International Journal of Applied Sciences and Smart Technologies

Volume 5, Issue 1, pages 27-38

p-ISSN 2655-8564, e-ISSN 2685-9432

Smart Technology in Construction Industry: Opportunity during COVID-19 Pandemic

Putri Fatimah[1,*], Ahyahudin Sodri[1], Udi Syahnoedi Hamzah[1]

[1]*School of Environmental Science, Universitas Indonesia*
[*]*Corresponding Author: putri.fatimah@ui.ac.id*

(Received 20-12-2022; Revised 24-12-2022; Accepted 30-12-2022)

Abstract
The construction industry is a sector that plays an essential role in economic growth. The COVID-19 pandemic is an uncertain situation that significantly affects humans and industries, including the construction industry. The operational construction projects are complex with various activities and involve a large of workers. Prevention of the spread of COVID-19 that changes lifestyles and improves technology adoption. This study examines the relationship between increased technology adoption and limited workers' social interaction in construction projects during the pandemic. A questionnaire survey was conducted to construction workers in DKI Jakarta, 74 valid responses were collected and correlation analyses were performed with SPSS version 28. The result of this study indicated a significant and positive correlation between increased technology adoption and limited workers' social interaction in a construction project during the pandemic. There are opportunities for the construction industry to implement a digital transformation, Building Information Modelling (BIM), and intelligence visualization technologies to cope with the impact of the COVID-19 pandemic on construction activities. This study provides evidence that smart technologies application has a significant role in supporting the construction industry to mitigate the impact of the COVID-19 pandemic and opportunities for continuous improvement towards post-pandemic.

Keywords: COVID-19, construction, industry, smart technology

1 Introduction

World Health Organization (WHO) announced coronavirus disease (COVID-19) as the name of a new disease [1]. COVID-19 affected the world's population, put pressure on the global health system, and was declared a pandemic by the World Health Organization (WHO)[2]. Confirmed cases of COVID-19 in Indonesia until December 2022 fluctuate. Based on the WHO dashboard, from 3rd January 2020 to 16th December 2020, there were 160,362 fatalities and 6,707,504 confirmed cases of COVID-19 in

Volume 5, Issue 1, pages 27-38

p-ISSN 2655-8564, e-ISSN 2685-9432

Indonesia [3]. The COVID-19 pandemic has occurred for over two years and is still ongoing. This crisis has an impact on various sectors, including the construction industry. Table 1 informs the impact of the COVID-19 pandemic on the construction industry from previous study.

Table 1. Impact of the COVID-19 pandemic on the construction industry

Locations	Impact of the COVID-19 pandemic
The United Kingdom	Construction companies suffered losses, financial constraints from clients and banks, delayed projects due to material deficiencies, extended project completion targets, and social distancing provisions became a major challenge in construction activities [4].
North America	Delays in material delivery result in material shortages, reduced efficiency and productivity, slowdown of ongoing projects and delays in new projects, additional costs, and workplace safety [5].
China	Management difficulties including stricter workplace supervision, difficulties in collaboration, reduced work efficiency, project delays, supply chain disruptions, longer material delivery times, temporary shutdown of construction sites, increased construction costs for COVID-19 prevention, increased material costs, machinery costs, extended project time, and reduced project profits [6].
Malaysia	Project delays, labor shortages and job losses, time overruns, cost overruns, company financial impacts, planning, and scheduling disruptions, movement restrictions, material price fluctuations, and uncertainty of company continuity [7]. Decreased project productivity, increased compliance costs, and exposure

Volume 5, Issue 1, pages 27-38
p-ISSN 2655-8564, e-ISSN 2685-9432

	of construction workers challenges to safety and occupational health [8].
Indonesia	Impacted to project performance, implementation of health protocols requires additional cost, and project completion time [9]. Significant impact on construction projects' completion time, project budget, and occupational health and safety [10].

The emergence of a complex pandemic impact on various aspects encourages companies and individuals to survive in this crisis condition, including optimizing the potential opportunities. The adoption of information technologies and digital transformation has accelerated due to the pandemic. Developing smart technologies significant impacts cost savings, quality improvement, and productivity gains on the project, which also supports the smart construction project approach to management [11]. A smart technologies system is integrated technologies used to monitor and manage environments or external system, improving human life and work, and accelerate the performance of routine or industrial operations [12].

Iqbal *et al.* [13] state that the construction sector should pursue innovative and digital approaches to improve business operations and leverage opportunities. In the COVID-19 pandemic context, research by Yang *et al.* [6] related to the impact of the COVID-19 pandemic on the construction industry in China, the result states that the positive impact of the COVID-19 pandemic is the improvement of technology adaptation. On a similar point, Li *et al.* [14] argue that the COVID-19 pandemic brings several opportunities for developing smart construction technologies and innovations in construction management. In addition, organizations must allocate resources to survive the pandemic, and be prepared for any uncertainties that may occur in the future [13]. The opportunities are applied by improving technology adoption and innovation that can support construction operations during the COVID-19 pandemic. This study examines the relationship between workers' interaction and technology adoption in the construction project. This study also explores the smart technology that can be applied to improve the construction industry's performance to cope with the pandemic.

Volume 5, Issue 1, pages 27-38
p-ISSN 2655-8564, e-ISSN 2685-9432

2 Research Methodology

This study focused on the construction project in DKI Jakarta, based on data COVID-19 task force in Indonesia, that the distribution of confirmed COVID-19 cases in Indonesia is highest in DKI Jakarta [15], thus referred to as the epicenter of COVID-19 cases[16]. This study was conducted at a private construction company (PT X) located in DKI Jakarta, based on the value of the project contracts undertaken, the company is a large category construction service company. The population in this study are workers who work on high-rise building construction projects in DKI Jakarta, where PT X is responsible as the main contractor. In order to examine the relationship between workers interaction and technology adoption, an online questionnaire survey was conducted for construction workers as the main data collection. Data were collected from September to October 2022. The respondent criteria are construction project workers who had work experience in DKI Jakarta during the COVID-19 pandemic. A simple random sampling method was employed with the calculation number of samples using the Isaac and Michael formula with an error degree of 5%. The minimum sample is 71 workers, and the actual survey collected 74 respondents.

A questionnaire survey uses a Likert 5-rating scale, with a rating of 1 expressing strongly disagree, and 5 expressing strongly agree. Attitudes, opinions, and perceptions of social phenomena are measured using the Likert scale [17]. The optimal number of alternative responses is five scales [18]. Correlation analysis was used to evaluate the strength of the relationship between variables. Correlation analyses were performed with IBM SPSS Statistics version 28. Kendall's tau value interpretations include weak correlations (>0-0.25); moderate correlations (>0.25-0.5); high correlations (>0.5-0.75); very high correlation (>0.75-0.99); and value of 1 for perfect correlation [19].

3 Results and Discussions

3.1 Demographic characteristics of the respondents

All respondents confirmed working on construction projects in DKI Jakarta during the COVID-19 pandemic. According to Table 2, almost 73% of respondents experienced

Volume 5, Issue 1, pages 27-38

p-ISSN 2655-8564, e-ISSN 2685-9432

more than 10 years, and other 27% have experienced more than 3 to 10 years. Based on this result, it can be deduced that all respondents have experience in the construction project. Various positions in the construction project were involved in this study, including project manager, site manager, HSE, engineers, and other positions representing the perspective of general construction workers. Detail of characteristics of respondents, such as work experience in the construction industry and job positions, are shown in Table 2.

Table 2. Demographic characteristics of respondents (N=74)

Characteristics		Frequency (F)	Percentage
Work experience in the construction industry	>3 – 7 years	7	9.4%
	>7 – 10 years	13	17.6%
	>10 – 19 years	25	33.8%
	20 years or more	29	39.2%
Job position	Project Manager	4	5.4%
	Site Manager	14	18.9%
	Engineer	11	14.9%
	Commercial	8	10.8%
	HSE	11	14.9%
	General Affair	3	4%
	Quality Supervisor	11	14.9%
	Quantity Surveyor	4	5.4%
	Drafter	8	10.8%

Source: Primary data analysis, 2022

3.2 Questionnaire data analysis

Correlation analysis of questionnaire data performed with software IBM SPSS. The output of the correlation analysis between increased technology adoption and limited workers' social interaction during the pandemic shows in Table 3.

Volume 5, Issue 1, pages 27-38

p-ISSN 2655-8564, e-ISSN 2685-9432

Table 3. Kendall's tau correlation coefficient

Variables	Kendall's tau correlation coefficient	Significance level
Increased technology adoption during the pandemic Limited workers' social interaction during the pandemic	0.375**	<0.001

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

Source: Primary data analysis, 2022

Correlation analysis between increased technology adoption and limited workers' social interaction during the pandemic, based on Table 3 Kendall's tau correlation value is 0.375, this value means a positive relationship with moderate strength and significance at the 0.01 level (2-tailed). During the COVID-19 pandemic, social distancing is included in the COVID-19 spread prevention protocol. Increased technology adoption can reduce face-to-face interaction and communication between workers to avoid the spread of COVID-19, but also it can increase the efficiency of construction work and implement COVID-19 prevention protocols [14]. Several innovative technologies have been applied to enhance construction site performance and support the health and well-being of construction workers [6].

3.3 Smart technologies in the construction industry

This section discusses some of the smart technologies opportunities that can be applied in the construction industry. Moreover, supporting the survey result described in the previous section. Digital transformation is recognized as a new paradigm of digital innovation, and information technology plays a vital role in the company, especially during the pandemic. Leontie, Maha, and Stoian [20] argue that digitalization is the most helpful to cope with the pandemic situation. The construction sector had to prioritize digital transformation for sustainability, and despite initiatives to implement digital transformation to enhance productivity, the COVID-19 pandemic has significantly increased digital transformation [21]. The digitalization of the construction sector is

Volume 5, Issue 1, pages 27-38
p-ISSN 2655-8564, e-ISSN 2685-9432

linked directly to the use of various information technologies known as construction technology 4.0 [20]. Ben-Zvi and J. Luftman [22] argue that digital transformation brings great changes to human life, and the COVID-19 pandemic drives these changes. Another study has the same point, Kamal [23] states that the adoption of digital technology is an opportunity during the COVID-19 pandemic; digital technology has been proven to support productivity. Digital transformation technologies help improve productivity, enhance safety and risk mitigation, high-quality buildings, and improve collaboration by collecting, analyzing, and using data from the entire supply chain in the construction industry [21].

One of the impacts of the pandemic that mainly occurs in construction projects is delays construction work, and delays in material supply, thus the efficient method is important to mitigate this impact. The Building Information Modelling (BIM) concept as a combination of methods and technology that organize the operational and support the management of the 3D models and other construction information in digital format during the period of the entire building's life cycle [24]. BIM is generally used by engineering positions to build design for each stage. BIM provides visual tools and information on the operations and materials, improving the quality and consistency of project life cycle costs [25]. BIM is a process, method, information project design, faster project management, cost-effective, and reduces environmental impact [26]. BIM can help facilitate the construction process more efficiently, and BIM-based design models can contribute to sustainable construction [27]. The application of BIM can prevent design errors and effective use of materials, and reduce the potential for construction waste generation [28].

The architectural engineering and construction industries have the popularity of visualization technologies such as virtual reality, augmented reality, and automation technology using robots and intelligent algorithms [11]. Artificial intelligence (AI) can address a productivity issue in the construction sector; throughout the building lifecycle AI utilize the data and leverages other technological capabilities to improve the construction process [29]. In context of the COVID-19 pandemic, using technology will have benefits for improving the quality of learning [30]. Visual technology can be adopted to promote health protocols and increase construction workers' awareness of complying

Volume 5, Issue 1, pages 27-38
p-ISSN 2655-8564, e-ISSN 2685-9432

with COVID-19 protocols, and audio-visual training can make it easier for workers to understand the training content.

In other applications, biometric identity methods such as facial recognition can be used by attendance systems to prevent the spread COVID-19 caused by physical touch [31]. Smart recognition gates enable effective and efficient workforce management by recording attendance and preventing unauthorized visitors [11]. According to Rafiq, Alimudin, and Rani [31], a face recognition attendance system has been implemented with the main concept when people face or objects appear then the camera will activate and show up on the monitor, and the temperature sensor will detect the object, the implementation has successfully achieved a high accuracy level of 80%. The application of smart recognition gates can develop with the application of the COVID-19 protocol, for example measuring body temperature, and COVID-19 vaccination status as screening when workers enter the project area.

4 Conclusions

Construction workers' interactions have been restricted due to the COVID-19 pandemic. Based on the result and discussion, it was shown that there is a significant and positive correlation between increased technology adoption and limited workers' social interaction during the COVID-19 pandemic. In short, the COVID-19 pandemic accelerates technology adaptation in the construction industry. There are prospects for the construction industry to adaption smart technology such as digital transformation, Building Information Modelling (BIM), and intelligence construction technologies. The limitation of this study is that the survey was conducted to workers regarding technology adoption in general. Therefore, the suggestion for further study is to conduct specific survey on the technology adoption based on each position, and cost-benefit analysis of smart technology. Besides the limitation, this study provides evidence that applying smart technology support improvement in the performance of the construction industry to cope impact of the COVID-19 pandemic and opportunities for post-pandemic.

Volume 5, Issue 1, pages 27-38

p-ISSN 2655-8564, e-ISSN 2685-9432

Acknowledgments

The authors would like to thank the private construction company in DKI Jakarta (PT X) for permitting this study and appreciate the participation of construction workers willing to be respondents and other parties involved in this study.

References

[1] World Health Organization, Novel Coronavirus(2019-nCoV) Situation Report – 22, (2020), [Online]. Available: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200211-sitrep-22 ncov.pdf?sfvrsn=fb6d49b1_2.

[2] M. Usman, Y. Ali, A. Riaz, A. Riaz, and A. Zubair, Economic perspective of coronavirus (COVID-19), J. Public Aff., 20 (4) (2020) 1–5,

[3] World Health Organization, WHO Health Emergency Dashboard - Indonesia Situation, (2022), https://covid19.who.int/region/searo/country/id (accessed Dec. 17, 2022).

[4] A. Shibani, D. Hassan, and N. Shak, The Effects of Pandemic on Construction Industry in the UK, Mediterr. J. Soc. Sci., 2117 (2020) 48–60.

[5] M. Raoufi and A. R. Fayek, Identifying Actions to Control and Mitigate the Effects of the COVID-19 Pandemic on Construction Organizations: Preliminary Findings, Public Work. Manag. Policy, 26 (1) (2021) 47–55,

[6] Y. Yang et al., Opportunities and Challenges for Construction Health and Safety Technologies under the COVID-19 Pandemic in Chinese Construction Projects," Int. J. Environ. Res. Public Heal. Artic., 18 (13038) (2021).

[7] D. Y. Gamil and A. Alhagar, The Impact of Pandemic Crisis on the Survival of Construction Industry : A Case of COVID-19, Mediterr. J. Soc. Sci., 11 (4) (2020) 122–128.

[8] A. Olanrewaju, A. AbdulAziz, C. N. Preece, and K. Shobowale, Evaluation of measures to prevent the spread of COVID-19 on the construction sites, Clean. Eng. Technol., 5 (100277) (2021).

[9] D. Larasati, N. Ekawati, S. Triyadi, A. F. Muchlis, and A. Wardhani, Impact of the

Volume 5, Issue 1, pages 27-38

p-ISSN 2655-8564, e-ISSN 2685-9432

Pandemic COVID-19 on the Implementation of Construction Contracts, IOP Conf. Ser. Earth Environ. Sci., 738(1) (2021) 1–12,

[10] R. Susanti, S. Fauziyah, and P. U. Pramesti, Lesson from pandemic Covid-19 for sustainability construction in Indonesia, AIP Conf. Proc., 2447 (1) (2021) 30013.

[11] M. Xu, X. Nie, H. Li, J. C. P. Cheng, and Z. Mei, Smart construction sites: A promising approach to improving on-site HSE management performance, J. Build. Eng., 49 (2021).

[12] M. Ion and G. Căruțașu, Smart Technology, Overview, and Regulatory Framework, Rom. Cyber Secur. J., 2 (1) (2020), [Online]. Available: https://rocys.ici.ro/spring-2020-no-1-vol-2/smart-technology-overview-and-regulatory-framework/.

[13] M. Iqbal, N. Ahmad, M. Waqas, and M. Abrar, COVID-19 pandemic and construction industry: Impacts, emerging construction safety practices, and proposed crisis management framework, Brazilian J. Oper. Prod. Manag., 18 (2) (2021) 1–17.

[14] Z. Li, Y. Jin, W. Li, Q. Meng, and X. Hu, Impacts of COVID-19 on construction project management: a life cycle perspective, Eng. Constr. Archit. Manag., (2022),

[15] COVID-19 Handling Task Force, Peta Sebaran Perkembangan Kasus Covid-19 di Indonesia, (2022). https://covid19.go.id/en/peta-sebaran (accessed Mar. 22, 2022).

[16] R. E. Caraka et al., Impact of COVID-19 large scale restriction on environment and economy in Indonesia, Glob. J. Environ. Sci. Manag., 6 (2020) 65–84.

[17] Sugiyono, Metode Penelitian Kuantitatif, Kualitatif, dan R&D, 19th ed. Bandung: Alfabeta, (2013).

[18] X. Chen, H. Yu, and F. Yu, What is the optimal number of response alternatives for rating scales? From an information processing perspective, J. Mark. Anal., 3 (2) (2015) 69–78.

[19] J. Sarwono, Path Analysis dengan SPSS. Jakarta: Elex Media Komputindo, (2012).

[20] V. Leontie, L. G. Maha, and I. C. Stoian, COVID-19 Pandemic and its Effects on the Usage of Information Technologies in the Construction Industry: The Case of Romania, Buildings, 12 (2) (2022).

[21] S. Kim, M. Lee, I. Yu, and J. W. Son, Key Initiatives for Digital Transformation, Green New Deal and Recovery after COVID-19 within the Construction Industry

Volume 5, Issue 1, pages 27-38

p-ISSN 2655-8564, e-ISSN 2685-9432

in Korea, Sustain., 14 (14) (2022).

[22] T. Ben-Zvi and J. Luftman, Post-Pandemic IT: Digital Transformation and Sustainability, Sustain., 14, (22) (2022) 1–11.

[23] M. M. Kamal, The triple-edged sword of COVID-19: understanding the use of digital technologies and the impact of productive, disruptive, and destructive nature of the pandemic, Inf. Syst. Manag., 37 (4) (2020) 310–317.

[24] J. P. Carvalho, L. Bragança, and R. Mateus, Optimising building sustainability assessment using BIM, Autom. Constr., 102 (2019) 170–182.

[25] M. Zoghi and S. Kim, Dynamic modeling for life cycle cost analysis of BIM-based construction waste management, Sustain., 12 (12) (2020) 2483.

[26] J. Čabala, M. Kozlovská, Z. Struková, and A. Tažíková, Benefits of BIM models and mixed reality in the implementation phase of construction projects, IOP Conf. Ser. Mater. Sci. Eng., 1252 (1) (2022) 012079.

[27] S. Soltani, The Contributions of Building Information Modelling to Sustainable Construction, World J. Eng. Technol., 4 (2) (2016) 193–199.

[28] A. Turkyilmaz, M. Guney, F. Karaca, Z. Bagdatkyzy, A. Sandybayeva, and G. Sirenova, A comprehensive construction and demolition waste management model using PESTEL and 3R for construction companies operating in central Asia, Sustain., 11 (6) (2019).

[29] S. O. Abioye et al., Artificial intelligence in the construction industry : A review of present status , opportunities and future challenges, J. Build. Eng., 44 (2021).

[30] H. Suparwito, Information Technology and Learning Methodology amid the COVID-19 Pandemic, Int. J. Appl. Sci. Smart Technol. 2 (2) (2020) 107–118.

[31] A. A. Rafiq, E. Alimudin, and D. P. Rani, Employee Presence Using Body Temperature Detection and Face Recognition, Int. J. Appl. Sci. Smart Technol., 4 (2) (2022) 173–184.

Volume 5, Issue 1, pages 27-38

p-ISSN 2655-8564, e-ISSN 2685-9432

This page intentionally left blank