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The Adoption of Current Safety Practices for the Construction of Telecommunication Masts and Towers in Nigeria: A Principal Component Analysis

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ABSTRACT

Construction safety practices is a significant aspect in the construction industry, as construction workers cannot operate in an accident free environment without proper adherence to safety guidelines. The construction and maintenance of telecommunication masts and towers can pose serious accident threat to workers on site, hence the need to adopt the current safety practices in the sector. This study outlined the current safety practices observed by workers in the construction of telecommunication masts and towers. The study adopted a quantitative research approach and data collected from the participants involved in the construction of telecommunication masts and towers in Nigeria. Information gathered was analysed using the mean item score (MIS), standard deviation (SD) and exploratory factor analysis (EFA). The findings showcased the current safety practices of telecommunication masts and towers in the Nigeria telecommunication industry to be; personal protective equipment (PPE), fire extinguisher, safety inspection, unauthorised entry to construction sites is prohibited, safety policy, safety education and training programs. These were seen to have a direct impact on the safety practices currently observed in the construction of telecommunications masts and towers in the Nigerian telecommunication industry. Non adherence to safety practices can hinder the welfare of the workers and economic growth of the country. Therefore, it is imperative for the telecommunication industry in Nigeria to adopt more ways of managing safety in the industry so as to improve the safety and welfare of construction workers and prevent negative economic infractions they may arise from accidents on sight. The government should adopt measures to ensure the current safety practices are enforced among all construction stakeholders who are involved in the construction of telecommunication masts and towers to prevent accidents from happening at construction sites.

Keywords: Safety practice, Safety policies, Site workers, Telecommunication construction, Masts and towers

INTRODUCTION

The construction industry is regarded globally as one of the most unsafe industries with a high risk of occupational accidents and injuries (Zhou et al., 2015). The construction of telecommunication masts and towers has become increasingly common in recent years with the growing demand for high-speed Internet connectivity and mobile network coverage (Vala and Vora, 2015). Safety practices has accomplished a constructive safety result of accident and injury anticipation through the engagement of site workers, engineers and technicians on the need to always remain safety conscious at all times in the industry (Wachter and Yorio, 2014).

These workers are unprotected regarding different kind of occupational safety and health risks such as struck-by hazards, fall from height, collapsed structure, radio frequency exposure, work fatigue, severe weather (hot and cold), electrocution, and cuts or lacerations as a result of using sharp tools and materials. It is imperative that the construction and maintenance workers are aware of their limitations, be physically fit, have a responsible attitude, are comfortable working at height, are able to communicate with other workers while working at height, are familiar with working at height procedures, are fully aware of the hazards related to the machinery which they are mandated to maintain, are properly instructed and trained, are familiar with working at height procedures, are fully aware of manufacturers' manual guides, are competent and trained to inspect and correctly use essential personal protective equipment (PPE), and are familiar with the construction site and associated hazards (Shin et al., 2021).

Safety practice should be considered during the design phase and along with all the construction activities (Saunders et al., 2017). Workers' irrational behaviours which might be difficult to monitor and control could result in the cause of accidents at the construction site (Teo et al., 2005). Since the construction industry remains the most dangerous profession with so many complications in carrying out the work, this has led to various cases of deaths among site workers and the public. On this note, inadequate occupational safety and health (OSH) in the construction industry has been pinpointed as a problem (Fang et al., 2023). The future of the construction industry is solely dependent on the health and safety management system. This contains the various measures aimed at observing, planning, and reducing occupational risks in the sector by taking proactive measures to protect against and mitigate site accidents. The goal of the health and safety practice in the construction industry is to carry out the work effectively and safely without causing any accident or hazard during the cause of the job (Zhou et al., 2012).

Literature Review

Safety practices at the construction site is an important aspect in the construction industry. The extent to which telecommunication construction workers comply with the safety rules and regulations in order to keep safe and avoid accidents from occurring at the work site in Nigeria is detailed in this study (Sanni-Anibire et al., 2020). Agbede et al. (2016) reveals that the organisations duty and vision is to relate published safety policy written by the board

of executive and government on issues relating to health and safety of construction workers. The organisation obligation towards H&S issues must be addressed by safety policies as it relates to the construction environment. Moreover, safety management practices in construction of telecommunication of masts and towers was further studied by Dorji and Hadikusumo (2006) who describe a safety policy as a declaration of goals and values that shows the commitment of the management towards ensuring good and safe working techniques at the construction site. A safety policy is a guideline of the safety practices that must be followed by site workers in so as to maintain healthy and safe working environments to avoid occurrence of accidents (Nor and Demong, 2016). Regular safety education and training of workers helps to improve their abilities and skills in other to identify hazards thereby reducing the risk of accidents on site (Maclean et al., 2011). The continuous exposal of workers to safety education and training are important for construction workers to prevent errors caused by humans which can lead to accidents and also to ensure that construction workers carry out repetitive work with expertise (Paringga, 2010).

In the same vein, safety practices are uphold by close monitoring of site workers adherence to safety in the construction environment. The required safety audits are created by the safety management system by evaluating all the components of the management system which are carefully examined so as to comply with the required standards. Safety audits involve safety inspections, document checks and in some cases, interviews (Keng and Razak, 2014). Safety inspections are one of the important safety practices that must be carried out by construction workers in order to maintain a safe and healthy working environment free of accidents (Permana, 2007).

The H&S of construction workers is important; therefore, the gathering of construction site workers at the workplace to discuss H&S matters should be done on a regular basis. The sole aim of the safety meetings is to reaffirm that all the site workers are clearly aware of the safety hazards that are associated with working at a construction site (Holt, 2008). In most cases, morning meetings are recommended for all workers and safety discussions on the possible prediction of danger are discussed before the commencement of activity of the day (Keng and Razak, 2014). In addition, the behaviour of the workers contributes to the possible hazards or accidents that are recorded at construction sites (Jin and Chen, 2013). Subsequently, fall is a major cause of accident in the construction site. Adequate safety fall protection system should be made available to workers so that they can select the most suitable protection device that is appropriate for their type of job. This is necessary at construction sites in the case of a situation where a construction worker is at risk of a fall when working at height of two metres or higher (Keng and Razak, 2014).

At the construction of telecommunication of masts and towers in Nigeria, it is imperative to reiterate that a proper safety zone should be allocated within the construction site in other to prevent danger from falling equipment (Elbeltagi and Hegazy, 2002). Construction sites are expected to be divided into red and green zones. The two zones are usually separated by installing safety signboards and boundary fence. The red zone, otherwise known as the

fabricated zone, are areas strictly for workers that are involved in the construction process and the minimum admissibility of workers to this zone is strictly adhered to. Workers have to wear PPE since the area is prone to danger. Meanwhile, the green zone, otherwise known as the non-fabricated zone, comprises of the car parks, clinic, offices, restaurant, and areas allocated for resting (Rosli et al., 2008). Also, the use of Personal protective equipment (PPE) is one of the several practices construction workers carry out in other to maintain a safe and healthy environment while carrying out their duties on construction site (Vitharana and Chinda, 2021). The Occupational Safety and Health Administration (OSHA) recommends various PPE to construction workers in order to help prevent accidents on construction sites. Some of the PPE that is suggested to construction workers includes foot protection (safety boots), face or eye protection (face shield or goggle glasses), head protection (hard hats), hand protection (hand gloves), hearing protection (earplugs), respiratory equipment, and protective clothing (impact-resistant clothing) (OSHA, 2005; Paringga, 2010).

Another way of maintaining safety practices is via the use of first aid training to assist non-medical professionals with the knowledge to help persons in an event of injury or sudden illness, before the arrival of medical personnel. Rendering first aid care does not depend on the severity or the result of the occupational injury in most cases (Fiske, 1999). The establishment of first aid has been widely recommended, and the proportion of trained first aiders to the non-first aiders at the construction sites varies from 1:25 to 1:50 which is subject to the workplace occupational H&S hazards. This means the more the risk at the construction site, the more the need for more construction workers to be trained on how to use first aid (Lingard, 2017).

Also, in construction sites, many site workers make use of highly flammable substances and most of their work is done in a complex/enclosed environment, which can give rise to blasts and fire burns (Khan et al., 2016). Fire extinguishers are mostly relied upon by construction sites for quenching fire since fire protection plans are not readily available or, in most cases, unaffordable during construction activities. Statistics has shown that 80% of all workplace accidents occur because of non-adherence to construction safety rules (rule-breaking behaviours) (Choudhry et al., 2008). Forceful entry into unauthorised hazardous areas at the construction site without the consent of the construction office or supervisor in charge of the construction process can create a disturbance to site workers, leading to serious accidents at the construction site. In respect to current safety practices, safety supervisors or trained observers oversee safety behaviour inspection on the basis of safety or entry regulations (Zhang and Fang, 2017).

Research Methodology

The study focused on identifying the current safety practices for the construction of telecommunication masts and towers in Nigeria. Using a quantitative approach. Data were obtained from construction safety professionals through the use of a well-structured questionnaire. Questionnaire was employed as a result of its usefulness in gathering information from a large

pool of respondents and also giving allowance for objectiveness of the research (Tan, 2011). The study was situated in Lagos and Abuja, Nigeria, The choice of the study area results from the large pool of telecommunication construction domiciled in the area which also boasts a large number of construction projects and safety professionals. The respondents were made up of architects, quantity surveyors, engineers, builder, Safety manager, project manager and consultant. Yamane (1967) approach was used in determining the sample size for this study, by determining the total number of register professionals as mentioned above. The sampling techniques was adopted for this study due to limitation of time and cost. Etikan et al. (2016) assert that convenience sampling is a method used to collect data from desired respondents who are readily available to contribute to the study. However, the selected respondent will fall within the parameters of telecommunication construction industry professionals and safety personnel throughout Lagos and Abuja. The questionnaire involved two sections. The former dwelt on the demographic information of the study's respondents with particular emphasis on the highest academic qualification, years of experience, age group, professional qualification, while the latter highlighted on the current safety practices for the construction of telecommunication masts and towers in Nigeria using a 5-point Likert scale. A total number of 103 respondents participated in the survey and a total number of 12 current safety practices were identified based on the literature review. The data received from respondents was analysed using Statistical Package for Social Science Version 29.0 (SPSS) adopting a three-stage process. Firstly, the reliability and validity of the research instrument was ascertained with the use of Cronbach's alpha. This gave a value of 0.910,thus affirming the validity and reliability of the research instrument since the resulting alpha value is above the threshold of 0.7 and tending towards 1.00 (Tavakol and Dennick, 2011). Secondly, descriptive statistics which helped in analysing the background information of the respondents and also ranked the identified current safety practices using mean item score (MIS). Thirdly, exploratory factor analysis (EFA) was used in determining the factor analysable of the identified current safety practice and the purpose of exploratory factor analysis is to provide insights on structured pattern, thus simplifying the understanding of the idea behind the relationship (Young and Pearce, 2013).

FINDINGS AND DISCUSSION

Background of Respondents

The distribution of the sample according to the academic qualifications of respondents reveals that 1.9% of the respondents have a matric Certificate (Grade 12), 11.7% of the respondents have a post-matric certificate or diploma, and 20.4% of the respondents are bachelor's degree holders, 14.6% of the respondents have an honour's degree, 34.0% of the respondents are master's degree holders and 17.5% of the respondents are doctoral degree holders. Based on the findings, it can be deduced that the population for the study had adequate academic backgrounds that helped them

complete the survey. Also, the distribution of the sample according to respondents' profession is 34% of the respondents were engineers by profession, 6.8% of the respondents were builders by profession, 10.7% of the respondents were architects by profession, 20.4% of the respondents were safety managers, 9.7% of the respondents were quantity surveyors, 15.5% of the respondents were project managers by profession and 2.9% of the respondents were consultants by profession. Based on the findings, it can be deduced that the population for the study is well represented within the sample collected. With respect to number of experience, the distribution of the sample "according to respondents' years of experience shows that a total of 8.7% of the respondents have less than a year experience in the industry, 16.5% of the total respondents have 1–2 years' experience in the sector, 23.3% of the respondents have 3–5 years' experience in the industry, 30.1% of the respondents have 6–10 years' experience in the industry, 12.6% of the respondents have 11–15 years' experience in the sector, 4.9% of the respondents have 16-20 years' experience in the industry, 2.9% of the respondents have 21–25 years' experience in the industry and 1.0% of the total respondents has more than 25 years' experience in the industry. It can be deduced that the respondents have a high range of experience in the construction industry, and their responses can be relied upon based on their experience. Furthermore, the distribution of the sample according to age group to which the respondents belong shows that 1.9% of the respondents were in the age group of 16–20 years, 13.6% of the respondents were between 21–25 years, 14.6% of the respondents were between 26–30 years, 32% of the respondent were between 31–35 years, 16.5% of the respondents were between 36–40 years, 8.7% of the respondents were between 41–45 years, 6.8% of the respondents were between 46–50 years, 4.9% of the respondents were between 51 years–55 years and 1% of the total respondents was 56 years or older.

Exploratory Factor Analysis

The study adopted the use of exploratory factor analysis (EFA) to group the identified current safety practices for the construction of telecommunication masts and towers. Exploratory factor analysis was conducted with the use of principal axis factoring (PAF) adopting Varimax rotation. The application of this method would help in the condensing of numerous variables into more manageable and cohesive sub-scales (Tabachnick and Fidell, 2007). A sample size of 132 was used for the current study because EFA requires large samples to generate satisfactory results (Hair et al., 2006). Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Bartlett's test of sphericity were employed to determine the factorability of the data set. KMO can be used to evaluate factor homogeneity and determine whether the partial correlation of the variables is at a minimum (Sharma et al., 2013). Table 1 shows the KMO value of 0.910, this is considered satisfactory to conduct a factor analysis as any value above 0.6 (the cut-off point) is considered suitable (Aliu et al., 2018). The Bartlett's test of sphericity gave a value of 613.347 and having a p-value of 0.000, thus being significant (Pallant, 2005). These results support the factorability and suitability of the data set for conducting exploratory factor analysis (EFA). Also, the correlation matrix of the results revealed that

every variable had a value ≥ 0.3, which confirms the applicability of the dataset as observed in previous studies (Hair et al., 2006).

Table 1. KMO and Bartlett's test.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.910
Bartlett's Test of Sphericity	Approx. Chi-Square	613.347
	Df	66
	Sig.	0.000

Result of the PAF as outlined in Table 2 indicates one components with initial eigenvalues > 1. The component has an eigenvalue of 6.338 with the highest percentage variance explained of 52.817%.

Table 2. Total variance explained.

	Initial Eigenvalues			**Extraction Sums of Squared Loadings**		
Factor	**Total**	**% of variance**	**Cumulative %**	**Total**	**% of Variance**	Cumulative
1	6.338	52.817	52.817	6.338	52.817	52.817
2	0.833	6.942	59.759			
3	0.728	6.065	65.824			
4	0.684	5.700	71.524			
5	0.655	5.461	76.985			
6	0.561	4.676	81.662			
7	0.513	4.274	85.936			
8	0.484	4.032	89.968			
9	0.376	3.131	93.099			
10	0.334	2.779	95.878			
11	0.276	2.299	98.177			
12	0.219	1.823	1 00.000			

The large one clusters factors shows the validity of the sample that reflects the characteristics of the larger population. The result presented in Table 2; outline the multiple comparison of the opinions given by the study's respondents based on their professional designation. The findings indicate that the respondents has similar viewpoints as provided by the professionals on the current safety practices in the construction of telecommunication masts and towers in Nigeria.

Table 3. The current safety practices in construction.

Safety Practices	$\bar{x}$	σX	**R**
Personal protective equipment (PPE)	4.1748	0.86803	1
Fire extinguishers	4.0583	0.95820	2
Safety inspections	4.0583	0.95820	2
Prohibiting unauthorised entry to construction site	4.0485	0.91157	4

(Continued)

Table 3. Continued

Safety Practices	$\bar{x}$	σX	R
Safety policy	4.0388	0.91740	5
Safety education and training programmes	4.0194	0.95979	6
First aid training	4.0194	0.90728	6
Safety fall protection system	3.9126	1.00105	8
Regular safety meetings	3.9126	0.91936	8
Safety zones (Green and Red)	3.9126	0.98126	8
Safety bulletin board	3.7864	0.92514	11
Safety culture	3.7670	0.94146	12

Where; $\bar{x}$ = Mean item score; σX = Standard deviation; R = Rank

DISCUSSION

The theoretical literature review is in agreement with the empirical findings of this research study. This is clear in the empirical study, which reveals that the safety practices observed by workers during the construction of telecommunication masts and towers in Nigeria are personal protective equipment according to Vitharana and Chinda (2015). fire extinguisher according to Khan et al. (2020) and safety inspection (Keng and Razak, 2014). Therefore, it is imperative for Nigeria telecommunication construction industry to adopt more ways of managing safety in the construction industry for the safety of construction workers. According to the existing literature on the assessment of safety practices in the successful construction of telecommunication masts and towers, there is a need to adopt more ways of enhancing workers' safety other than the traditional means of safety practices. The use of personal protective equipment and fire extinguishers are not enough to maintain workers' safety in construction site. Hence there is a great need for advancing more ways to maintain workers' safety in construction sites such as safety inspections, prohibiting unauthorised entry to construction sites, safety policy, safety education and training programmes, first aid training, safety fall protection systems, regular safety meetings, safety zones, safety bulletin boards and a safety culture so as to prevent workers from having accidents during the construction of telecommunication masts and towers in Nigeria. The results mentioned above were in agreement with the findings in the study by Vitharana and Chinda (2015) of personal protective equipment (PPE) was discovered to be the most ranked ways of mitigating hazards at the telecommunication construction site. In addition, fire extinguisher and safety inspection were also found to limit the risk of accident at the construction site based on their ranking according to the study by Khan et al. (2020); (Keng and Razak, 2014).

CONCLUSION

Results from the literature review established the current safety practices observed by workers during the construction of telecommunication masts and towers in Nigeria. Twelve safety practices were identified as the current

safety practices in other to prevent accidents from happening to construction workers. These practices include personal protective equipment (PPE), fire extinguishers, safety inspections, prohibiting unauthorised entry to construction sites, a safety policy, safety education and training programmes, first aid training, a safety fall protection systems, regular safety meetings, a safety zone (green and red), a safety bulletin board, and establishing a safety culture. The questionnaire survey results obtained from the randomly selected respondents revealed that the identified safety practices are being used in the Nigerian telecommunication industry. Moreover, the usage level revealed that the most widely used practices are PPE and fire extinguishers. These are followed by safety inspections, prohibiting unauthorised entry to construction sites, a safety policy, safety education and training programmes, first aid training, a safety fall protection system, regular safety meetings, a safety zone (green and red), safety bulletin boards, and a safety culture. It can be said conclusively that both the theoretical and empirical findings of this research objective was achieved as anticipated.

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REFERENCES

Agbede, J. O., Manu, P., Agbede, O. A. and Mahamadu, A. M., 2016. Health and safety management practices in the Nigerian construction industry: A survey of construction firms in South Western Nigeria. Construction Management and Economics. Report, 2, pp. 293–304.

Che Mohd Nor, R. and Rochin Demong, N. A., 2016. The awareness level of the safety and health of the operational level. Advances in Business Research International Journal, 2(1), pp. 1–8.

Choudhry, R. M., Fang, D., & Ahmed, S. M. (2008). Safety management in construction: Best practices in Hong Kong. Journal of Professional Issues in Engineering Education and Practice, 134(1), 20–32.

Dorji, K. and Hadikusumo, B. H., 2006. Safety management practices in the Bhutanese construction industry. Journal of Construction in Developing Countries, 11(2), pp. 53–75.

Elbeltagi, E. and Hegazy, T., 2002, April. Incorporating safety into construction site management. In 1st International Conference on Construction in the 21st Century "Challenges and Opportunities in Management and Technology (pp. 261–268).

Etikan, I., Musa, S. & Alkassim, R., 2016. Comparison of Convenience Sampling and Purposive Sampling. American Journal of Theoretical and Applied Statistics., 5(1), pp. 1–4.

Fiske, S. (1999). Why employees need first aid training. Occupational Hazards, 61(2), 55–57.

Fried, E. A., Zhou, G., Shah, R., Shin, D. W., Shah, A., Katz, D. and Burnett, G. W., 2021. Barrier devices, intubation, and aerosol mitigation strategies: personal protective equipment in the time of coronavirus disease 2019. Anesthesia & Analgesia, 132(1), pp. 38–45.

Hair JF, Black WC, Babin BJ, Anderson RE, Tatham RL. 2006. Multivariate Data Analysis, 6th Edn. Pearson Prentice Hall, Pearson Education, Inc., Upper Saddle River, New Jersey 07458.

Holt, A. S. J. (2008). Principles of construction safety: John Wiley & Sons.
Jin, R. and Chen, Q., 2013. Safety culture: effects of environment, behavior & person. Professional Safety, 58(05), pp. 60–70.
Keng, T. C. and Razak, N. A., 2014. Case studies on the safety management at construction site.
Lingard, H. (2017). First aid and occupational health and safety: The case for an integrated training approach. Burns: Journal of the International Society for Burn Injuries, 111–117.
Liu, J. C., Mickley, L. J., Sulprizio, M. P., Dominici, F., Yue, X., Ebisu, K., Anderson, G. B., Khan, R. F., Bravo, M. A., & Bell, M. L. (2016). Particulate air pollution from wildfires in the western US under climate change. Climatic Change, 138, 655–666.
Nawi, M. N. M., Ibrahim, S. H., Affandi, R., Rosli, N. A. and Basri, F. M., 2016. Factor affecting safety performance construction industry. International Review of Management and Marketing, 6(8), pp. 280–285.
Pallant J. 2005. SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS for Windows (Version 12). 2nd ed, Allen and Unwin, Crows Nest NSW2065 Australia.
Paringga, L. A. (2010a). No title. Construction Safety in Jakarta, Indonesia, Too little info.
Paringga, L. A., 2010. Construction Safety in Jakarta, Indonesia (Doctoral dissertation, Universiti Teknologi Malaysia).
Sanni-Anibire, M. U. I. Z. Z., Mahmoud, A. B. U. B. A. K. A. R. and Al-Ayouni, M. A. J. E. D., 2020. Causes of scaffold accidents in construction industry. Proceedings of the 3rd European and Mediterranean International Structural Engineering and Construction: Holistic Overview of Structural Design and Construction, pp. 3–8.
Saunders, L. W., Kleiner, B. M., McCoy, A. P., Ellis, K. P., Smith-Jackson, T., & Wernz, C. (2017). Developing an inter-organizational safety climate instrument for the construction industry. Safety Science, 98, 17–24.
Sharma RS, Alexander N, Ho W, Arasu P. 2013. Functional modelling and analysis of IDM e-tailer platforms. International Journal of E-Business Research. 7(20101): 38–59.
Škrtić, M., Sriskanthadevan, S., Jhas, B., Gebbia, M., Wang, X., Wang, Z., Hurren, R., Jitkova, Y., Gronda, M., Maclean, N. and Lai, C. K., 2011. Inhibition of mitochondrial translation as a therapeutic strategy for human acute myeloid leukemia. Cancer cell, 20(5), pp. 674–688.
Tabachnick, B. & Fidell, L., 2001. Using multivariate statistics, Boston: Allyn and Bacon.
Tan WCK. 2011. Practical Research Methods. Pearson Custom: Singapore.
Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. International Journal of Medical Education, 2, 53–55. doi: 10.5116/ijime.4dfb.8dfd.
Teo, Y. H., Yap, J. H., an, H., Yu, S. C. M., Zhang, L., Chang, J., & Cheong, K. H. (2022). Enhancing the MEP coordination process with BIM technology and management strategies. Sensors, 22(13), 4936.
Vala, M., & Vora, V. Reliable and scalable broadcast scheme for safety applications in vehicular ad hoc network.
Vitharana, V. H. P. and Chinda, T., 2021. Development of a lower back pain prevention index for heavy equipment operators in the construction industry: system dynamics modelling. International Journal of Construction Management, 21(7), pp. 677–693.

Wachter, J. K. and Yorio, P. L., 2014. A system of safety management practices and worker engagement for reducing and preventing accidents: An empirical and theoretical investigation. Accident Analysis & Prevention, 68, pp. 117–130.

Yamane, T., 1967. Statistics, An Introductory Analysis, 2nd Ed, New York: Harper and Row.

Young AG. Pearce S. 2013. A beginner's guide to factor analysis: Focusing on exploratory factor analysis. Tutorials in Quantitative Methods for Psychology. 9(2):79–94.

Zhang, P., Li, N., Fang, D. and Wu, H., 2017. Supervisor-focused behavior-based safety method for the construction industry: Case study in Hong Kong. Journal of Construction Engineering and Management, 143(7), p. 05017009.

Zhang, Z., Guo, H., Gao, P., Wang, Y. and Fang, Y., 2023. Impact of owners' safety management behavior on construction workers' unsafe behavior. Safety science, 158, p. 105944.

Zhou, W., Whyte, J., & Sacks, R. (2012). Construction safety and digital design: A review. Automation in Construction, 22, 102–111.

Zhou, Z., Goh, Y. M., & Li, Q. (2015). Overview and analysis of safety management studies in the construction industry. Safety Science, 72, 337–350.