Interrelation between Human Factor–Related Accidents and Work Patterns in Construction Industry

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Abstract: The shortage of labor in the construction industry is quickly becoming a global phenomenon. To encourage more people to begin careers in construction, work patterns that promote both more leisure and accident rate reduction need to be put in place. This study used logistic regression to analyze 7,497 accident cases that have occurred in the Hong Kong construction industry. Principally, it was found that human factor–related accidents and work patterns are interrelated for both millennials and nonmillennials. Therefore, an adjustment in work patterns may lead to a reduction in accident rates, which could encourage more people, both young and old, to choose a career in the construction industry. **DOI: 10.1061/(ASCE)CO.1943-7862.0001642.**

Introduction

Globally, the construction industry faces a labor shortage. Turner and Townsend (2017) showed that 24 out of the 43 (56%) global markets analyzed in a survey suffer from skill shortages in the construction industry. This is up from 20 reported a year earlier, which indicates the persistence of the problem. Essentially, Hong Kong Construction Association (2017) reported the labor shortage over a 5 year period from 2013 to 2017, with a current shortage rate of 5.47%. The estimated increase in total labor supply in Hong Kong is also expected to be lower than the expected increase in demand for construction workers. According to the Government of Hong Kong SAR (2015), total manpower requirements in the construction industry should rise at an average annual rate of 1.4%, while total manpower supply in Hong Kong is expected to increase by only 0.4% on average annually from 2012 to 2022. Concurrently, the Hong Kong construction industry also faces an aging-population problem. According to the Construction Workers Registration Board (2017), as of April 2017, 66.11% of registered construction workers were over 40 years of age. This phenomenon also seems to be global since countries such as the United Kingdom (McNair and Flynn 2006) and the United States (Center for Construction Research and Training 2014) face a similar dilemma. This aging problem highlights the labor shortage problem because it reveals the unwillingness of the younger generation to enter the construction industry.

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Older people are more prone to accidents (Dong et al. 2012) and higher injury costs (Schwatka et al. 2012). They also have a lower level of physical fitness, which affects their overall performance and productivity (Jebens et al. 2015). Likewise, skill shortages may lead to declines in productivity and slowed industrial growth (Lobo and Wilkinson 2008). This suggests that both an aging workforce and a skill/labor shortage have negative effects on the construction industry. Stunted growth and productivity in the construction industry can have a devastating effect on an economy (Dang and Low 2011), hence the need to address the issue of the labor shortage and the aging workforce in the construction industry.

Though various strategies such as increased training, increased wages, and labor migration have been proposed and implemented to decrease the shortage rate and the participation rate of the younger workforce (Ho 2016; MacKenzie et al. 2000), more remains to be done due to the persistence of the problems. Ho (2016) suggested that improved working conditions, including those related to health, safety, and welfare, could improve the attractiveness of Hong Kong construction industry to prospective employees.

Therefore, the objective of this study was to determine whether work patterns and human factor–related accidents were interrelated in order to suggest policies that would reduce accident rates and thereby encourage the younger generation to choose a career in the construction industry, thereby reducing the construction industry workforce shortage. The next section of this paper presents a literature review. This is followed by the research method adopted in this study and results and discussion sections. The final section presents the conclusions of the paper.

Literature Review

Human Factor–Related Accidents

In accident causation models, multiple causation theory suggests that for every accident, there may be many contributing factors, causes, and subcauses (Raouf 2011). These contributing factors can be categorized into behavioral factors and environmental factors. The behavioral factors are human factors specific to individual workers themselves, such as poor physical and mental state, lack of knowledge, inappropriate attitude, and lack of skills. Environmental factors, on the other hand, are related to the physical working conditions under which the workers do their jobs, such as a dangerous working environment and run-down equipment (Raouf 2011). In Hong Kong, Choudhry and Fang (2008) found that workers were involved in unsafe acts due to a lack of safety awareness and psychological factors, among others. Human error accounts for 80% of incidents in complex high-risk systems in the construction industry (Garrett and Teizer 2009). Hence, there is a need to determine whether accidents in Hong Kong are also more related to human factors than to environmental factors.

Work Patterns

Work pattern is the manner in which a job is performed, such as shift work, hours worked, and days of the week (Segen's Medical Dictionary 2011). Studies have shown that certain work patterns generally have effects on accidents. They are major contributing factors in human-related accidents. For instance, Wagstaff and Lie (2011) and Dembe et al. (2005) found that working long hours and shift work could increase the risk of accidents. Costa (1996) also demonstrated that night work could interfere with work performance and efficiency, resulting in errors and accidents, among other issues. Dembe et al. (2005) reported that working overtime could result in a 61% increase in injury hazard rate. Working at least 12 h per day has a 37% increased hazard rate, and working at least 60 h per week increased hazard rates by 23%. Wagstaff and Lie (2011) determined that both shift work and long working hours have a negative effect on safety at work. The authors reported that work periods longer than 8 h bring cumulatively increased accident risk. The risk of accidents for those working 12 h a day would be twice as high as those working 8 h a day. Hence, there is also a need to include the effects of night work in the examination of human factor–related accidents.

Additionally, previous studies showed that accidents were more likely to occur in the early part of the week (Rozenfeld et al. 2010), and accident severity increases as the week progresses (Camino López et al. 2008). In Hong Kong, Tao et al. (2017) discovered that the younger generation places more importance on taking Saturdays off than on money. In Australia, Lingard et al. (2008) found that a compressed work week was positively received, although wage workers expressed concerns about the impact on their take-home pay. Therefore, this study includes an examination of the relationship between certain days of the week—Monday, Saturday, and Sunday—and human factor–related accidents.

To maximize productive time and enhance health and safety, Yi and Chan (2013) proposed an optimal work–rest schedule of 15 min breaks after 2 h of work in the morning and 20 min breaks after 1 h and 55 min of work in the afternoon for construction rebar workers in hot weather in Hong Kong. Accordingly, this study also includes an investigation of the relationship between human factor–related accidents and work patterns that involve working more than 2 h without adequate rest.

Other Factors Affecting Human Factor–Related Accidents

Soltanzadeh et al. (2016) found that unsafe acts caused accidents that are by definition more human factor–related than environmental and are understandably associated with accident severity. Yau (2004) also found that some specific human factors had significant effects on accident severity for private vehicle owners in Hong Kong. Hence, this study explore the need to consider controls for accident severity. In addition, several studies have shown the relationship between accidents and location (Dumrak et al. 2013; Huang and Hinze 2003; López Arquillos et al. 2012); hence, there is also a need to consider the accident location. Dong et al. (2004) found that safety and health training were associated with reduced work injury–related compensation claims, especially for young workers. Additionally, training has been identified as one of the critical factors in predict accident risk (Lee and Halpin 2003). Hence, there is a need to consider training. Lastly, there is a need to manage environmental factors, as previous studies identified them as accident causation factors (e.g., Mitropoulos et al. 2005; Sawacha et al. 1999).

Research Gap

Many previous studies concentrated only on investigating work patterns and accidents generally (Dembe et al. 2005; Wagstaff and Lie 2011). Cottini and Lucifora (2013) investigated workplace mental health conditions across 15 European countries. They concluded that adverse job demands, such as shift work and intensive tasks, were strongly associated with reported mental problems, e.g., stress. In construction research, Chan (2011) identified fatigue as a leading risk factor of construction accidents. Therefore, work patterns would most likely influence accidents through their effects on the physical and emotional well-being of workers, so there is a need to investigate the relationship between human factor–related accidents and work patterns in the construction industry. Also, a study on the relationship between work patterns and human factor–related accidents would provide insight into the association between work patterns and the physical and emotional well-being of workers. Additionally, human factors have been identified as the greatest contributor to danger, and they are more difficult to control compared with environmental or technical factors (Reason 1995). Thus, research on their determinants would make it easier to develop effective control measures. Additionally, very little has been done to investigate the generational differences among workers in relation to work patterns and human factor–related accidents in the construction industry in an attempt to solve the aging-population problem in the industry.

Research Method

This study draws inferences from both reviewed literature and data analyses. The data used for this study were collected from Mass Transit Railway Corporation Limited (MTRC), a company that operates and manages Hong Kong's mass transit railway, making an average of 5.6 million passenger trips per weekday (MTR Corporation 2016). It also engages in property development, making it one of the major players in the Hong Kong construction industry. As of December 31, 2015, railway construction and property development in progress for MTRC was valued at around HK$37 billion (the Hong Kong dollar is pegged to the US dollar at a rate close to HK$7.8 = US$1) (MTR Corporation 2015). This represents 17% of the gross value of construction projects in Hong Kong in 2015 (HK$224 billion) (Census and Statistics Department 2017). In addition, MTRC has built, operated, and maintained mass transit railway systems and provided related services in China Mainland, the UK, Sweden, and Australia (MTR Corporation 2016). Considering all the aforementioned details, it is safe to suggest that the use of data collected from MTRC is suitable for the purposes of this study.

The data consist of a total of 7,497 recorded accidents between May 2009 and October 2015 (Table 1). These accidents occurred during the construction of five new railway projects: the Shatin-Central Link, West Island Line, Express Rail Link, South Island Line, and Kwun Tong Line. These projects involved both the construction of railway lines (civil work) and the construction of railway stations (building work) as part of the Hong Kong

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Table 1. Summary of accident cases by year

Year	Frequency	Percentage
2009	5	0.1
2010	170	2.3
2011	415	5.5
2012	976	13
2013	1,798	24
2014	2,355	31.4
2015	1,778	23.7
Total	7,497	100

Table 2. Accident cases analyzed by trade of injured person (Top 10; 56%)

Trade	Frequency	Percentage
Laborer	1,986	47.3
Rigger	371	8.8
Steel bender/fixer	349	8.3
Tunnel worker	313	7.5
Welder	242	5.8
Supervisor/foreman/team	228	5.4
Carpenter (general woodwork)	218	5.2
Metal tube scaffolder	209	5.0
Plant operator	150	3.5
Carpenter (formwork erection)	135	3.2
Total	4,201	100.0

Government's Railway Development Strategy. The railway stations are multilevel buildings with multiple shopping complexes. Additionally, the various trades of the construction industry are well represented in the data (Table 2). Therefore, the construction industry is well exemplified in the data.

Logistic regression was adopted in estimating the relationship between human factor–related accidents and work patterns. Logistic regression was used because the dependent variable (human factor–related accidents) considered in this study is a binary variable. Logistic regression is specially formulated to predict the probability that an event will occur using a given binary dependent variable or a combination of explanatory variables that can either be categorical or continuous (Hair et al. 2006). This approach has been used in previous accident studies in the construction industry (e.g., Chau et al. 2004, 2002). The data were subdivided into two categories: millennials and nonmillennials. Subsequently, each data set, including the data set for all victims, were analyzed. In line with Ng et al. (2010) and Real et al. (2010), 1980 was used as the cut-off benchmark for millennials. Out of the 7,497 records of this study, 1,941 have missing values. Hence, two methods, listwise deletion (LD) and multiple imputation (MI), were used to address the issue, and the results were subsequently compared. In listwise deletion, all incomplete cases are dropped entirely from the analysis. Graham (2009) indicated that this method of handling missing data might lead to biased parameter estimates and the loss of power when the number of missing cases is greater than 5%, though when the sample size is large, the loss of power and the biased parameter estimate are reduced (Acock 2005). Multiple imputation is used to generate possible values for missing cases through the pooling of multiple simulated values. It entails three stages: imputation, analysis, and pooling (Peng and Zhu 2008). During the imputation stage, each missing value is replaced by simulated values multiple times, thereby creating multiple data sets. The analysis stage fits the model using the various data sets, while the pooling stage combines the models from the various data sets. The main limitation of MI is that each application of MI produces slightly different imputed values and related statistics, so the results cannot always be replicated (Peng and Zhu 2008). The MI method was found to have superior performance to other techniques of handling missing data in logistic regression (Peng and Zhu 2008). Therefore, the method was adopted. Prior construction research using logistic regression has used MI methods (e.g., Alexander et al. 2012; Spee et al. 2016).

As discussed in the literature review, human factor–related accidents refer to accidents with contributing factors specific to individual workers, such as poor physical and mental state, lack of knowledge, inappropriate attitude, and lack of skills. Environmental factor–related accidents are relate to physical working conditions, such as dangerous working environment and degradation of equipment. In this research, the victims and their supervisors identified various factors that contributed to accidents in their opinions, and they were subsequently grouped into human and environmental factors. Human factor is the dependent variable. To model it, a value of 1 was assigned to any accident record where a human-related factor was mentioned to have been partly/jointly responsible for the accident, while a value of 0 was assigned if no such factor was indicated. The independent variables are those discussed in the earlier literature review in the sections "Work Pattern" and "Other Factors Affecting Human Factor–Related Accidents." They are night, 2 h after rest, Monday, Saturday, and Sunday. All the variables are presented in binary form (Table 3). Night goes from 7 p.m. to 7 a.m., and a value of 1 was assigned if an accident occurred during the period and 0 otherwise. The variable 2 h after rest includes the periods 10:01 a.m. to 12 noon, 3:01 p.m. to 3:15 p.m., and 5:46 p.m. to 6 p.m. (Yi and Chan 2014). A value of 1 was assigned if an accident occurred

Table 3. Categorical and binary variables

Variable	Definition	Measurement
2 h after rest	10:01 a.m. to 12 noon, 3:01 p.m. to 3:15 p.m. and 5:46 p.m. to 6 p.m.	1 if 2 h after rest, 0 otherwise
Accident category	Accidents that require more than 3 days' sick leave	1 if reportable, 0 otherwise
Apprentice	Training undergone to acquire skills needed to do job	1 if apprentice, 0 otherwise
Monday		1 if accident occurred on Monday, 0 otherwise
Saturday		1 if accident occurred on Saturday, 0 otherwise
Sunday		1 if accident occurred on Sunday, 0 otherwise
Environmental factor	Factors related to physical working condition such as dangerous working environment and degradation of equipment	1 if present, 0 otherwise
Human factor	Human factors specific to worker such as poor physical and mental state, lack of knowledge, inappropriate attitude, and lack of skills	1 if present, 0 otherwise
Night	7 p.m. to 7 a.m.	1 if night, 0 otherwise
Place of accident	Location of accident, for example, civil worksite or building worksite	1 if civil worksite, 0 otherwise
Treatment given	Type/place where treatment was given (first aid, clinic, or hospital)	1 if treated in a hospital, 0 otherwise

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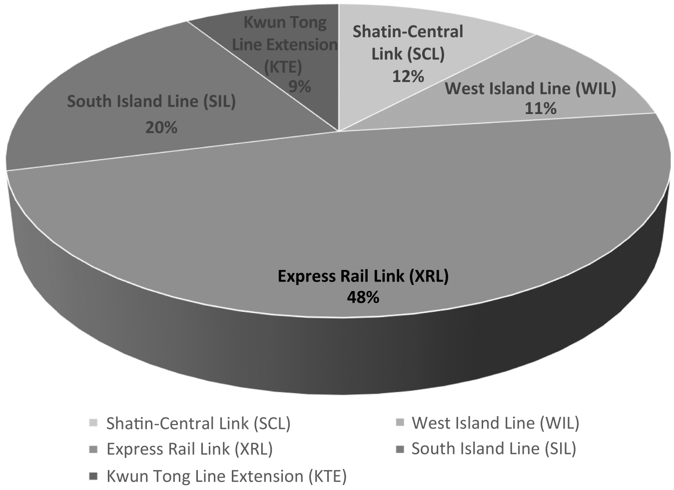

Fig. 1. Summary of accident cases for the five new railway projects.

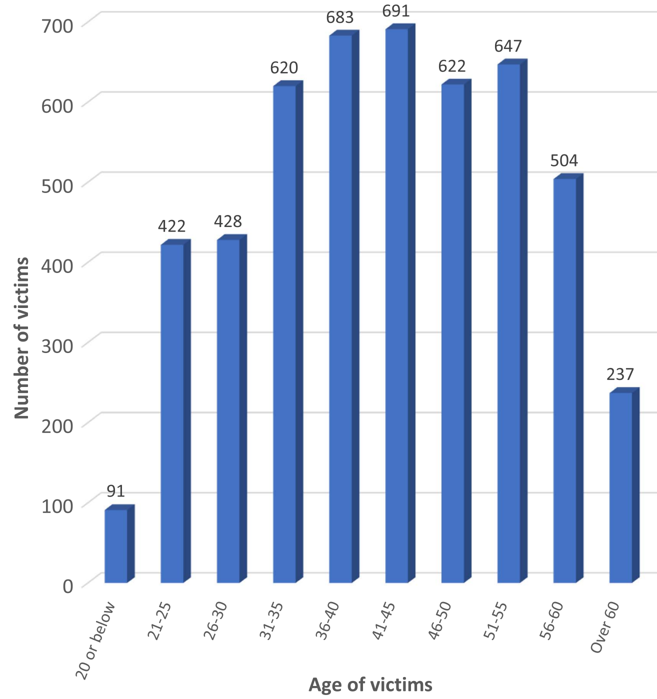

Fig. 2. Accident cases analyzed by age.

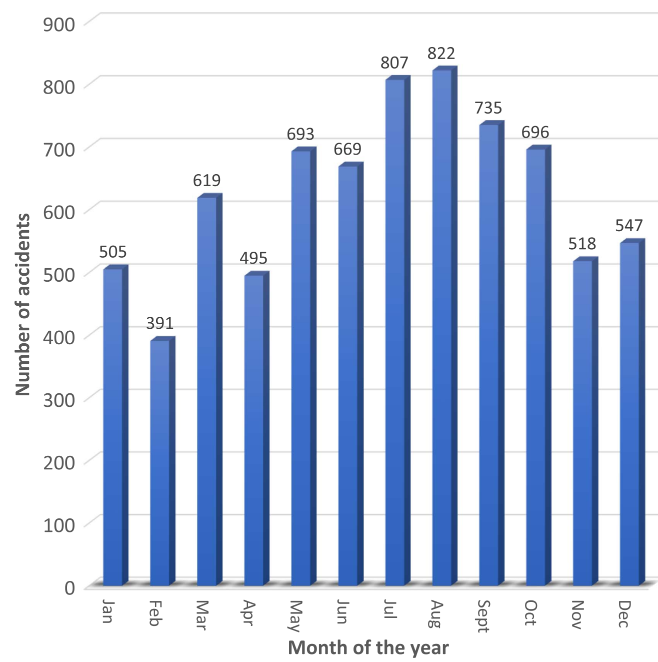

Fig. 3. Accident cases analyzed by month.

during the period and 0 otherwise. Additionally, a value of 1 was assigned if an accident occurred on Sunday, Monday, or Saturday, and 0 otherwise.

Other variables were included as control variables to control the effect of nonhuman factors on accidents. These include accident category, treatment given, environmental factor, place of accident, and apprentice. Accident category and treatment given are measures of accident severity, while apprentice was used to model training received. Accidents that resulted in three or more sick leave days were categorized as reportable accidents and were assigned a value of 1, and 0 otherwise. Regarding the place of accident, civil worksite was assigned the value of 1 and 0 otherwise. If an environmental factor was reported, a value of 1 was assigned, and 0 otherwise. A victim who was an apprentice at the time of an accident was assigned a value of 1, and 0 otherwise. The definitions and measurements of the categorical and binary variables as just highlighted are summarized in Table 3.

Results

The proportion of accidents that occurred at each of the five project sites is presented in Fig. 1. Most of the accidents occurred during the period from January 2013 to October 2015, with 79.1% of the accidents taking place at that time (Table 1). Of the victims, 95.1% (6007) were male workers, while only 4.1% (307) were female workers. The gender of the remaining 1,183 victims was not stated. Fig. 2 shows the age distribution of the victims; 44% of the victims were between 31 and 55 years old. Additionally, 40% of the accidents occurred between June and September (Fig. 3), 84% occurred between Monday and Friday (Fig. 4), and 80% occurred between 9 a.m. and 6 p.m. (Fig. 5). Additionally, 60% of the victims had 3 months' or less experience on site (Fig. 6).

The correlation analysis of both the dependent and independent variables are presented in Table 4. It reveals that environmental factors and human factors have the highest correlation of 0.78. None of the other variables had correlations above 0.5. The multicollinearity test conducted also confirms this (Table 5) since all the variance inflation factors (VIFs) are less than 2. The logistic regression results are presented in Tables 6–9. For the LD data set for all victims, the Cox–Snell R^2 is 0.48 and the Nagelkerke R^2 is 0.64. The Cox–Snell R^2 ranges between 0 and less than 1, while Nagelkerke R^2, on the other hand, has values that range between 0 and 1 (Hair et al. 2006). The closer the values are to 1, the better the model fit (Hair et al. 2006). Thus, the dependent variables explain 64% of the variation in human factor–related accidents. The MI data set for all victims yielded a better model fit with a Cox–Snell R^2 of 0.48 and Nagelkerke R^2 of 0.67. Since the MI data sets yielded a better model fit, they was used for the millennial versus nonmillennial analysis. The Cox–Snell R^2 and the Nagelkerke R^2 were 0.50 and 0.69, respectively, for millennials and 0.48 and 0.67, respectively, for nonmillennials.

For the work-pattern-related factors, night, 2 h after work, and Monday were found to be significant in both the MI and LD data

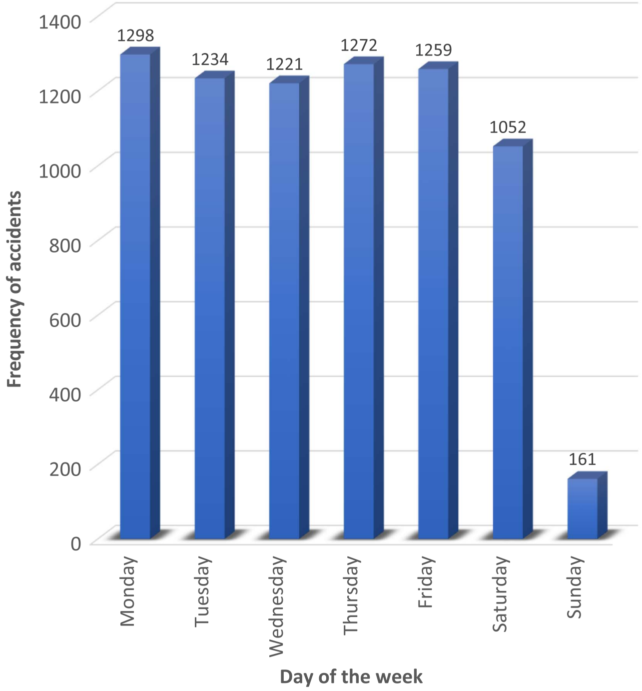

Fig. 4. Accident cases analyzed by day of week.

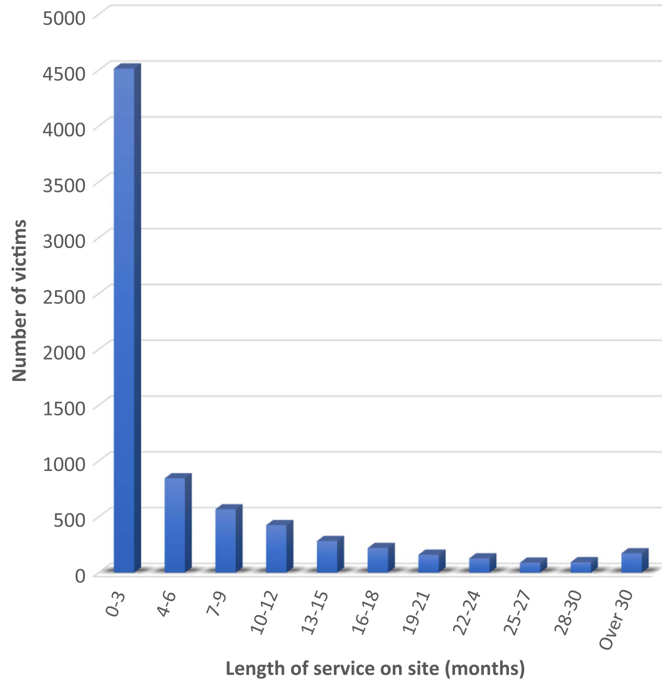

Fig. 6. Accident cases analyzed by length of service on site (months).

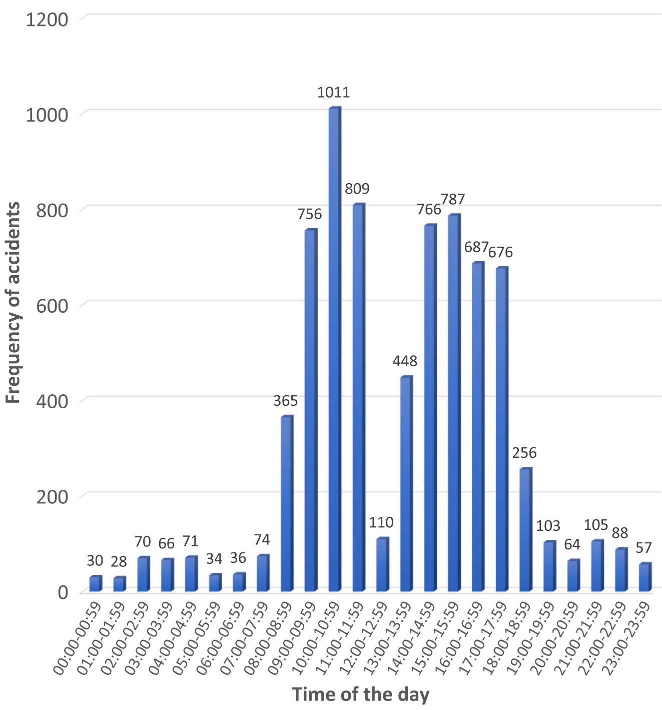

Fig. 5. Accident cases analyzed by accident time.

sets for all victims. The odds that the accident was caused by human factors increased at night. Workers work at night due to either night shift work or overtime work. Therefore, this indicates that both shift work and overtime work may increase stress and fatigue level, which may cause human errors and eventually lead to accidents (Cottini and Lucifora 2013; Dembe et al. 2005). Furthermore, the odds that the accident is caused by a human factor increased 2 h after rest. This substantiates that long working hours without adequate rest may increase stress and fatigue levels, causing human errors and, consequently, more accidents (Yi and Chan 2013). Additionally, this study established that the odds that an accident was caused by a human factor increased on Mondays when all victims are considered. This is consistent with earlier Monday-effect findings (Campolieti and Hyatt 2006; Card and McCall 1996). For the millennials, among the work pattern variables, only Monday is significant, while for nonmillennials, 2 h after rest and night are the significant variables. This indicates that nonmillennials are prone to human factor–related accidents when working at night and when adequate rest periods are not provided. This is likely because they are older and are more prone to accidents (Dong et al. 2012). Millennials, on the other hand, are more prone to human factor–related accidents on Mondays, as illustrated by the logistic regression results. This may be attributed to the fact that the safety measures that need to be put in place before starting work after the weekend break might not have been adhered to. To prevent accidents among the younger generation, policies should be put in place to ensure that safety measures are observed. Constant reminders of safety measures especially after the weekend and vacation breaks should be provided. Other policies to prevent accidents, especially for nonmillennials, may include reorganization of rest periods so there are multiple rest periods rather than single long ones. Additionally, training on health and sleep management may be provided regularly to workers who work at night to help them stay alert at night.

All the control variables were statistically significant for both the LD and MI data sets for all victims. They are accident category, place of accident, environmental factors, apprentice, and treatment given. They were all significant at above 97% confidence levels. The likelihood that an accident was caused by human factors increased when the accident was reportable (requires more than 3 days' sick leave). This confirms that there exists a relationship between accident severity and human factor–related accidents. On the other hand, there seems to exist a negative relationship between treatment given and human factor–related accidents. This may be

Table 4. Correlation analysis and descriptive statistics of dependent and independent variables

Variable	Accident category	Place of accident	Monday	Saturday	Sunday	2 h after rest	Night	Apprentice	Treatment given	Environmental factor	Human factor
Accident category	1.00	0.13[a]	−0.01	0.02	0.01	−0.01	0.03[b]	−0.01	0.41[a]	0.15[a]	0.05[a]
Place of accident	0.13[a]	1.00	0.00	0.02	0.00	−0.03[b]	0.05[a]	−0.03[b]	0.08[a]	0.25[a]	0.09[a]
Monday	−0.01	0.00	1.00	−0.19[a]	−0.07[a]	0.01	−0.05[a]	−0.01	−0.02	0.00	0.02
Saturday	0.02	0.02	−0.19[a]	1.00	−0.06[a]	−0.01	−0.01	−0.01	0.03[a]	0.00	0.00
Sunday	0.01	0.00	−0.07[a]	−0.06[a]	1.00	0.00	0.13[a]	−0.02	0.06[a]	0.02	0.02
2 h after rest	−0.01	−0.03[b]	0.01	−0.01	0.00	1.00	−0.19[a]	0.01	−0.05[a]	0.00	0.03
Night	0.03[b]	0.05[a]	−0.05[a]	−0.01	0.13[a]	−0.19[a]	1.00	−0.01	0.18[a]	0.05[a]	0.02
Apprentice	−0.01	−0.03[b]	−0.01	−0.01	−0.02	0.01	−0.01	1.00	−0.03[b]	−0.03[b]	−0.03
Treatment given	0.41[a]	0.08[a]	−0.02	0.03[a]	0.06[a]	−0.05[a]	0.18[a]	−0.03[b]	1.00	0.13[a]	−0.03
Environmental factor	0.15[a]	0.25[a]	0.00	0.00	0.02	0.00	0.05[a]	−0.03[b]	0.13[a]	1.00	0.78[a]
Human factor	0.05[a]	0.09[a]	0.02	0.00	0.02	0.03	0.02	−0.03	−0.03	0.78[a]	1.00

[a]Correlation is significant at the 0.01 level (2-tailed).
[b]Correlation is significant at the 0.05 level (2-tailed).

Table 5. Multicollinearity test

Independent variable	Variance inflation factor
Accident category	1.22
Place of accident	1.04
Monday	1.05
Saturday	1.05
Sunday	1.03
Night	1.90
2 h after rest	1.04
Job factor	1.05
Treatment given	1.25
Apprentice	1.00

Table 6. Logistic regression result for all victims (LD data set)

Variable	B	Exp (B)	P-value
2 h after rest	0.21	1.24	0.02
Night	0.42	1.52	0.00
Saturday	0.08	1.08	0.49
Sunday	0.39	1.48	0.21
Monday	0.20	1.22	0.06
Environmental factor	4.25	69.73	0.00
Apprentice	−1.27	0.28	0.00
Accident category	0.52	1.67	0.00
Place of accident	1.32	3.76	0.00
Treatment given	−0.28	0.76	0.01
Constant	−3.53	0.03	0.00
Nagelkerke R^2	0.67		
Cox–Snell R^2	0.48		

Table 7. Logistic regression result for all victims (MI data set)

Variable	B	Exp (B)	P-value
2 h after rest	0.21	1.24	0.02
Night	0.42	1.52	0.00
Saturday	0.08	1.08	0.49
Sunday	0.39	1.48	0.21
Monday	0.20	1.22	0.06
Environmental factor	4.25	69.73	0.00
Apprentice	−1.27	0.28	0.00
Accident category	0.52	1.67	0.00
Place of accident	1.32	3.76	0.00
Treatment given	−0.28	0.76	0.01
Constant	−3.53	0.03	0.00
Nagelkerke R^2	0.67	—	—
Cox–Snell R^2	0.48	—	—

Table 8. Logistic regression result for millennials (2,066)

Variable	B	Exp (B)	P-value
2 h after rest	−0.12	0.88	0.55
Night	0.43	1.54	0.11
Saturday	−0.04	0.96	0.88
Sunday	0.16	1.17	0.81
Monday	0.40	1.50	0.07
Environmental factor	4.40	81.61	0.00
Apprentice	−2.00	0.14	0.00
Accident category	0.04	1.04	0.87
Place of accident	1.53	4.63	0.00
Treatment given	0.07	1.08	0.79
Constant	−3.71	0.02	0.00
Nagelkerke R^2	0.69		
Cox–Snell R^2	0.50		

Table 9. Logistic regression result for nonmillennials (5431)

Variable	B	Exp (B)	P-value
2 h after rest	0.32	1.38	0.00
Night	0.40	1.49	0.02
Saturday	0.12	1.13	0.37
Sunday	0.39	1.48	0.24
Monday	0.12	1.12	0.37
Environmental factor	4.21	67.56	0.00
Apprentice	−0.75	0.47	0.10
Accident category	0.64	1.89	0.00
Place of accident	1.26	3.53	0.00
Treatment given	−0.38	0.69	0.00
Constant	−3.49	0.03	0.00
Nagelkerke R^2	0.67		
Cox–Snell R^2	0.48		

due to the increased safety initiatives being implemented by MTRC, which has led to fewer cases of lost-time accidents (MTR Corporation 2016). In this study, only 22% of accidents required hospital treatment. It was also established from this study that the likelihood that an accident was caused by human factors increased when working on a civil engineering worksite compared to other worksites such as a building worksite. No plausible reason for this is known at the moment. A reasonable suggestion would be that a typical civil engineering worksite seems to be technologically more complex and requires more attention to details than other worksites. A detailed look at the data suggests that 50% of the human factor–related accidents were due to a lack of concentration. In addition, the results show that the possibility that an accident was caused by human factors increased when an environmental factor was also responsible for the accident. Since workers are responsible for taking care of their own equipment, those who are more prone to behavioral issues (a human factor–related accident) may also be more likely to be negligent with their equipment, thereby triggering an accident that is also environmental factor–related. The result similarly signifies that the probability that an accident was caused by a human factor decreased when the victim was an apprentice. This suggests that apprentices tend to be a lot more focused and less stressed on the job. Additionally, apprentices tend to take on less responsibility and less-risky assignments. Hence, they are less likely to be involved in accidents. For millennials, environmental factors, apprentice status, and place of accident were significant, while environmental factors and apprentice status were the only significant factors for nonmillennials.

Limitation

The major limitation of this study is that the data do not include variables such as number of work hours per week, overtime work done per week, and work shift practice of each victim that could be used to measure work patterns directly. This shows the need to explore more time factors as work pattern variables. Such variables should be taken into consideration when collecting accident data in the future. Additionally, further research can be done to ascertain the direct effect of accidents on the career choices of millennials.

Conclusion

The Hong Kong construction industry faces labor shortages and aging-population problems. The aging labor force and labor shortage problems can be addressed only by attracting more people to enter the construction industry. To encourage more people, both young and old, to begin a career in construction, work patterns that promote site safety need to be implemented. The dismal records of site safety have discouraged not only the younger generation from entering the construction industry but also their parents from allowing them to do so (Tao et al. 2017). This study, therefore, aimed to investigate the relationship between work-pattern and human factor–related accidents to offer suggestions that might help minimize accident rates. A total of 7,497 recorded accidents between May 2009 and October 2015 were collected from MTRC. Logistic regression was performed, and it was found that eight variables, accident category, place of accident, Monday, night, 2 h after rest, environmental factor, apprentice, and treatment given, were found to be significantly associated with human factor–related accidents when all victims were considered. For millennials, Monday, environmental factor, apprentice, and place of accident were found to be significant, while night, 2 h after rest, environmental factor, and apprentice were found to be significant for nonmillennials. Most importantly, human factor–related accidents and work patterns were found to be significantly interrelated among all age groups. To reduce accident rates among millennials, it is proposed that constant training and safety reminders be provided, especially after weekend breaks or other vacation breaks. For nonmillennials, it is proposed that rest periods should be restructured and training on health and sleep management be provided regularly to reduce human factor–related accidents. In all, the devastating effects of accidents may actually discourage people from working in the construction industry. Therefore, reduced accident rates among both millennials and nonmillennials should encourage both the younger and older generations to enter the construction industry.

Data Availability Statement

Data analyzed during the study were provided by a third party. Requests for data should be directed to the provider indicated in the acknowledgments. Information about the *Journal*'s data-sharing policy can be found here: http://ascelibrary.org/doi/10.1061/(ASCE)CO.1943-7862.0001263.

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