complex and unique, as it involves enormous stakeholders amid its value chains involves multiple fragmented counterparts from all levels with a diverse background in responding the specific discrete and sui generis of each projects. Moreover, the financial capability of small and medium-sized enterprises ("SMEs") and short-term thinking as well as its reluctant practices in adaptation, considering the short-term nature of construction project, increased the difficulties of construction 4.0 initiative despite of the remarkable benefits (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020).

II. LITERATURE REVIEW

A. *Overview*

Productivity growth is an essential component of economic development (Acs, Lafuente, Sanders, & Szerb, 2017), whereby it is an increase in value of outputs produced for a given level of inputs, over a given period of time (Parliament of Australia, 2009). Rao et al. (2001) advocates three key determinants of productivity growth such as i) accumulation of physical capital, ii) accumulation of human capital, and iii) rate of innovation and technological change (Rao, Ahmad, William, & Kaptein-Russel, 2001). Thereby, technology advancement is the one of the key drivers of economic development, whilst industrial revolution is crucial in escalating national productivity (Hercko, Slamkova, & Hnat, 2015).

From the beginning of industrialization, technological advances forged paradigm changes called "industrial revolution" (Forcael, Ferrari, Opazo-Vega, & Pulido-Arcas, 2020). Cambridge Dictionary (2017) defined industrial revolution as "the period of time during which work began to be done more by machines in factories than by hand at home" (Liao, Loures, Deschamps, Brezinski, & Venancio, 2018). Industrial revolution also refers to the emergence, during the transition from a pre-industrial to an industry society, of modern economic growth (Vries, 2008). Industrial revolution invariably instigate disruption to the competitive status quo as well as unequivocal novel prerequisite to workforce and infrastructure. Therefore, as a natural consequence of being a technology-oriented world coupling with economic disquietude and increasingly complex and volatile business environment, the rules for survive and success in business are diverged exponentially (Lim & Lim, 2014). Michael Burke[1] (2018) advocates "current business models, strategies, and capabilities will not be sufficient in any of these future worlds" (Buehler, Buffet, & Castagnino, 2018).

B. *Industrial Revolution 4.0*

First industrial revolution ("IR") or IR 1.0 in 18th century related to water and steam power on mechanical equipment in replacing the manual works, whereby was the greatest breakthrough in soaring human

[1] Michael Burke is the Chairman and CEO of AECOM and Co-Chair of the World Economic Forum Infrastructure and Urban Development Community.

productivity. Second industrial revolution or IR 2.0 in 19th century was actuated by electrical energy, effectuate mass production and assembly line production wherein tremendously increase the volume of production with lower cost. Third industrial revolution or IR 3.0 or digital revolution in 1970s, emerged with the rise of electronics, was connected with innovation of technology and information technology ("IT") switching from analogue electronic and mechanical devices to the available digital technology amid enabling partial automation (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020) (Nowotarski & Paslawski, 2017).

The fourth industrial revolution or industry 4.0 or IR 4.0 was introduced by German Government in 2011 as high technology strategies for the development of new concept of German economic policy (Roblek, Mesko, & Krapez, 2016). IR 4.0 will be marked by the full automation, digitization, and decentralized production processes through several crucial components such as i) cyber-physical systems ("CPS"), ii) internet of things ("IoT"), iii) internet of services ("IoS"), iv) advanced robotics, v) big data analytics, vi) cloud manufacturing, vii) augmented reality, simulation, viii) system integration, and ix) addictive manufacturing (Tay, Lee, Chan, Alipal, & Abdul Hamid, 2019) (Ibrahim, Esa, & Mustafa Kamal, 2019). IR 4.0 enables interconnection between all mechanized automation through technologies advancement to operate and share information without the human intervention (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020). IR 4.0 is blurring the lines between the physical, digital, and biological spheres as it devices physical and virtual manufacturing scenarios, whereby transforming factories' environment into one of intelligent manufacturing (Forcael, Ferrari, Opazo-Vega, & Pulido-Arcas, 2020) with six fundamental concepts such as interoperability, virtualization, decentralization, real-time capability, service orientation, and modularity (Alaloul W. S., Liew, Zawawi, & Mohanned, 2018).

Baur & Wee (2015) defined IR 4.0 as "a broad term consisting of a confluence of trends and technologies that are likely to reshape the way things are made" (Sawhney, Riley, Irizarry, & Perez, 2020). Hermann et al. (2016) defined IR 4.0 as "a new level of value chain organization and management across the lifecycle of product" (Sawhney, Riley, Irizarry, & Perez, 2020). Maskuriy et al. (2019) defined IR 4.0 as "the IoT and IoS integrated with the manufacturing environment where all industrial businesses around the globe connect and control their machinery, factories, and warehousing facilities intelligently through cyber-physical systems by sharing information that triggers actions" (Maskuriy, Selamat, Ali, Maresova, & Kerjcar, 2019). IR 4.0 is impelling curtailment of low-skill task and escalation of high-skill task, involving implementation of control and IT related activities and automation (Mohamad, et al., 2018). Varies industries such as manufacturing, automobile, and banking industry have benefitted from the implementation of IR 4.0 on their daily operational activities in terms of productivity, accuracy, efficiency, and customer satisfaction (Lau, et al., 2019).

Liao et al. (2017) study showed IR 4.0 is benefitting the manufacturing through vertical integration, horizontal integration, and end-to-end engineering, as it integrates people, machines, and data amidst creating more agile and responsive supply chain (Raj, Dwivedi, Sharma, & Jabbour, 2020). Ministry of International Trade and Industry of Malaysia mentioned IR 4.0 will increase flexibility, productivity, quality, and reduction time to market (Mohd. Aripin, Zawawi, & Ismail, 2019). Sony & Naik (2018) mentioned the high level of digitization and automation of organizational supply chain enables agile, efficient, responsive, and cost effective to the manufacturing processes (Sony & Naik, 2020). Moreover, this industrial revolution not merely introduced the modern techniques in supporting and advancing every component within industry, it also embraces sustainability in terms of social, economic, and environmental (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020).

C. CONSTRUCTION 4.0

"Industrie 4.0" or IR 4.0 was originated in 2011 at the Hannover Fair in Germany as an alleviation stratagem in responding to the intensify competition in the global marketplace; primarily focusing on manufacturing industry. The introduction of this novel technology revolutionizes the industries' traditional modus operandi, including construction industry. Construction 4.0 is the adoption and adaptation of IR 4.0 theoretical framework into the construction industry (Sawhney, Riley, Irizarry, & Perez, 2020), involves technological changes in associate with the engagement unorthodox modus operandi to the processes, materials, and markets (Forcael, Ferrari, Opazo-Vega, & Pulido-Arcas, 2020). Oesterreich and Teuteberg (2016) described construction 4.0 as "a variety of interdisciplinary technologies that digitize, automate, and integrate the construction process at all stage of the value chain" (Oesterreich & Teuteberg, 2016). Sawhney et al. (2020) defined construction 4.0 as "a paradigm that uses cyber-physical systems, and the Internet of Things, Data, and Services to link the digital layer consisting of Building Information Modelling ("BIM") and Common Data Environment ("CDE") and the physical layer consisting of the asset over its whole life to create an interconnected environment integrating organizations, processes, and information to efficiently design, construct, and operate assets" (Sawhney, Riley, Irizarry, & Perez, 2020). Construction 4.0 set forth the new framework in planning, designing, and delivering built environment assets / edifice in a more effective and efficient manner by focusing on the physical-to-digital transformation and vice versa (Dallasega, Rauch, & Linder, 2018).

Construction 4.0 is leveraging and optimizing the digitalization and computerization by adopting the latest technology and modern construction method to enhance construction productivity towards global competitiveness amidst contributing to country's economic status (Ibrahim, Esa, & Mustafa Kamal, 2019). Construction 4.0 enables new opportunities for companies on increasing their competitiveness, quality of works, and timely project completion as well as attaining sustainable building environment and decision making in building technology (Forcael, Ferrari, Opazo-Vega, & Pulido-Arcas, 2020). Moreover, Forcael et al. (2020) advocates that construction 4.0 is not merely a technological upgrade to traditional construction, it is a vogue of perceiving and understanding construction and transforming the concept of construction itself in the light of innovation and increased productivity (Forcael, Ferrari, Opazo-Vega, & Pulido-Arcas, 2020). Meanwhile, they suggested the two (2) pillars of construction 4.0 consisting i) digitalization and ii) industrialization.

Figure 1 Diagram of Construction 4.0 pillars (Forcael, Ferrari, Opazo-Vega, & Pulido-Arcas, 2020)

Construction 4.0 unfolds several benefits consisting high efficiency and productivity, accuracy and quality-centered, collaboration, sustainability, and safety, as well as rejuvenate the eroded image of construction industry (Sawhney, Riley, Irizarry, & Perez, 2020) (Kozlovska, Klosova, & Strukova, 2021). Construction 4.0 enables organizations in meeting new emergent needs amidst provides capabilities in preparation of the next society evolution as well as transforming the design, fabrication, usage, operation, maintenance, and services of the products or building assets (Maskuriy, Selamat, Ali, Maresova, & Kerjcar, 2019). Whilst construction 4.0 also enables easier and lesser flaw in the monitoring and controlling processes (Ibrahim, Esa, & Mustafa Kamal, 2019). The success of construction 4.0 is not inexistent; Kozlovska et at. (2021) cited You & Feng (2020) on the successful case of implementing cyber-physical system in the construction project of the Xiong'an citizen

service center. The construction project completed within schedule, notably the cyber-physical system enables close collaboration between production, logistics, and assembly process by monitoring the supply chain of prefabricated components and eliminating the delay of quality inspection information, amidst promoting sustainable construction (Maskuriy, Selamat, Ali, Maresova, & Kerjcar, 2019).

D. *Obstacles*

Construction industry is one of the most dynamic and responsive industrial sectors of any economy (Osunsanmi, Aigbavboa, & Oke, 2018) and also one of the largest industries in the world, accounting 13% annual turnover of the global Gross Domestic Product ("GDP") (Axelsson, Froberg, & Eriksson, 2019). Construction industry is playing an important role in national economic growth through strengthening and enabling other sectors amidst provides basic amenities and infrastructure in supporting social development such as road, railways, ports, and buildings. Those amenities and infrastructure are crucial in improving social living standards and quality of life, resulting promote better utilization of physical and human resources (Mirawati, Othman, & Risyawati, 2015). Nonetheless, construction industry has been traditionally labeled as unproductive (Forcael, Ferrari, Opazo-Vega, & Pulido-Arcas, 2020), wherein heavily rely on manual labor, mechanical technology, and established operating and business model (Buehler, Buffet, & Castagnino, 2018). Compare to manufacturing's 3.6% productivity growth per annum, construction industry's productivity improvement rate of 1% per annum for the past 20 years is piteous and dreadful (Axelsson, Froberg, & Eriksson, 2019).

Oesterreich and Teuteberg (2016) concluded several factors spurred the dilatory in engaging construction 4.0 resulting slow productivity improvement such as complexity, uncertainty, fragmented supply chain, short-term thinking, and culture (Oesterreich & Teuteberg, 2016). Moreover, the nature of construction industry is complex and unique, as it involves enormous stakeholders amid its value chain involves multiple fragmented counterparts from all levels with a diverse background in responding the specific discrete and sui generis of each projects. Beside the financial capability of SMEs and short-term thinking as well as its reluctant practices in adaptation, considering the short-term nature of construction project, increased the difficulties of construction 4.0 initiative despite of the remarkable benefits (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020).

Notwithstanding of the challenges, construction industry must improvise and adapt the ever-changing global economy (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020). Thereby, construction industry must embrace the opportunities afforded by technology (i.e., construction 4.0) to enhance the efficiency and productivity, as well as improve performance of construction industry and the consistency and quality of its outputs (i.e., amenities and infrastructure) (Sawhney, Riley, Irizarry, & Perez, 2020). Liao et al. (2018) mentioned that construction industry's organizations must prepared in transforming their production environment by capitalizing the emergence of technologies, to foster integration, collaboration, flexibility, cognition, and connectivity, whereby action from governments to organizations is crucial (Liao, Loures, Deschamps, Brezinski, & Venancio, 2018). These will positively influence the national economy by ensuring infrastructure gap is narrowed and boosting the overall economic development (Maskuriy, Selamat, Ali, Maresova, & Kerjcar, 2019) by providing an atmosphere where resources such as equipment, materials, labor, and capital are traded in creating an infrastructure within an economy (Osunsanmi, Aigbavboa, & Oke, 2018).

Socio-cultural theory was put forth by a Russian psychologist, Lev S. Vygotsky in 1979. He explained human cognitive development is connected with culture and society as well as institutional and historical context (Aliyu & Yakubu, 2019). Historically formed settings such as family life and peer group interaction and in institutional contexts like schooling, organized sports activities, and workplaces (Lantolf & Thorne, 2007).

Vygotsky (1979) suggested the "genetic law of development" that encompasses two (2) stages in cultural development. First stage is intermental then following by intramental, the former start from social then the psychological and the latter is within the learner. In brief, as learners participate in joint activities and internalize the effects of working together, they acquire new strategies and knowledge of the world and culture (Aliyu & Yakubu, 2019). The first stage is having strong link with institutions, whereby North (1990) defined institutions as "humanly devised constraints that structural political, economic, and social interaction" (Hopp & Stephan, 2012), consisting formal and informal. Wherein, formal can be political and economic rules and contracts, whereas informal includes codes of conduct, conventions, attitudes, value, and norms of behavior (Thornton, Ribeiro-Soriano, & Urbano, 2011). Institutions are constituted by culture and social relations, whilst human, social, and cultural capital are pre-requisite in acquiring financial capital and other resources needed to start a business (Thornton, Ribeiro-Soriano, & Urbano, 2011). In this case, it will be the resources needed in implementing construction 4.0 in companies or within construction industry.

Thereby, it is in line with the several scholars' studies, wherein Oesterreich and Teuteberg (2016) explicit short-term thinking and culture are the factors contributing to slow implementation of construction 4.0 (Oesterreich & Teuteberg, 2016). Alaloul et al. (2020) identified social factors, particularly cultural habits, has the greatest influence towards the successful implementation of construction 4.0 (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020). Lau et al. (2019) suggested several social factors that prolonged the implementation of construction 4.0 (Lau, et al., 2019). Mohd. Aripin et al. (2019) concluded that acceptance of technology and individual hesitance are among the potential barriers in implementing industry 4.0 technologies due to conservatism and adoption of new knowledge and skills (Mohd. Aripin, Zawawi, & Ismail, 2019). Kozlovska et al. (2021) cited other studies concluding that the social factor was proved to be the most important factor influencing the successful implementation of IR 4.0 technologies in the construction industry (Kozlovska, Klosova, & Strukova, 2021). These studies alongside the socio-cultural theory above, proven socio-cultural is the crucial factor of implementation of construction 4.0 in Malaysia.

III. PROBLEM STATEMENT

The conservative approach of construction industry is leading to inertia in the context of technology advancement and change, in this case construction 4.0. Alaloul et al. (2020) identified social factors, particularly cultural habits, has the greatest influence towards the successful implementation of construction 4.0 because it has a permeant effect throughout the construction processes involving multiple stakeholders and parties (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020). Lau et al. (2019) suggested several social factors that retarded the implementation of construction 4.0 encompassing low awareness, gaps between academy and industry, employees' acceptance and adaptability, and training and development (Lau, et al., 2019). Kozlovska et at. (2021) cited other study, mentioned that the social factor was proven to be the most important factor influencing the successful implementation of construction 4.0 (Kozlovska, Klosova, & Strukova, 2021). Mohd. Aripin et al. (2019) concluded that acceptance of technology and individual hesitance are among the potential barriers in implementing industry 4.0 technologies due to conservatism and adoption of new knowledge and skills (Mohd. Aripin, Zawawi, & Ismail, 2019). Sony and Naik (2020) mentioned that top management involvement and commitment is the main determinant for the readiness of IR 4.0 and sustaining new initiative. Unequivocally, employees must adapt to multifaceted of adaptability by virtue of the changes in the traditional nature of employment and works structural (Sony & Naik, 2020).

Since IR 4.0 and construction 4.0 are in its precursory, pertinent publications are meagre. Research in associated with IR 4.0 can only be discerned from year 2013, wherein only 8 publications were found in connected with construction 4.0 in year 2017 (Nowotarski & Paslawski, 2017). Kozlovska et al. (2021) found 195 publications related to the interconnection of IR 4.0 and construction 4.0 in year 2021 (Kozlovska, Klosova, & Strukova, 2021). The finite publications related to construction 4.0 signifies farther research in this filed is desideration and pivotal (Nowotarski & Paslawski, 2017). Bearing in mind that the above-mentioned publications are studies from researchers and scholars over the world. Hence, scanty publications in related to construction 4.0 that focusing on Malaysia's construction industry is anticipated. Therefore, it could be concluded that construction 4.0 in Malaysia is in the process of formation and there are needs for further investigation.

As a summary to the above, social factor is the main influential on procrastinating the implemention of industry construction 4.0 in Malaysia amidst studies of socio-cultural that influence the implementation of construction 4.0 in Malaysia is sparse. Coupling with the current research is focusing on technical aspect of technologies associated with IR 4.0 rather than ethical, economical, socio-cultural, or environmental (Kozlovska, Klosova, & Strukova, 2021), this paper serve in closing the gap by focusing on socio-cultural of construction industry that impeding the implementation of construction 4.0 in Malaysia, aim to enumerate and examine the influential in socio-cultural of construction industry.

IV. CONCEPTUAL MODEL

This study aims to enable country policy makers and organization decision makers possess the perspicuous insights that impeding the implementation of construction 4.0 in Malaysia. Wherein hoping the insights will facilitate in gambit pragmatic strategy to diminish the balk that engendered by social or cultural factors.

The following proposed conceptual framework aims to explore the relationships among the four independent variables that engender the late implementation of construction 4.0 in Malaysia.

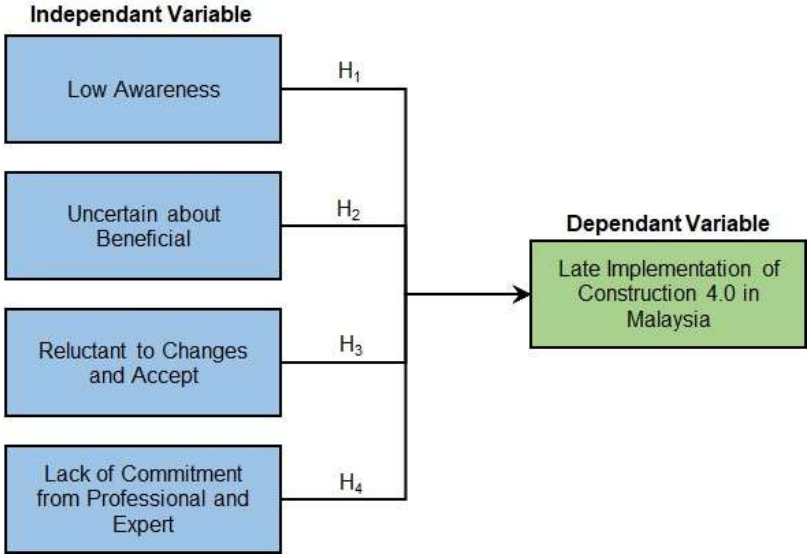

Figure 2 Conceptual Framework

The followings hypotheses were developed for this study: -

Hypotheses 1 : There is a relationship between **low awareness** and late implementation of construction 4.0 in Malaysia.

Hypotheses 2 : There is a relationship between **uncertain about beneficial** and late

implementation of construction 4.0 in Malaysia.

Hypotheses 3 : There is a relationship between **reluctant to changes and accept** and late implementation of construction 4.0 in Malaysia.

Hypotheses 4 : There is a relationship between **lack of commitment from professional and expert** and late implementation of construction 4.0 in Malaysia.

V. CONCLUSION

IR 4.0 augment quality and productivity of construction amidst attract domestic and foreign investors (Maskuriy, Selamat, Ali, Maresova, & Kerjcar, 2019). Thereby, government, construction industry, and academia are playing an important role in leveraging the enormous benefits of construction 4.0 amidst preparing the new generation for future jobs in the light of hasty technology advancement. Nonetheless, the finite publications related to construction 4.0 signifies farther research in this filed is desideration and pivotal (Nowotarski & Paslawski, 2017), especially construction 4.0 in Malaysia. Thereby, this paper intended to provide pragmatic insights to scholars and academician for their future studies and/or development amidst delineate the necessary areas or topics, which may or may not covered in this paper, for future research. Furthermore, Alaloul et al. (2020) identified social factors and cultural habits is the main impediment of construction 4.0 in Malaysia (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020). Oesterreich and Teuteberg (2016) and Kozlovska et al. (2021) concluded that current studies pay little attention to ethical, economical, socio-cultural, or environmental (Oesterreich & Teuteberg, 2016) (Kozlovska, Klosova, & Strukova, 2021). Therefore, this paper serves to accentuate the major socio-cultural challenges in Malaysia's construction industry that impeding the implementation of construction 4.0 to country policy makers and organization decision makers.

There are construction practices which have been implemented in construction industry and the processes have demonstrated significant impact throughout multiple platforms. Nonetheless, the challenges transpired must be addressed by all involved parties to ensure a successful implementation (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020). Therefore, it is imperative that industry's practitioners are opened in embracing the emerged technologies (Lau, et al., 2019) as the rules for survive and success in business are changed exponentially (Lim & Lim, 2014), because the current business models, strategies, and capabilities will not be compatible in the future world (Buehler, Buffet, & Castagnino, 2018).

VI. LIMITATION

This paper is focusing on socio-cultural factors that hindering the implementation of construction 4.0 in Malaysia. Thereby, socio-cultural factors are the sole pivot of this study, without considering other factors such as political, economic, technological, environmental, and legal that suggested in the previous studies by other scholars (within or outside Malaysia). Because this study is aiming to scrutinize the major factors within the parameter of socio-cultural that impeding the construction 4.0 in Malaysia, rather than general studies of all PESTEL factors. This paper aims to collect data and feedback from varies stakeholders within Malaysia's construction industry, fundamentally personnel from consultancy firms in private sectors including architect, civil & structural engineer, mechanical & electrical engineer, and consultant quantity surveyor.

Alaloul (2020) suggested that other contributing factors within the PESTEL frameworks are related to one another and should be addressed simultaneously (Alaloul W. S., Liew, Zawawi, & Kennedy, 2020), which is aligned with the studies from Oesterreich and Teuteberg (2016) suggested PESTEL must be embraced in

reaping the benefits from construction 4.0 (Oesterreich & Teuteberg, 2016). Therefore, other factors besides socio-cultural such as political, economic, technological, environmental, and legal that were not studied in this paper should be studied meticulously in the future research. Moreover, Oesterreich and Teuteberg (2016) and Kozlovska et al. (2021) pointed out that ethical must be further research as the extensive growth of digitalization may affect the workforce such as retrenchment, etc. (Oesterreich & Teuteberg, 2016) (Kozlovska, Klosova, & Strukova, 2021). Maskuriy et al. (2019) suggested that studies are lacking on overall project life cycle's management processes as well as the operation, and tactical and strategic planning in the collaborative and autonomous synchronization system (Maskuriy, Selamat, Ali, Maresova, & Kerjcar, 2019). Nowotarski & Paslawski (2017) mentioned multidiscipline approach required to be examining in creating special rules, procedures, and methods for introduction of construction 4.0 in SMEs sector (Nowotarski & Paslawski, 2017).

In summary, the future research may focus on i) Political, economic, technological, environment, and legal factors, ii) Ethical issues, iii) Management process for overall project life cycle, and iv) Operation and tactical and strategic planning. Moreover, data collection shall be collected from other practitioners and/or stakeholders such as developer, main contractors, sub-contractors, and other specialist contractors.

REFERENCES

1. Abas, N. (2015, October 27). *Research Methodology.* Retrieved from Razak UTM Malaysia: https://razak.utm.my/zaida/wp-content/uploads/sites/169/2015/11/RESEARCH-METHODOLOGY-27Okt15.pdf
2. Abdulai, R. T., & Owusu-Ansah, A. (2014). Essential Ingredients of a Good Research Proposal for Undergraduate and Postgraduate Students in the Social Sciences. *SAGE Open July-September 2014 DOI: 10.1177/2158244014548178*, 1-15.
3. Abu Hassan, Z., Schattner, P., & Mazza, D. (2006). Doing A Pilot Study: Why Is It Essential? *Malaysian Family Physician 2006, Vol 1, No 2&3*, 70-73.
4. Acs, Z. K., Lafuente, E., Sanders, M., & Szerb, L. (2017). *Productivity and growth : the relevance of the national system of entrepreneurship.* Retrieved from Semantic Scholar: https://www.semanticscholar.org/paper/Productivity-and-growth-%3A-the-relevance-of-the-of-Lafuente-Sanders/5e8d37314012fa15b44e0b49636d446e4cb657af#paper-header
5. Alaloul, W. S., Liew, M., Zawawi, N. W., & Kennedy, I. B. (2020). Industrial Revolution 4.0 in the construction industry: Challenges and opportunities for stakeholders. *Ain Shams Engineering Journal 11 (2020)*, 225-230.
6. Alaloul, W. S., Liew, M., Zawawi, N. W., & Mohanned, B. (2018). Industry Revolution IR 4.0: Future Opportunties and Challenges in Construction Industry. *MATEC Web of Conferences 203, 02010 (2018) ICCOEE 2018.* Kuala Lumpur: EDP Sciences.
7. Aliyu, M. M., & Yakubu, H. S. (2019). Implications of the Sociocultural Theory on Students' Reading Comprehension. *Bulletin of Advanced English Studies, 3(2) 2019*, 84-91.
8. Amin, T. (2019, March). *Inferential Statistics.* Retrieved from Research Gate: https://www.researchgate.net/publication/331874135_Inferential_Statistics
9. Apsalone, M., & Sumilo, E. (2015). Socio-Cultural Factors and International Competitiveness. *Business, Management and Education ISSN 2029-7491 / eISSN 2029-6169, 2015, 13(2)*, 276-291.

10. Apuke, O. D. (2017). Quantitative Research Methods a Synopsis Approach. *Arabian Journal of Business and Management Review (Kuwait Chapter), Vol 6 (10)*, 40-47.
11. Axelsson, J., Froberg, J., & Eriksson, P. (2019, October 02). Architecting systems-of-systems and their constituents: A case study applying Industry 4.0 in the construction domain. *Systems Engineering DOI: 10.1002/sys.21516*, pp. 455-470.
12. Backhaus, S. K., & Nadarajah, D. (2019). Investigating the Relationship between Industry 4.0 and Productivity: A Conceptual Framework for Malaysian Manufacturing Firms. *Procedia Computer Science 161 (2019)*, 696-706.
13. BEM. (2021). *Professional Engineer with Practising Certificate*. Retrieved from Board of Engineers Malaysia: http://bem.org.my/professional-engineer-with-practising-competency?_engineerresult_WAR_engineerdirectoryportlet_dcipline=CIVIL&_engineerresult_WAR_engineerdirectoryportlet_key=WEBPEPC&_engineerresult_WAR_engineerdirectoryportlet_name=&_engineerresult_WAR_
14. Bhatti, M. (2010). *Research Methodology.* Retrieved from Studentsrepo: http://studentsrepo.um.edu.my/3125/6/Chapter_3.pdf
15. Borawska, A. (2017). The Role of Public Awareness Campaigns in Sustainable Development. *Econoimc and Environmental Studies, Vol.17, No.4 (44/2017)*, 865-877.
16. BQSM. (2021). *List of Registered Members*. Retrieved from Board of Quantity Surveyors Malaysia: https://www.bqsm.gov.my/list-of-registered-members/consultant-qs.html
17. Buehler, M., Buffet, P. P., & Castagnino, S. (2018, June 13). *The Fourth Industrial Revolution is about to hit the construction industry. Here's how it can thrive.* Retrieved from World Economic Forum: https://www.weforum.org/agenda/2018/06/construction-industry-future-scenarios-labour-technology/
18. CIDB. (2021, March 24). *Registered Local Contractors as at 24 March 2021*. Retrieved from Construction Industry Development Board: https://www.cidb.mu/local-contractors
19. Dallasega, P., Rauch, E., & Linder, C. (2018). Industry 4.0 as an enabler of proximity for construction supply chains: A systematic literature review. *Computers in Industry, Vol.99*, 205-225.
20. Dayag, A. M. (2015). *Research Design and Methodolgy.* Retrieved from Academia: https://www.academia.edu/36044631/Chapter_3_RESEARCH_DESIGN_AND_METHODOLOGY
21. Forcael, E., Ferrari, I., Opazo-Vega, A., & Pulido-Arcas, J. (2020). Construction 4.0: A Literature Review. *Sustainability 2020, 12, 9755; doi:10.3390/su12229755*, 1-28.
22. Ghobakhloo, M. (2019). Industry 4.0, digitization, and opportunities for sustainability. *Journal of Cleaner Production*, 1-21.
23. Hercko, J., Slamkova, E., & Hnat, J. (2015). Industry 4.0 as a factor of productivity increase. *Transcom 2015*, 22-24.
24. Hopp, C., & Stephan, U. (2012). *The influence of socio-cultural environments on the performance of nascent entrepreneurs: Community culture, motivation, self efficacy and start-up success.* Retrieved from Aston University: http://publications.aston.ac.uk/id/eprint/21116/1/Influence_of_socio_cultural_environments_on_the_performance_of_nascent.pdf
25. Hyari, K. H. (2005). *Introduction to Construction Industry.* Retrieved from ResearchGate: https://www.researchgate.net/publication/292401396_Introduction_to_Construction_Industry

26. Ibrahim, F., Esa, M., & Mustafa Kamal, E. (2019). Towards Construction 4.0: Empowering BIM Skilled Talents in Malaysia. *International Journal of Scientific & Technology Research, Vol.8, Issue 10*, 1694-1700.
27. Kozlovska, M., Klosova, D., & Strukova, Z. (2021). Impact of Industry 4.0 Platform on the Formation of Construction 4.0 Concept: A Literature Review. *MDPI Sustainability 2021, 13, 2683. https://doi.org/10.3390/su13052683*, 1-15.
28. KPKT. (2021). *Carian Pemaju Perumahan Swasta*. Retrieved from Kementerian Perumahan Dan Kerajaan Tempatan: https://ehome.kpkt.gov.my/index.php/pages/view/172?mid=153
29. Kumar, S. (2018). Understanding Different Issues of Unit of Analysis in a Business Research. *Journal of General Management Research, Vol. 5, Issue 2*, 70-82.
30. LAM. (2021). *List of Registered Professional Architect*. Retrieved from Lembaga Arkitek Malaysia: https://portal.lam.gov.my/lam/website_member_list.php?gtype=pa
31. Lantolf, J. P., & Thorne, S. L. (2007). Sociocultural Theory and Second Language Learning. Mahwah, NJ: Lawrence Erlbaum.
32. Lau, S. E., Aminudin, E., Zakaria, R., Saar, C. C., Abidin, N., Roslan, A., . . . Shaharuddin, A. (2019). Revolutionizing the Future of the Construction Industry: Strategizing and Redefining Challenges. *WIT Transactions on The Built Environment*, 105-115.
33. Lekan, A., Clinton, A., & Owolabi, J. (2021). The Disruptive Adaptations of Construction 4.0 and Industry 4.0 as a Pathway to a Sustainable Innovation and Inclusive Industrial Technological Development. *Buildings 2021, 11, 79*, 1-28.
34. Levin, K. A. (2006). Study Design III: Cross-Sectional Studies. *Evidence-Based Dentistry (2006) 7, doi: 10.1038/sj.ebd.640037*, 24-25.
35. Liao, Y., Loures, E. R., Deschamps, F., Brezinski, G., & Venancio, A. (2018). The impact of the fourth industrial revolution: a cross-country/region comparison. *ISSN 1980-5411 (On-line version) Production, 28, e20180061, 2018 DOI: 10.1590/0103-6513.20180061*.
36. Lim, S., & Lim, J. H. (2014). *The Leader, The Teacher & You.* Singapore: Imperial College Press.
37. Maskuriy, R., Selamat, A., Ali, K. N., Maresova, P., & Kerjcar, O. (2019). Industry 4.0 for the Construction Industry - How Ready is the Industry. *Applied Sciences, 2019, 9, 2819; doi:10.3390/app9142819*, 1-26.
38. Mirawati, N., Othman, S., & Risyawati, M. (2015). Supplier-Contractor Partnering Impact on Construction Performance: A Study on Malaysian Construction Industry. *Journal of Economics, Business and Management, Vol. 3, No. 1*, 29-33.
39. Mohamad, E., Sukarma, L., Mohamad, N., Salleh, M., A Rahman, M., Abdul Rahman, A., & Sulaiman, M. (2018). Review of Implementation of Industry 4.0 Globally and Preparing Malaysia for Fourth Industrial Revolution. *[No.18-11] 日本機械学会 第 28 回設計工学・システム部門講演会講演論文集〔2018.11.4-6, 沖縄県読谷村〕*.
40. Mohd. Aripin, I., Zawawi, E. M., & Ismail, Z. (2019). Factors Influencing the Implementation of Technologies Behind Industry 4.0 in the Malaysian Construction Industry. *MATEC Web Of Conferences IConBEE2018* (pp. 1-5). Kuala Lumpur: EDP Sciences.

41. Nowotarski, P., & Paslawski, J. (2017). Industry 4.0 Concept Introduction into Construction SMEs. *IOP Conf. Series: Materials Science and Engineering 245 (2017) 052043 doi:10.1088/1757-899X/245/5/052043*, 1-10.
42. OECD. (2008). *OECD Policy Roundtables Construction Industry 2008.* Retrieved from Organisation for Economic Co-operation and Development: https://www.oecd.org/regreform/sectors/41765075.pdf
43. Oesterreich, T. D., & Teuteberg, F. (2016). Understanding the implications of digitisation and automation in the context of Industy 4.0: A triangulation approach and elements of a research agenda for the construction industry. *Computers in Industry*, 121-139.
44. Osunsanmi, T. O., Aigbavboa, C., & Oke, A. (2018). Construction 4.0: The Future of the Construction Industry in South Africa. *International Journal of Civil and Environmental Engineering, Vol.12, No.3*, 206-212.
45. Parliament of Australia. (2009). *Productivity growth and its importance.* Retrieved from Committees - Parliament of Australia: file:///C:/Users/cheegin.liong/Downloads/http___www.aphref.aph.gov.au_house_committee_economics_productivity_report_chapter%202.pdf
46. Raj, A., Dwivedi, G., Sharma, A., & Jabbour, A. L. (2020). Barriers to the adoption of industry 4.0 technologies in the manufacturing sector: An inter-country comperative perspective. *International Journal of Production Economic 224 (2020) 107546*.
47. Rao, S., Ahmad, A., William, H., & Kaptein-Russel, P. (2001). The Importance of Innovation for Productivity. *International Productivity Monitor, 2*, 11-18.
48. Roblek, V., Mesko, M., & Krapez, A. (2016). A Complex View of Industry 4.0. *SAGE, April-June 2016, DOI: 10.1177/2158244016653987*, 1-11.
49. Sawhney, A., Riley, M., Irizarry, J., & Perez, C. (2020). A Proposed Framework for Construction 4.0 Based on a Review of Literature. *EPiC Series in Built Environment, Vol. 1*, 301-309.
50. Sawyer, S. (2017). Analysis of Variance: The Fundamental Concepts. *The Journal of Manual & Manipulative Therapy, Vol.17 No.2*, 27-38.
51. Schober, P., Boer, C., & Schwarte, L. (2018, February). *Correlation Coefficients: Appropriate Use and Interpretation.* Retrieved from Research Gate: https://www.researchgate.net/publication/323388613_Correlation_Coefficients_Appropriate_Use_and_Interpretation
52. Sekaran, U. (2003). *Research Methods for Business - A Skill Building Approach.* New York: John Wiley & Sons, Inc.
53. Sony, M., & Naik, S. (2020). Key Ingredients for evaluating Industry 4.0 readiness for organizations: a literature review. *An International Journal, Vol. 27, No.7*, 2213-2232.
54. Taherdoost, H. (2016). Sampling Methods in Research Metodology; How to Choose a Sampling Technique for Research. *International Journal of Academic Research in Management, Vol.5 No.2, ISSN: 2296-1747*, 18-27.
55. Thornton, P. H., Ribeiro-Soriano, D., & Urbano, D. (2011). Socio-Cultural factors and entrepreneurial activity: An overview. *International Small Business Journal 29(2)*, 105-118.
56. Ugoni, A., & Walker, B. (1995). The t Test An Introduction. *Comsig Review, Vol.4 No.2*, 37-40.

57. University of Pretoria. (2010). *Research Design and Methodology.* Retrieved from UPSpace Institutional Repository: https://repository.up.ac.za/bitstream/handle/2263/24016/04chapter4.pdf?sequ%20ence=5

58. Vries, P. (2008). *The Industrial Revolution.* Retrieved from ResearchGate: https://www.researchgate.net/publication/282572543_The_Industrial_Revolution#:~:text=Abstract,per%20capita%20in%20real%20terms.

59. Zabidin, N., Belayutham, S., & Ibrahim, C. (2019). Industrial Revolution (IR) 4.0 in Construction Engineering Education: A Bibliometric Analysis. *Journal of Building Performance, ISSN:2180-2106, Vol. 10, Issue 2*, 21-27.