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Attitudes, Awareness, Readiness and Barriers towards the Internet of Things Adoption among the Construction Industry in East Coast Malaysia

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Abstract

There is an argument that the Internet of Things (IoT) adoption is relatively low especially in the construction industry. Hence, an initiative to examine the IoT adoption amongst contractors becomes the main focus of this study. This initiative is achieved by studying the current standing on relationship of attitudes, awareness, readiness and barriers towards the IoT adoption among contractors in Kelantan. Population of this study is enclosed to 330 contractors who are based in Kelantan on the categories of Grade G5, G6 and G6 with the Construction Industry Development Board (CIDB) of Malaysia. These categories are the top three of highest-rank contractors in Malaysian construction industry that possess high possibility of having the IoT adoption in their organization. Therefore, the results shown that the attitudes, awareness, readiness, and barriers are contributing to the changes in the adoption of IoT among the contractors. Significant relationship between IoT adoptions with the construction industry has been elaborated accordingly. As such, this study has given some useful indication for enhancing IoT adoption in the construction industry among contractors and the Government of Malaysia might take some action to pursue on the IoT adoption to embrace the Industrial Revolution 4.0 (IR 4.0) in this country.

Keywords: Internet of Things; Construction Industry; Contractors; IoT; Kelantan

1. Introduction

Construction industry is a vital sector for economic in many countries and there are many advantages for using IoT in the construction sector (Gamil, Abdullah, Abd Rahman & Asad, 2020). A construction project involves complex activities (Ma & Fu, 2020) and involves a lot of people especially during construction stage that requires strict monitoring and site supervision at every stage of constructions activity (Ingle & Mahesh, 2020). Tamošaitienė, Sarvari, Chan and Cristofaro (2021) stated that most of the construction projects are very complex and involves many parties such as contractors, suppliers, manufacturers, and also different expertise of professionals such as architects, civil & structural engineers, mechanical & electrical engineers, and quantity surveyors. According to Craveiro et. al, (2019), the nature of construction industry is traditionally slow to adapt on the new technologies, thus the application and adoption of technologies enabled by digitalization is still at initial stage. The IoT has the potential to transform the construction industry by the assistance of new solutions for industry player to adapt and make changes (Craveiro et. al, 2019).

The growth of digital technology in construction industry stated by Turkova, Archipova and Fedorovna (2020) has given positive impact to the industry player in dealing with their business activities. The existence of the IoT and the growth of digital technology have changed contractor's preference and forced the traditional way of doing work to evolve and harmonize with the latest technology developed in the market. Therefore, it is challenging in doing transformation from traditional low-tech labour-intensive methods in the direction modern high-tech capital intensive (Woodhead et al., 2018). The study indicates that almost 8,832 with 51% registration of grade G5, G6 (2,101) with 12% and G7 (6,374) with 37% contractors in Malaysia with the Construction Industry Development Board (CIDB).

However, the registration contractors of grade G5 (103) with 31%, G6 (62) with 19% and G7 (165) with 50% contractors based in Kelantan registered in Malaysia with CIDB.

Contractors are playing a key role in the construction industry in Malaysia to construct buildings or other infrastructure works at the high level of professionalism. Amusan et al., (2018) has summarised from the previous studies on the importance of Information Communication Technology (ICT) to construction industry for the reason of meeting the targeted period of time, complexity environments and operational disintegration that force many organizations either small or big industry player to fit in their organizations with ICT into their daily business activities. Study done by Holt (2015) is aiming to get the information related on the technologies that are in used and also those gaining adhesion in the construction industry in order to help educators choosing the right technologies that should be incorporated with the program of study. In the era of Forth Industrial Revolution, contractors have to strive hard to compete with each other in order to ensure that they can remain on the top and are always updated on current technologies. Focusing and spending more investment in technology and human capital are very important to form foundation in construction organizations towards the era of Industrial Revolution 4.0 (IR 4.0) in Malaysia. Technology becomes an extension of human beings and other things. Technological change is one of the matters that organization has to make an appropriate arrangement on because of rapid developments in the country (Nor Hayati Kassim et.al 2020)

Technological change is widely known as one of the significant reasons for economic growth (Fischer, 2001). In order to keep relevance in the industry, construction organizations need to adopt these technologies change. IR 4.0 in the construction industry is often linked to the digitalization of construction planning, construction monitoring and construction tools. Success in IoT adoptions in some of the construction organizations is still lacking and need to be improved. According to Amusan, et al., (2018) it is believed that the use of ICT in the construction industry will ensure to help in several problem solving such as on the security issues and could reduce time from overall construction period. As soon as an organization has decided to adopt and implement a new information technology system, it is important that the employees have to accept the innovation and obligate themselves to use the new developed system, or else it will have negative consequence on the technology adoption (Frambach & Schillewaert, 2002).

Due to rapid changes in current situation in the environment that involves new technology, smooth process of IoTs adoption is necessary (Ghosh, Edwards & Hosseini, 2020; Gamil et al., 2020). Top management of the organization should play an important role to ensure IoT adoption will be implemented based on the desire of the organization. Each of the employees in the organization are looking forward to obey on the decision by top management. Therefore, an organization needs a very clear direction as the understanding by the employees on IoT adoption is mainly relying on each step that taken by the organizations. Awareness on the current use of IoT as the world is moving towards IR 4.0 is very crucial to each organization in order not to be left behind in the competitive economics. Combination of individual as employee, organizational direction and technological aspects are the important determinants for adoption process by the organizations. As such, this study aims to assess whether the factor of attitudes, awareness, readiness and barriers on IoTs have significant relationship to its adoption among contractors and whether the contractors have adopted IoT in managing construction projects?

2. Literature review

Construction industries adopt the Internet of Things (IoT) and it has become a popular trend of usage among the clients, consultants, contractors, suppliers and workers in the construction site. Recent studies by Xu et al. (2018) and Zhong et al. (2017) have found benefits of the application of IoT in achieving more efficient in term of production and management of progress during construction period. There are three main factors that could influence user's willingness to use IoT applications which the performance expectancy that relates to users whether they feel IoT applications can help increases their work performance; effort expectancy that relates to users whether these applications are easy to learn and use; and social influence that relates to users whether people around them is supporting the use of the system (Chen et al, 2020). The construction organization should not only focus on the system that could help in improving the work performance, but it is also important to ensure employees feel comfortable and enjoy to use IoT applications while completing their task. According to Mahmud et al., (2018), there are several categories that are found on the potential of IoT utilization in the Malaysian construction industry such as Smart Communication, Remote Operation, Supply Replenishment, Maintenance of Machinery and Equipment, Power, Fuel and Energy Savings, Augmented Reality and so on.

Nature of construction industry is very unique because it always looks out for new design, new location, new costing and new materials that are introduced by manufacturers. Based on Brous et al. (2020), organization is always expecting the benefit on the adoption of IoT, but it may lead to changes that are commonly unexpected. Construction projects are very complex and always involve a lot of party such as clients, consultants (architects, engineers, quantity surveyor), contractors and suppliers. Each of them is playing different important roles starting from planning of the stage up to the completion and compliance stage for the construction work. Beyond that, many other parties also will be

involved in the construction projects such as local authorities, service provider like Tenaga Nasional Berhad (TNB) and Air Kelantan Sdn. Bhd. (AKSB), manufacturers, sub-contractors and many more. Some of the projects need to appoint specialist for design purposes in order to meet client's needs. As a result of these unique characteristic, it has often been difficult for the construction industry to properly coordinate and manage information and record the gain of the organization or individual.

According to de Castro Freitas and Freitas (2020), disorganized of information and records always led to miscommunication and misinterpretation information that contribute to the advent of breakdown in supply chains. Coordination among parties in the construction is a big challenge and the bigger size of the project, the more challenges in coordination of works, management of documents, controlling resources and also security aspect in the construction sites. Thus, the need for increase on data gathering and processing has brought the important of IoT in driving for smart construction to the next step (Gbadamosi et al., 2019). Based on the Diagram 1 below, it shows basic hierarchy in the construction projects.

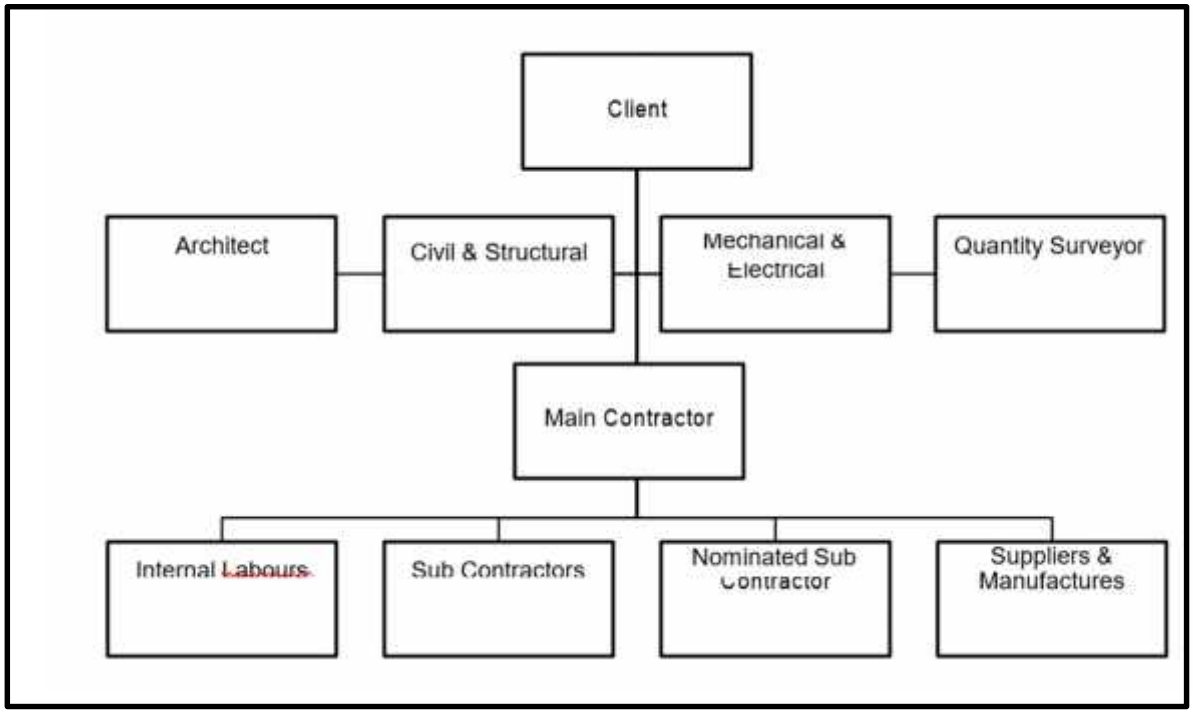

Figure 1. Basic Organization Chart for Construction Projects

Before the construction works takes place, consultant must get the approval from the local authority such as Majlis Daerah Bachok, Majlis Daerah Jeli or other local authority which depend on the location of the projects. During the construction, monitoring and supervision of the works will be done by consultants to ensure all the work by contractor are according to the specification and drawings. Most of construction project has been fixed on the date for completion that is agreed by the contractors and clients. Therefore, construction projects involve a very tight time schedule and it takes full attention to plan and coordinates construction activities. There is a challenge for the construction industry to increases efficiency and productivity to improve information and communication support for the core activities at construction sites. As discussed by Woodhead et al. (2018), the application of IoT is in various stages of construction including during design, construction works and facility management. ICT systems and IoT devices such as drone that support on-site working condition must ensure it is easy to do project monitoring, present project progress and support a wide range of user environments ranging from mobile phones to large displays for presentation and sharing of data. It is also important if the IoT applications could do some checking and foresee possibility of constructability problems before it appears during the construction.

According to Haugan (2001) project management software also includes project planning and scheduling, resource management, budgeting and project cost control, management of contract and construction risk management. Construction project planning and scheduling by using IoT devices will assist in managing work packages, interdependencies, resources allocation and durations each of construction activities for project monitoring. Apart from the common use of construction project planning software such as Microsoft Project, there are also other software such as Primavera, Power Project and other growing web-based collaboration tools.

Mead (2001) has mentioned that the information could be defined as transmission of the data and messages between persons within the communication system. Successful management of information has a critical influence on the performance of a project. The use of information technology can help in increasing the capability of construction development. Nowadays, the use of ICT is vital in the construction industry to ease the industry player in various construction firms and organization. Based on Magaba and Cowden (2015), construction people who could get to timely and accurate information will reduce or maintain project durations, make better use of resources, increase labor productivity, increase equipment productivity and could contribute to cost saving. Therefore, as mentioned by Peansupap (2004) it is observed that, information and communication technology (ICT) can be seen as vital reason for improving the efficiency and effectiveness of production in the industry. Therefore, it is important that the contractors should made available proper network platform to ensure IoT devices are connected and functionable. Samuelson (2003) supported that ICT utilization is relatively high in the design phase and in facility management and its use by contractors and site workers in the production process is still low. Based on the nature of construction activities, possibilities for productivity improvement are often reflected due to efficiency in running the construction business. Koroteev, Huang and Kamrunnaher (2020) found that savings in manual labour costs and shortening of the construction period result from higher productivity, determination of optimal usage of machines and putting them on the right places for workers to do repetitive works or avoiding dangerous incidents at the workplace.

Construction risks could be managed properly with effective communication between parties in the project team. The study done by Adeleke, Bamgbade, Salimon and Lee (2019) relating to the construction industries in Kuantan, shows that there is an important relationship between effective communication and management of construction risk. Therefore, IoT could be one of the vital medium to transfer information that could be shared immediately and precisely to the right person, at the right time and in the right place during construction period. The basic thing in every successful project is to reduce the risk by good communication and transferring the information among parties in the constructions.

3. Methodology

A total number of the contractor's population based on the information gathered from the official website of CIDB all over Malaysia is 8,832 companies for the contractors who were registered with Grade G7, followed by 2,101 companies for Grade G6 and 6,374 companies for Grade G5. For this study, it covered only the entire contractor's organization based in Kelantan that possessed Grade G7, G6 and G5 registered under Construction Industry Development Board (CIDB) constituted the population of this study. The reason to choose these contractors as target population was mainly because these contractors were in the top three of their categories selected by utilizing cluster sampling. The total estimated population of this study was 330 contractors who were under CIDB that were based in Kelantan. According to the calculation by the software GPower 3.1, the minimum sample size for this study was 74 sample. A survey monkey was distributed to the respondents by sending questionnaires through the respondents' emails and individuals' mobile phones.

4. Results and discussion

4.1 Demographics

Based on the 109 respondents in this survey, the majority age of the respondents was ranging between 41 to 50 years old that contributed 47% from the total of respondents while the lowest age of respondents was above 56 years old which was 9% as shown in Table 1. However, the age of the respondents that ranging between 21 to 30 years old were not found in this survey. It shows that, the possibility factors of not having respondents taking part in this survey could be due to financial capability, limited knowledge in construction and not adequate experience to start businesses as a contractor at the higher grade of registration. As depicted, the domination of the respondents was related to Grade G6 contractor registered under the Construction Industry Development Board (CIDB) that contributed total of 43 respondents or 39% while the lowest numbers were from Grade G6 contractor which was only 27 respondents or 25% from the total number of questionnaires received from the survey.

Table 1. Demographics

	Frequency	Percentage (%)
Company's experience		

Less 5 years	0	0
5-15 years	31	28
16-25 years	51	47
26-35 years	27	25
More than 35 years	0	0
Age		
21 to 30 years	0	0
31 to 40 years	35	32
41 to 50 years	52	47
51 to 55 years	12	11
56 years and above	10	9
Registration Grade		
Grade G7	39	36
Grade G6	43	39
Grade G5	27	25

With regards, most of the company had an experience ranging between 16 to 25 years that contribute 47% from the total of respondents. As shown in Table 1 indicates the lowest company year of experience is ranging between 5-15 years which is 28% out of 109 respondents. It shows that, these categories of contractors had strong experience as builders in the construction industry.

4.2 Correlation analysis

From the Table 4.11, the results of study showed adoption on IoT (TADP) had negligible relationship to the barriers of adopting IoT (TBAR) (r=0.100) and attitudes towards IoT (TBHV) (r=0.186) while readiness of company on the IoT (TREADY) (r=0.448) and awareness on use of IoT (TAWARE) (r=0.397) had low positive correlation to the adoption on IoT (TADP). In addition, two variables had no statistically significant correlation which became the barriers of adopting IoT (TBAR) (.300) and behaviour towards IoT (TBHV) (.053). Therefore, if any increase or decrease in one variable do not significantly relate to increase or decrease in another variable. However, two other variables; readiness of company on the IoT (TREADY) and awareness on use of IoT (TAWARE) were low positive correlated to the adoption on IoT (TADP) but significantly at the 5% significance level.

Table 2. Correlation Matrix

Variable		Attitudes (TBHV)	Awareness (TAWARE)	Readiness (TREADY)	Barriers (TBAR)	Adoption (TADP)
TBHV	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	109				
TAWARE	Pearson Correlation	.303**	1			
	Sig. (2-tailed)	.001				
	N	109	109			
TREADY	Pearson Correlation	.368**	.420**	1		
	Sig. (2-tailed)	.000	.000			
	N	109	109	109		
TBAR	Pearson Correlation	-.079	.081	.073	1	
	Sig. (2-tailed)	.416	.403	.449		
	N	109	109	109	109	
TADP	Pearson Correlation	.186	.397**	.448**	.100	1
	Sig. (2-tailed)	.053	.000	.000	.300	
	N	109	109	109	109	109

***. Correlation is significant at the 0.01 level (2-tailed).*

4.3 Coefficient analysis

Multiple regression analysis was run to predict the adoption of IoT from attitudes towards IoT (TBHV), readiness of company on the IoT (TREADY), awareness on use of IoT (TAWARE) and barriers on the IoT adoption (TBAR). There were two variables which were not statistically significant to the prediction which were attitudes towards IoT (TBHV) and barriers on the IoT adoption (TBAR), $p > 0.05$, while the other two variables were statistically significant to the prediction which were readiness of company on the IoT (TREADY) and awareness on use of IoT (TAWARE), $p < 0.05$. Table 3 shows that:

Table 3. coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.855	.289		2.961	.004
	TBHV	-.013	.095	-.013	-.137	.891
	TAWARE	.192	.072	.252	2.659	.009
	TREADY	.288	.082	.343	3.529	.001
	TBAR	.052	.083	.054	.628	.532

i) The coefficient value of attitudes towards IoT (TBHV) was negatively related to the adoption of IoT (TADP). For every 1% increase in TBHV, other independent variables were held constant, TADP would decrease by 1.30%. However, coefficient of attitudes towards IoT was not statistically significant at 5% significance level which was in the value of p = 0.891.

ii) The coefficient value of barriers on the IoT adoption (TBAR) is negatively related to the adoption of IoT (TADP). For every 1% increase in TBAR, other independent variables were held constant, TADP would increase by 5.20%. However, coefficient of barriers on the IoT was not statistically significant at 5% significance level which was value of p = 0.532.

iii) The coefficient value of awareness on use of IoT (TAWARE) was positively related to the adoption of IoT (TADP). For every 1% increase in TAWARE, other independent variables were held constant, TADP would increase by 19.20%. Coefficient of awareness on use of IoT was statistically significant at 5% significance level which was value of p = 0.009.

iv) The coefficient value of readiness of company on the IoT (TREADY) was positively related to the adoption of IoT (TADP). For every 1% increase in TREADY, other independent variables were held constant, TADP would increase by 28.80%. Coefficient of readiness of company on the IoT was statistically significant at 5% significance level which was value of p = 0.001.

5. Conclusions

Based on the findings, it can be concluded that most of construction professionals still do not embrace and are not exposed with the current technology especially the Internet of Things (IoTs) to improve their communication and business activities while serving their clients. With the view of technology awareness and adoption among construction professional in East Cost Malaysia, it seems that effective training programs, campaign, and introducing new policy by government are crucial to enhance the construction professional's involvement towards technology in construction industry (Moshood, 2020; Salleh, Palaniappan, Theng, Helmi, Hamid & Kassim, 2020; Adeleke, Bamgbade, Salimon & Lee, 2019). Technology can offer many advantages to construction professional, especially in terms of increasing productivity and efficiency through digitalization and automation of data management. IoT adoption in construction industry is still far behind from the other industry such manufacturing, automotive and agricultural. Therefore, for the purpose of future research, it is recommended to study on what are the main drives for the success of the IoT implementation in the construction industry. It is suggested that future research could be done through qualitative method by observation and interviewing the panel from CIDB, Public Work Department, Economic Planning Unit and other industry players for further understanding on the initiative by the government and needs from the industry.

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References

Adeleke, A., Bamgbade, J., Salimon, M. G., & Lee, C. K. (2019). Project management performance and its influence on Malaysian building projects. *KnE Social Sciences*, 313–329-313–329.

Amusan, L. M., Oloniju, L. I., Akomolafe, M., Makinde, A., Peter, N. J., Farayola, H., & Osawaru, F. A. I. T. H. (2018). Adopting information and communication technology in construction industry. *International Journal of Mechanical Engineering and Technology (IJMET)*, *9*(1), 739-746.

Brous, P., Janssen, M., & Herder, P. (2020). The dual effects of the Internet of Things (IoT): A systematic review of the benefits and risks of IoT adoption by organizations. International Journal of Information Management, 51, 101952.

Chen, J. H., Ha, N. T. T., Tai, H. W., & Chang, C. A. (2020). The willingness to adopt the Internet of Things (IoT) conception in Taiwan's construction industry. Journal of Civil Engineering and Management, 26(6), 534-550.

Craveiroa, F., Duartec, J. P., Bartoloa, H., & Bartolod, P. J. (2019). Additive manufacturing as an enabling technology for digital construction: A perspective on Construction 4.0. *sustainable development*, *4*, 6.

D Moshood, T. (2020). Emerging Challenges and Sustainability of Industry 4.0 Era in the Malaysian Construction Industry. *TD Moshood, AQ Adeleke, G. Nawanir, WA Ajibike, RA Shittu, Emerging Challenges and Sustainability of Industry*, *4*, 1627-1634.

de Castro Freitas, R., & Freitas, M. d. C. D. (2020). Information management in lean office deployment contexts. *International Journal of Lean Six Sigma*, *11*(6), 1175-1206.

Fischer, M. M. (2001). Innovation, knowledge creation and systems of innovation. The Annals of Regional Science, 35(2), 1-25.

Frambach, R. T., & Schillewaert, N. (2002). Organizational innovation adoption: A multi-level framework of determinants and opportunities for future research. Journal of Business Research, 55(2), 163-176.

Gamil, Y., Abdullah, M. A., Abd Rahman, I., & Asad, M. M. (2020). Internet of things in construction industry revolution 4.0. *Journal of Engineering, Design and Technology*, *18*(5), 1091-1102.

Gbadamosi, A.-Q., Oyedele, L., Mahamadu, A.-M., Kusimo, H., & Olawale, O. (2019). *The role of internet of things in delivering smart construction*. Paper presented at the CIB World Building Congress 2019, Hong Kong SAR, China.

Ghosh, A., Edwards, D. J., & Hosseini, M. R. (2020). Patterns and trends in Internet of Things (IoT) research: future applications in the construction industry. *Engineering, Construction and Architectural Management*, *28*(2), 457-481.

Haugan, G. T. (2001). *Project planning and scheduling*: Berrett-Koehler Publishers.

Holt, E. A. (2015). Emerging Technology in the Construction Industry: Perceptions from Con-struction Industry Professionals. *age*, *26*, 1.

Ingle, P. V., & Mahesh, G. (2020). Construction project performance areas for Indian construction projects. *International Journal of Construction Management*, 1-12.

Koroteev, D., Huang, J., & Kamrunnaher, M. (2020). *Construction cost control and duration analysis of rehabilitation project.* Paper presented at the Journal of Physics: Conference Series.

Ma, L., & Fu, H. (2020). Exploring the influence of project complexity on the mega construction project success: a qualitative comparative analysis (QCA) method. *Engineering, Construction and Architectural Management*, *27*(9), 2429-2449.

Magaba, M., & Cowden, R. (2015). The Impact of Technological Changes on Project Management at a Company Operating in the Construction Industry. *Kuwait Chapter of the Arabian Journal of Business and Management Review*, *5*(1), 8-38.

Mahmud, S. H., Assan, L., & Islam, R. (2018). Potentials of internet of things (IoT) in malaysian construction industry. *Annals of Emerging Technologies in Computing*, *2*(4), 44-52.

Mead, S. P. (2001). Developing benchmarks for construction information flows. *Journal of Construction Education*, *6*(3), 155-166.

Nor Hayati Kassim, Norlina Mohamed Noor, Jati Kasuma, Juliza Saleh, Ceaser Dealwis, Muhamad Azim Nurhisham (2020). Sustaining Job Performance through Technology Acceptance with Usage of Whatsapp Mobile Application, *International Journal of Service Management and Sustainability*, 5(1), 123-148.

Peansupap, V., & Walker, D. H. (2004). *Strategic adoption of information and communication technology (ICT): case studies of construction contractors.* Paper presented at the 20th Annual ARCOM Conference.

Salleh, F., Palaniappan, S., Theng, I. L. P., Helmi, H. N. M., Hamid, A., & Kassim, N. M. (2020). A review on risk management implementation in the construction industry. *Journal of Critical Reviews, 7*(11), 562-567.

Samuelson, O. (2003). IT Usage in Construction and Facility Management. Thesis, Royal Institute of Technology, Stockholm.

Tamošaitienė, J., Sarvari, H., Chan, D. W., & Cristofaro, M. (2021). Assessing the Barriers and Risks to Private Sector Participation in Infrastructure Construction Projects in Developing Countries of Middle East. *Sustainability, 13*(1), 153.

Turkova, V., Archipova, A., & Fedorovna, Z. (2020). *Digital transformation of the Russian construction industry.* Paper presented at the IOP Conference Series: Materials Science and Engineering.

Woodhead, R., Stephenson, P., & Morrey, D. (2018). Digital construction: From point solutions to IoT ecosystem. *Automation in Construction, 93*, 35-46.

Xu, G., Li, M., Chen, C. H., & Wei, Y. (2018). Cloud asset-enabled integrated IoT platform for lean prefabricated construction. Automation in Construction, 93, 123-134.

Zhong, R. Y., Peng, Y., Xue, F., Fang, J., Zou, W., Luo, H., Ng, S. T., Lu, W., Shen, G. Q. P., & Huang, G. Q. (2017). Prefabricated construction enabled by the Internet-of-Things. Automation in Construction, 76, 59-70.