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Quantitative Analysis of MRT Rail Construction Industry Workers' Perception of the Human Factor Contributing to Occupational Accidents

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Abstract

Occupational accident rates in the construction industry are among the highest compared to other industrial sectors. The human factor plays a major role in contributing to overall occupational accidents in this industry compared to other factors. This study aims to investigate and evaluate aspects of the human factor contributing to occupational accidents in the MRT construction industry. A questionnaire was used for data collection from the MRT construction project around the Klang Valley. Descriptive analysis was used to analyse aspects of the human factor. Mann-Whitney U tests were utilized to compare the perceptions of the management and construction site workers. Pearson correlation tests were used to elaborate on the relationship between all aspects contributing to occupational accidents. Respondents agreed that all aspects studied contribute to occupational accidents except human physical and physiological aspects. The comparison between management and construction site workers indicates no significant difference in their perspectives on human factors. Additionally, the results showed two "moderate" strength relationships: between attitude and dangerous behaviour, and between attitude and competency. This study provides an in-depth understanding of safety improvement pertaining to the human factor, and it can guide MRT construction stakeholders to prevent future accidents.

Keywords: Occupational Safety and Health, Construction Safety, Accident Factor, Workplace Accident, Human Factor

Introduction

The construction industry is an industry that has a high risk of occupational accidents due to its dynamic nature (Juhari & Arifin, 2020b; Khosravi et al., 2014; Li et al., 2015; Misiurek & Misiurek, 2017). The uniqueness of this dynamic construction industry is due to the

construction project's development nature, where the construction site's hazards and risks keep changing (Choudhry & Fang, 2008; Tam et al., 2004; Zhou et al., 2015). According to Misiurek & Misiurek (2017); Fass et al (2017), the rapid development and economic growth have led the construction industry to become one of the most hazardous industries in the world (Fass et al., 2017; Misiurek & Misiurek, 2017). Construction is also labelled as the industry with the highest case of occupational accidents and fatalities (Juhari & Arifin, 2020b).

In Malaysia, the occupational accident rate in the construction industry is among the highest compared to other industrial sectors. In 2018, the occupational accident rate in the construction industry recorded a figure of 3.11 per 1,000 employees. The occupational accident rate continued to increase in 2019, with a value of 3.81 per 1,000 employees (DOSH 2021). As for occupational fatality, the construction industry has recorded the highest rate in Malaysia yearly compared to other industrial sectors (DOSH, 2021). The fatality rate in the construction industry in Malaysia in 2017, 2018, and 2019 was recorded at 14.57, 13.44, and 1.28 per 100,000 employees, respectively (DOSH, 2021).

In the context of the mass rapid transit (MRT) rail construction industry in Malaysia, a total of 8 cases of fatal accidents, 7 permanent disabilities, and 19 temporary disabilities have been reported to the Department of Occupational Safety and Health (DOSH) Malaysia throughout the four years of the MRT construction project from 2012 to 2015 (DOSH, 2018). Therefore, efforts from all stakeholders to prevent occupational accidents should be empowered. This is because occupational accidents, illnesses and near-miss injuries are major indicators of an organisation's occupational safety and health (OSH) culture (Hughes & Ferrett, 2015).

Recent studies on occupational accidents in the construction industry show that factors affecting occupational accidents are most likely similar regardless of the country (Aksorn & Hadikusumo, 2008; Arifin et al., 2021; Macedo & Silva, 2005). Based on previous studies, it can be concluded that the factors affecting occupational accidents can be divided into five factors: human (worker); workplace; materials and equipment; management; and environmental influences (Haslam et al., 2005a; Hide et al., 2003; Jaafar et al., 2015; Stępień, 2014; Tam et al., 2004). The human factor is considered the major contributor to overall occupational accidents in construction sites compared to other factors (Hamid et al., 2008; Haslam et al., 2005a; Jaafar et al., 2018; Zin & Ismail, 2012). Thus, the objective of this study is to analyse and evaluate all aspects of the human factor in contributing to occupational accidents in the MRT construction industry.

Literature Review

Currently, traffic congestion is one of the major problems faced by many urban areas in Malaysia, especially in the Klang Valley. Therefore, public transport services, especially rail-based such as railways, MRTs and Light Rail Transits (LRTs), should operate more efficiently and effectively in order to attract more people to utilise this public transport method in addressing the traffic congestion issues (Arifin & Derahim, 2020; Khalid et al., 2014). The MRT construction project around the Klang Valley is one of the major projects under the Economic Transformation Program (ETP) in the Greater Kuala Lumpur area. This project involves the construction of rail-based public transport networks, which will integrate with the LRT, Monorail, KTM Komuter, KLIA Express and KLIA Transit systems (MRT Corp, 2014).

Factors contributing to occupational accidents: overview

Good OSH management is very important to ensure the safety of workers at the workplace (Arifin et al., 2017). According to Qing et al (2014), the rail construction project is characterized as a large-scale operation, utilising modern technologies, complex structures, high technical and quality standards, long-term, and requires the cooperation of various parties (Samantra et al., 2017). Factors affecting occupational accidents must be mastered clearly because it is a crucial step in occupational accident prevention measures (Khosravi et al., 2014).

Filho et al (2002); Jaafar et al (2018) pointed out that occupational accidents are predictable phenomena where the switch is present in the workplace. Factors affecting occupational accidents can be identified and can be managed accordingly to prevent accidents from happening. Khanzode et al (2012) stated that the factors affecting occupational accidents in the work system could be identified based on causal accident theories such as accident proneness theory, domino theory, socio-technical systems theory and macroergonomic theory (Khanzode et al., 2012). Factors affecting occupational accidents in the MRT construction industry should be identified and studied in order to manage all the hazards and risks in the industry effectively. Therefore, a safe and healthy working environment can be promoted, and occupational accidents can be avoided.

Generally, factors affecting occupational accidents are divided into five factors namely human; workplace; materials and equipment; management; and environmental influences (Haslam et al., 2005b; Hide et al., 2003; Jaafar et al., 2015, 2018; Juhari & Arifin, 2020a; Stępień, 2014; Tam et al., 2004). Workplace factors are one of the factors that contribute to accidents in the construction industry (Haslam et al., 2005b). Workplace factors include working conditions; site housekeeping; layout/ site space; and working environment (Jaafar et al., 2015; Stępień, 2014). Construction machinery, materials and equipment are basic needs during construction projects. According to Misiurek and Misiurek (2017), machines and equipment were created to assist construction work. However, improper handling creates a potential threat that can lead to occupational accidents. Examples of materials and equipment factors are the suitability of the materials/ equipment; conditions of the material/ equipment; safety protection design; knowledge of the materials/ equipment used (Hale et al., 2012; Jaafar et al., 2015; Juhari & Arifin, 2020b; Reese & Eidson, 2006; Stępień, 2014). Management factor is also known as an organizational factor. This factor can regulate occupational accidents through proactive measures in order to minimalise and prevent accidents beforehand (Jaafar et al., 2015). Based on previous studies, examples of management factors are OSH policy; resources management; organizational safety culture; and OSH management (Jaafar et al., 2015; Stępień, 2014). Environmental influences can be associated with external factors that may cause accidents in which the organization may not have control (Hale et al., 2012). These factors might not be direct, but they can be external factors that increase the risk of occupational accidents (Jaafar et al., 2015). Environmental influence factors can be divided into three main aspects, namely political and legislative influence; social influence; and market situations (Hale et al., 2012; Jaafar et al., 2015; Reese & Eidson, 2006; Stępień, 2014). On the other hand, the human factor needs to be focused because it is believed to be the most significant contributing factor towards occupational accidents in the construction site compared to other factors (Hamid et al., 2008; Arifin et al., 2020; Haslam et al., 2005b; Zin & Ismail, 2012).

Human Factor

According to the research conducted by Haslam et al (2005b), the human factor (i.e. a worker or a group of workers), which particularly includes attitudes, behaviours and competencies, has contributed to 70 percent of accidents on construction sites compared to other factors. Based on the research carried out by Hamid et al. (2008), they stated that the theory of human error had placed the worker as a key factor in causing an accident. In Malaysia, the research conducted by (Zin & Ismail, 2012) also shows that human behaviour is a major contributor to occupational accidents in the construction industry. According to (Jehring & Heinrich, 1951), who expanded the Domino Theory in 1931, 88 percent of all accidents are caused by unsafe acts, 10 percent by unsafe conditions, and two percent by "acts of God". Based on previous studies, the human factor can be divided into four main aspects, namely attitude; dangerous behaviour; human physical and physiological; and competency (Asilian-Mahabadi et al., 2020; Hale et al., 2012; Jaafar et al., 2015; Reese & Eidson, 2006; Stępień, 2014).

Attitude Aspect

Human attitude is one aspect linked to the human factor in affecting occupational accidents in the construction industry. Some important items under the human attitude aspects have been identified as contributing to the high rate of accidents in the construction industry, such as the issue of risk perceptions; and irresponsible attitudes among construction site workers (Baldissone et al., 2019; Kontogiannis et al., 2017; Reese & Eidson, 2006). Moreover, overconfident attitude; becoming idle; and lack of worker vigilance are aspects that need further attention (Baldissone et al., 2019; Hale et al., 2012; Reese & Eidson, 2006; Stępień, 2014). In addition, the worker attitude that is related to a lack of awareness and assessment of the situation; no motivation and morale/ spirit; and no sense of responsibility for safety issues are important aspects that need to be taken into account in order to improve safety performance (Hamid et al., 2008; Baldissone et al., 2019; Hale et al., 2012; Stępień, 2014).

Dangerous Behaviour Aspect

The second aspect of the human factor is dangerous behavior aspects that are closely related to unsafe acts. The dangerous behaviour aspects can be divided into two items, namely errors and intentional actions (Hale et al., 2012; Jaafar et al., 2018; Stępień, 2014). Examples of errors in the context of dangerous behaviour are the disuse or improper use of protective equipment and protection facilities; improper, chaotic or hurried execution of works; and the use of improper technologies (Jaafar et al., 2018). Examples of intentional actions in the context of dangerous behaviour are non-adherence to rules; not noticing or lack of warnings or information about hazards; ignoring hazards; and deliberate undertaking of risk or dangerous work methods (Ajayi et al., 2021; Asilian-Mahabadi et al., 2020; Han et al., 2020; Jaafar et al., 2018; Stępień, 2014).

Human physical and physiological aspect

The third aspect that contributed to the human factor is human physical and physiological. For the human physical and physiological aspects, the important thing related to human physical factors are body size (e.g. being fat or thin); height; physical strength and flexibility; and stamina (Reese & Eidson, 2006). According to Hamid et al. (2008) and Haslam et al. (2005a), human physiological factors associated with occupational accidents are fatigue and reduced capability of senses. Other than that, poisoning and influence of medicines; health problems; and stress among the construction site workers also need to be focused (Hamid et

al., 2008; Hale et al., 2012; Haslam et al., 2005a; Stępień, 2014). Poisoning and the influence of medicines include drug addiction and alcohol intake, as studied by (López-Arquillos et al., 2017; Lee et al., 2022; Jaafar et al., 2018).

Competency Aspect

Another important aspect of the human factor is competency. In discussing the worker's competency regarding occupational safety at workplaces, the important thing that needs to be focused is knowledge and skills (Gürcanli & Müngen, 2013; Jaafar et al., 2018; Raheem & Issa, 2016; Reese & Eidson, 2006; Stępień, 2014). Stępień (2014) emphasized that work experience and talents are important in associated with the competency aspect. Ismail et al (2019); Hapsari et al (2019) added that safety training; language and communication barriers; and literacy and calculation skills are among the things that contribute to occupational accidents in the construction industry.

Research Methodology

Questionnaire Design

This study uses a quantitative approach where a survey questionnaire is the main tool to obtain data. A set of questionnaires was developed based on all aspects of the human factor contributing to occupational accidents from the literature review. The questionnaire comprised two main sections (1) Section A: Respondent background, and (2) Section B: Human factors contributing to occupational accidents in the MRT construction industry. Section A consists of five questions related to respondent background, namely gender, age, educational background, occupational category, and work experience. Section B comprised 30 questions related to four aspects under the human factor i.e., attitude (8 questions); dangerous behaviour (7 questions); human physical and physiological (8 questions); and competency (7 questions). A 5-point Likert-type scale was adopted for all questions in Section B (1 = Strongly Disagree, 5 = Strongly Agree). Furthermore, open questions on all aspects of contributing to occupational accidents were asked to obtain opinions from respondents.

Before the ground analysis, a pilot study was conducted to ensure the reliability of the questionnaire items. Cronbach's Alpha analysis was used to test whether the items were consistent and reliable. The Cronbach's Alpha value for the questionnaire was 0.876 (i.e., attitude: 0.901, dangerous behaviour: 0.885, human physical and physiological: 0.823, and competency: 0.895), indicating high internal consistency and good respondents' consistency (George & Mallery, 2012; Pallant, 2016).

Population and sampling

The population and samples of this study were focused on the location of the MRT Sungai Buloh-Serdang-Putrajaya Line (SSP) construction project around the Klang Valley, which started in 2016 and completed by 2023 (MRT Corp, 2017). The respondents for this study focused only on local workers in the MRT SSP Line construction project. They comprised two groups, namely (1) the management/ professional group that influences the planning, implementation and monitoring of OSH management at construction sites and (2) the construction site worker group, which are workers who work directly at construction sites.

According to data obtained from DOSH Malaysia, there were 20 contractor companies registered under DOSH Malaysia for the MRT SSP Line construction project (DOSH, 2020). The total population of the entire workforce for all 20 contractor companies as of September 2020 was 1,727, where 555 of them were categorized as management/ professionals, while the

other 1,172 were categorized as construction site workers (DOSH, 2020). The present study used a sample size based on the sample size calculation introduced by (Ariola, 2006). A total number of 530 respondents' responses were collected. The respondents representing management/ professional and construction site workers groups were 232 and 298, respectively. The respondents were selected according to inclusion criteria. Respondents were eligible if they were (1) at least 18 years of age, (2) able to read and understand English or Malay, and (3) must be employees of the main or subcontractor companies of the MRT SSP Line construction project.

Data Collection

The questionnaires were circulated to contractor companies in two ways: (1) through direct circulation to respondents in meetings/ programmes involving the MRT SSP Line contractor companies with DOSH Malaysia as well as at the construction site project; (2) via electronic circulation such as email and short message service (SMS) where the questionnaire was designed by using Google Forms and were followed up by phone calls. A total of 95 responses were received through direct circulation, and 435 responses via electronic circulation (Google Forms). The total number of responses received from respondents was 530.

Data Analysis Method

The data obtained from the respondents were analysed using *IBM SPSS Statistics Version 23.0* software. The statistical analysis used in this study was descriptive and inferential analysis. Descriptive analysis (i.e., frequency and percentage) was used to analyse personal and employment information. Every aspect of the human factor contributing to occupational accidents was analysed to investigate the perception of both management/ professional and construction site workers groups. They were analysed by calculating the mean and standard deviation. After that, the overall suitability scale (Table 1) was used to interpret a conclusion on all aspects contributing to occupational accidents. Mann-Whitney U test was utilized in order to compare the perceptions between the management and construction site workers towards aspects of the human factor. The Mann-Whitney U test is commonly used to compare differences between two independent groups when the dependent variable is ordinal (Alison & Susan, 2021; Chua, 2020; Cohen, 2013). The hypotheses set for this analysis are as below:

Research hypothesis, H_A: the mean ranks of the two groups are not equal.
Null hypothesis, H_O: the mean ranks of the two groups are equal.

Inferential analysis was used to determine the strength of the relationship between all aspects contributing to occupational accidents. The inferential analysis method used in this study was the Pearson correlation test. The Pearson correlation test was chosen because this study's data variables were normally distributed. The normality test for all variables was carried out to ensure the normality of variables. The normality test results found that the skewness value ranges from 0.057 to 0.615; and from -0.080 to 0.260 for the management/ professional and construction site workers groups, respectively. Hence, from the normality test results, it was interpreted that the data distribution is normal because the skewness value is between -2 and 2 (Alison & Susan, 2021; Chua, 2020; Cohen, 2013). Meanwhile, *Guilford's Rule of Thumb* was used to determine the strength of relationships between variables through the coefficient correlation value, as presented in Table 2 (Newton & Knight, 2022).

Table 1
Overall mean scale definition of the suitability

Mean Scale Interval	Degree of Suitability
1.00 – 1.80	Strongly Disagree
1.81 – 2.60	Disagree
2.61 – 3.40	Medium
3.41 – 4.20	Agree
4.21 – 5.00	Strongly Agree

Source: Kontogiannis et al (2017)

Table 2
Relationship strength interpretation based on the value of coefficient correlation according to Guilford's Rule of Thumb

Coefficient correlation (r)	Relationship strength
± 0.90 - 1.00	Very strong
± 0.70 - 0.90	Strong
± 0.40 - 0.70	Moderate
± 0.20 - 0.40	Weak
± 0.01 - 0.20	Very weak
0.00	No relationship

Source: Newton & Knight (2022)

Research Results and Discussions

Respondents' socio-demography

For the direct circulation method, 105 questionnaires were distributed, and a total of 95 usable questionnaires were collected, resulting in a 90.5% response rate for the survey. As for the electronic circulation method, emails and messages were sent to all 20 contractor companies' staff, and a total of 435 responses were received via Google Forms survey. Therefore, the total number of responses received from respondents was 530. Once the total of respondents reached 530, the Google Forms survey was turned off in order not to receive any other responses. This is because the total number of respondents is 530, and sufficient for data analysis. The total response rate for both data collection methods was very high (i.e., 95.25%) because all contractor companies for this MRT project were invited to participate in the survey with support from their respective OSH division. Furthermore, there was a specific session for the questionnaire feedback during programmes involving the MRT SSP Line contractor companies with DOSH Malaysia.

This research was conducted to control social desirability bias with assurance of confidentiality and anonymity (Krumpal, 2013). The survey was comprised of a cover letter and a questionnaire. The cover letter explained that participation was voluntary and all responses would be confidential. To maintain the respondent's anonymity, information such as name and signature were avoided in the questionnaire. Moreover, a mixture of positively and negatively worded questions as well as prompt wording were used in the questionnaire in order to reduce social desirability bias, as suggested by Krumpal (2013). In addition, the respondents were provided with some instructions such as (1) their involvement was completely voluntary and they could withdraw from the study at any time, (2) all questions had to be completed, and respondents must complete the questionnaire themselves, and (3) discussions with fellow colleagues about the questionnaire were not allowed. All contractor

companies for this MRT project were invited to participate in the survey with support from their respective OSH division.

Table 3 shows the respondent's socio-demography details from the data collection. As seen in Table 3, most of the respondents were male (92.8%). Age ranging from 20 to 30 years old was the majority (46.6%), followed by 30 to 40 years old (28.5%). More than 70% of the respondents completed secondary school (37.9%) and were holders of Bachelor's Degree (34.3%).

Table 3
Respondents Socio-demography

Characteristic	Category	Frequency (N=530)	Percentage (%)
Gender	Male	492	92.8
	Female	38	7.2
Age	< 20 years	34	6.4
	20 – 30 years	247	46.6
	30 – 40 years	151	28.5
	40 – 50 years	73	13.8
	> 50 years	25	4.7
Educational background	PhD/ Master's	30	5.7
	Bachelor's Degree	182	34.3
	Diploma	117	22.1
	Secondary School	201	37.9
Occupational category	Top Management	45	8.5
	Middle Management	187	35.3
	Construction workers	298	56.2
Work experience	< 1 year	89	16.8
	1 - 2 years	94	17.7
	2 - 5 years	204	38.5
	5 - 10 years	84	15.9
	> 10 years	59	11.1

On top of that, 56.2% of the respondents were categorized as construction workers; 35.3% as middle management, and the remaining 8.5% as top management. Examples of top and middle management groups are heads of departments; division directors; executive employees; engineers; and safety and health officers (SHO). The construction worker group are workers who work on a full-time basis at construction sites, such as safety supervisors; technicians; crane operators; and general workers. In terms of work experience, the respondents were divided into those with less than 1 year (16.8%); 1 - 2 years (17.7%); 2 - 5 years (38.5%); 5 - 10 years (15.9%); and more than 10 years (11.1%).

Evaluation of attitude aspect

Table 4 shows the evaluation of attitude aspects for both management/ professional and construction site worker groups. For the management/ professional group, two items were classified as "Strongly Agree", two items as "Agree", and four other items as "Medium", with a mean value between 2.98 to 4.60. On the other hand, for the construction site worker

group, two items were classified as "Strongly Agree", one item as "Agree", and five other items as "Medium", with a mean value between 2.74 to 4.67.

Table 4
Evaluation of attitude aspect

Attitude Aspect	Management/ Professional		Mean Scale	Construction Site Workers		Mean Scale
	Mean	Standard deviation		Mean	Standard deviation	
Workers have low risk perceptions on accidents.	3.53	0.789	Agree	3.32	0.721	Medium
Workers have bad or irresponsible attitude.	3.13	0.917	Medium	2.89	0.748	Medium
Workers have overconfidence attitude.	3.13	1.017	Medium	2.97	0.822	Medium
Workers becoming idle.	3.69	0.873	Agree	3.66	0.850	Agree
Workers' lack of vigilance.	4.36	0.771	Strongly Agree	4.37	0.729	Strongly Agree
Workers' lack of awareness and assessment of situation.	4.60	0.683	Strongly Agree	4.67	0.634	Strongly Agree
Workers have no motivation and morale/ spirit.	2.98	0.732	Medium	2.74	0.645	Medium
Workers have no sense of responsibility for safety issues.	3.14	0.790	Medium	2.76	0.780	Medium
Total Average	**3.57**	**0.822**		**3.42**	**0.741**	

Respondents from the management/ professional group agreed that items contributing to occupational accidents in the MRT construction industry for the attitude aspect were "workers' lack of awareness and assessment of the situation" (4.60), "workers' lack of vigilance" (4.36), "workers becoming idle" (3.69), and "workers have low-risk perceptions on accidents " (3.53). These findings are consistent with previous studies where the attitude of the construction workers is related to the lack of awareness regarding hazards and risks; and lack of vigilance during performing activities at construction sites that contribute to occupational accidents (Asilian-Mahabadi et al., 2020; Baldissone et al., 2019; Reese & Eidson, 2006). Kontogiannis et al (2017) also added that situation assessment on construction sites by workers is important as it helps to create awareness about hazards and risks related to critical work activities (Kontogiannis et al., 2017). According to Hale et al (2012), workers becoming idle is one of the causes of occupational accidents. In addition, workers' perception of OSH also affects the safety performance of a construction company (Cheng et al., 2010).

The most important items creating occupational accidents, as agreed by the respondents from the construction site worker group, were "workers' lack of awareness and assessment of the situation" (4.67), "workers' lack of vigilance" (4.37), and "workers become idle" (3.66). These three items are the same as the perception from the management/ professional group.

Meanwhile, there are respondents who explained that they had experienced occupational accidents involving their workers, who fell from heights due to the attitude of

becoming idle. Other respondents also stated that there were some occupational accident cases due to falling objects as well as property damage related to the attitude of workers.

Overall, the total average mean value regarding the attitude aspect for the management/ professional and construction site worker groups was 3.57 and 3.42, respectively. Therefore, both groups "Agree" that the attitude aspect influences occupational accidents in the MRT construction industry.

Evaluation of dangerous behaviour aspect

Table 5 shows the evaluation of the dangerous behaviour aspect for both management/ professional and construction site worker groups. For the management/ professional group, three items were classified as "Strongly Agree" and four other items as "Medium", with a mean value between 2.68 to 4.50. As for the construction site worker group, three items were classified as "Strongly Agree", three items as "Medium", and one other item as "Disagree", with a mean value between 2.56 to 4.55.

Respondents from the management/ professional group agreed that items contributing to occupational accidents in the MRT construction industry for dangerous behaviour aspect were the "use of improper technologies" (4.50), "improper, chaotic or hurried execution of works" (4.24), and "disuse or improper use of protective equipment and protection facilities" (4.21). As seen in Table 5, these three items were also agreed by the construction site worker group with the following mean values: "use of improper technologies" (4.55), "disuse or improper use of protective equipment and protection facilities" (4.37), and "improper, chaotic or hurried execution of works" (4.33).

Previous studies indicate that using improper technologies by workers can cause accidents in the construction industry (Cheng et al., 2010; Fung et al., 2012). Additionally, disuse or improper use of personal protective equipment (PPE) and protection facilities by workers at construction sites also contributes to injury and fatality accidents (Cheng et al., 2010; Khosravi et al., 2014). Due to these facts, workers at construction sites must use proper PPE correctly in order to reduce the risk of injury if accidents happen. In the meantime, some respondents clarified that they had experienced occupational accidents involving their subordinates, where the workers were doing a high-risk task without proper eye protection.

Overall, the total average mean value regarding the dangerous behaviour aspect for management/ professional and construction site worker group were the same which is 3.44. Thus, both groups "Agree" that the dangerous behaviour aspect contributes to occupational accidents in the MRT construction industry.

Table 5
Evaluation of dangerous behaviour aspect

Dangerous Behavior Aspect	Management/ Professional		Mean Scale	Construction Site Workers		Mean Scale
	Mean	Standard deviation		Mean	Standard deviation	
Error: Disuse or improper use of protective equipment and protection facilities.	4.21	0.758	Strongly Agree	4.37	0.670	Strongly Agree
Error: Improper, chaotic or hurried execution of works.	4.24	0.722	Strongly Agree	4.33	0.680	Strongly Agree
Error: Use of improper technologies.	4.50	0.550	Strongly Agree	4.55	0.586	Strongly Agree
Intentional actions: Non-adherence to rules.	2.74	0.753	Medium	2.56	0.618	Disagree
Intentional actions: Not noticing or lack of warnings or information about hazard.	2.72	0.759	Medium	2.82	0.754	Medium
Intentional actions: Ignoring hazards.	2.68	0.797	Medium	2.71	0.742	Medium
Intentional actions: Deliberate undertaking of risk or dangerous work methods.	2.97	0.786	Medium	2.71	0.780	Medium
Total Average	**3.44**	**0.732**		**3.44**	**0.690**	

Evaluation of the Human Physical and Physiological Aspects

The results of the evaluation of human physical and physiological aspects for both management/ professional and construction site worker groups are presented in Table 6. For the management/ professional group, one item was classified as "Agree", two items as "Medium", three items as "Disagree", and two items as "Strongly Disagree", with a mean value between 1.47 to 3.43. On the other hand, for the construction site worker group, three items were classified as "Medium", three items as "Disagree", and two items as "Strongly Disagree", with a mean value between 1.52 to 3.28.

One item that has been agreed as contributing to occupational accidents for human physical and physiological aspects by the respondent from the management/ professional group was "fatigue and reduced capability of senses", with a mean score of 3.43 and a standard deviation of 0.729. The issue of fatigue among workers while performing activities at construction sites should be focused on because Hamid et al (2008); Maynard et al (2021) have identified in their studies that fatigue which is related to body effort, is one of the causes of accidents at the workplace. Besides that, Haslam et al (2005a) stated that the problem of fatigue among construction workers was due to long working hours without adequate rest, and as a result, the worker's concentration decreased and subsequently affected their safety during performing tasks at the site.

Table 6
Evaluation of human physical and physiological aspects

Human Physical and Physiological Aspect	Management/ Professional		Mean Scale	Construction Site Workers		Mean Scale
	Mean	Standard deviation		Mean	Standard deviation	
Physical: Body size of workers are not suitable (fat, thin).	1.94	0.552	Disagree	2.02	0.515	Disagree
Physical: Height of workers are not suitable.	1.69	0.526	Strongly Disagree	1.66	0.523	Strongly Disagree
Physical: Physical strength and flexibility of workers decreased.	2.68	0.723	Medium	2.60	0.665	Medium
Physical: Low stamina.	2.47	0.852	Disagree	2.40	0.666	Disagree
Physiological: Fatigue and reduced capability of senses.	3.43	0.729	Agree	3.28	0.677	Medium
Physiological: Poisoning and influence of medicines.	1.47	0.616	Strongly Disagree	1.52	0.587	Strongly Disagree
Physiological: Health problem.	2.44	0.900	Disagree	2.18	0.703	Disagree
Physiological: Stress.	2.95	0.820	Medium	2.76	0.766	Medium
Total Average	**2.38**	**0.715**		**2.30**	**0.638**	

Two items that have been classified as "Medium" by respondents from the management/ professional group were "stress" (2.95) and "physical strength and flexibility of workers decreased" (2.68). As for the construction site worker group, three items that have been classified as "Medium" were "fatigue and reduced capability of senses" (3.28), "stress" (2.76), and "physical strength and flexibility of workers decreased" (2.60). Based on the research findings by Hamid et al (2008); Hale et al (2012), the stress problem associated with workers' emotions in the construction industry also leads to occupational accidents. The other remaining items for the human physical and physiological aspect, as shown in Table 6, were not agreed by respondents in contributing to occupational accidents.

Overall, the total average mean value with respect to the human physical and physiological aspects for management/ professional and construction site worker groups was 2.38 and 2.30, respectively. Hence, both respondent groups had a perception to "Disagree" with human physical and physiological aspects influencing occupational accidents in the MRT construction industry.

Evaluation of the Competency Aspect

Table 7 shows the evaluation of competency aspects for both management/ professional and construction site worker groups. For the management/ professional group, three items were classified as "Strongly Agree", one item as "Agree", and the rest three items as "Medium", with a mean value between 2.97 to 4.47. Meanwhile, for the construction site worker group, all competency aspects are the same as the management/ professional group's perception, with a mean value between 2.72 and 4.61.

Table 7
Evaluation of the competency aspect

Competency Aspect	Management/ Professional		Mean Scale	Construction Site Workers		Mean Scale
	Mean	Standard deviation		Mean	Standard deviation	
Workers have low knowledge regarding to task.	4.46	0.643	Strongly Agree	4.54	0.519	Strongly Agree
Workers have low skills regarding to task.	4.47	0.783	Strongly Agree	4.61	0.669	Strongly Agree
Workers have less/ no work experience.	4.24	0.626	Strongly Agree	4.36	0.620	Strongly Agree
Workers have less/ no safety training.	3.25	0.750	Medium	3.17	0.736	Medium
Workers have low talents.	2.97	0.699	Medium	2.72	0.706	Medium
Language and communication barrier.	3.87	0.654	Agree	3.59	0.608	Agree
Literacy and calculation skills	3.25	0.895	Medium	2.79	0.819	Medium
Total Average	**3.79**	**0.721**		**3.68**	**0.668**	

Respondents from the management/ professional group agreed that items affecting occupational accidents in the MRT construction industry for competency aspect were "workers have low skills regarding task" (4.47), "workers have low knowledge regarding task" (4.46), "workers have less/ no work experience" (4.24), dan "language and communication barrier" (3.87). As can be seen in Table 7, these four items were also agreed by the construction site worker group with the following mean values: "workers have low skills regarding task" (4.61), "workers have low knowledge regarding task" (4.54), "workers have less/ no work experience" (4.36), and "language and communication barrier" (3.59). Gürcanli and Müngen (2013), through their study, found that accidents involving less skilled workers in the construction industry were the highest contributor (46 percent) to the occupational accident rate in Turkey. In addition, Rahman et al (2022) stated that worker skills with respect to their tasks are a crucial factor in ensuring that construction activities are carried out safely. Thus, Reese and Eidson (2006) also emphasized that working experience is vital to producing skilled workers. Raheem and Issa (2016); Rahman et al (2022) added that the training and competency requirements of each worker in the construction industry are crucial to producing knowledgeable workers and thus inculcating a good safety culture within an organization. In addition, some respondents explained that they had experienced occupational accidents involving their subordinates because the workers did not have the skills to operate a skylift machine correctly.

Overall, the total average mean value with respect to the competency aspect for the management/ professional and construction site worker groups were 3.79 and 3.68, respectively. Hence, both respondent groups had a perception to "Agree" with the competency aspect affecting occupational accidents in the MRT construction industry.

Comparison of evaluation on human factor between management/ professional and construction site workers groups

The comparison results of perception between the management and construction site workers on the human factor using the Mann-Whitney U test are tabulated in Table 8. The mean values scored for both groups of respondents are very close, and the results fall in the same mean scale categories for all aspects of the human factor studied.

Table 8
Comparison of perception between the management and construction site workers on the human factor by using Mann-Whitney U test

Aspect of Human Factor	Mean Value		Asymp. Sig. (2-tailed)
	Management/ Professional	Construction Site Workers	
Attitude	3.57	3.42	0.165
Dangerous behavior	3.44	3.44	0.782
Human physical and physiological	2.38	2.30	0.327
Competency	3.79	3.68	0.691

Through the Mann-Whitney U test that was performed, all Asymp. Sig. (2-tailed) values (p value) obtained are greater than the specified alpha level (.05). Thus, this finding concluded that the null hypothesis could not be rejected. It shows no significant difference in perception between both groups of respondents towards human factors contributing to occupational accidents in the MRT construction industry. These comparison results indicated that the perception of both management and construction site worker respondents pertaining to humans as an accident causal factor is equal, similar to the previous study by (Jaafar et al., 2018).

Relationships of all aspects of the human factor contributing to occupational accidents

The results of the correlation analysis to identify the relationships in all aspects of the human factor contributing to occupational accidents are tabulated in Table 9. From the analysis results, it was found that all the existing relationships showed a positive linear relationship at the confidence level of 99% or guided by the value of p, where the p value was less than the confidence level of 1% ($p < 0.01$).

Among all aspects of the human factor, the relationship between "attitude" and "dangerous behaviour" recorded the highest coefficient correlation value ($r = 0.466$, $p < 0.01$). When the attitude of workers in the context of safety is increased, it will create a safer workplace that leads to less dangerous behaviour [67]. This was followed by the relationship between "attitude" and "competency" ($r = 0.401$, $p < 0.01$), the relationship between "attitude" and "human physical and physiological" ($r = 0.396$, $p < 0.01$), the relationship between "dangerous behaviour" and "competency" ($r = 0.371$, $p < 0.01$), the relationship between "human physical and physiological" and "competency" ($r = 0.361$, $p < 0.01$), and the relationship between "dangerous behaviour" and "human physical and physiological" ($r = 0.269$, $p < 0.01$). These results are parallel with many previous studies and showed that aspects of "attitude", "dangerous behaviour", "competency", and "human physical and physiological" are related to each other in influencing safety performance (Hamid et al., 2008; Aksorn & Hadikusumo, 2008; Haslam et al., 2005a; Vinodkumar & Bhasi, 2011).

Table 9
Relationships of aspect of human factor

Aspect of Human Factor	**Pearson Correlation Test**			
	Attitude	Dangerous behavior	Human physical and physiological	Competency
Attitude	1.000	r = 0.466** p = 0.000	r = 0.396** p = 0.000	r = 0.401** p = 0.000
Dangerous behavior		1.000	r = 0.269** p = 0.000	r = 0.371** p = 0.000
Human physical and physiological			1.000	r = 0.361** p = 0.000
Competency				1.000

** Correlation is significant at 0.01 level

Referring to *Guilford's Rule of Thumb,* it was interpreted that the relationship between "attitude" and "dangerous behaviour" ($r = 0.466$, $p < 0.01$) and the relationship between "attitude" and "competency" ($r = 0.401$, $p < 0.01$) have a relationship strength of "moderate" because the coefficient correlation values were between 0.40 and 0.70. The other four existing relationships were categorized as "weak" relationship strength because the coefficient correlation values were between 0.20 and 0.40 (Newton & Knight, 2022).

Overall, it was concluded that two relationships with the strength of "moderate" and four relationships with the strength of "weak" existed in all aspects of the human factor contributing to occupational accidents.

Conclusion

In Malaysia, the rate of occupational accidents in the construction industry generally and the MRT construction industry particularly is high. Various parties have made numerous efforts to improve OSH performance to reduce occupational accidents. This paper focused on the human factor affecting occupational accidents in MRT construction in Malaysia by means of quantitative analysis. This study showed that the MRT rail construction industry workers' perception regarding aspects of attitude, dangerous behaviour, and competency with respect to the human factor influenced occupational accidents. However, human physical and physiological aspects were not agreed in contributing to occupational accidents. Moreover, it was found that there is no significant difference in the perception between the management and construction site workers towards the human factor. Finally, the results indicated that there were two relationships with "moderate" strength i.e., the relationship between attitude and dangerous behaviour; and the relationship between attitude and competency. Therefore, this study introduces the theoretical contribution that attitudes, dangerous behaviour, and competency contributed to occupational accidents in construction sites due to human factors.

The human factors contributing to occupational accidents must be understood to ensure the suitability of occupational safety intervention practices implemented, which can create a safe and healthy workplace in the MRT rail construction industry. Subsequently, the result of this study provides an in-depth understanding of safety improvements pertaining to the human factor, and all MRT construction stakeholders should prioritize it to plan further improvement measures to prevent occupational accidents from occurring in the future.

Therefore, the contextual contribution of this study recommends practical implications for all MRT construction stakeholders, such as developers, consultants, government agencies, and safety practitioners, to focus on attitudes, dangerous behaviour, and competency since they are the most significant aspects that affect occupational safety at workplaces.

This study has a limitation where it only covers the ongoing MRT SSP Line construction project in Malaysia. Future studies could perhaps cover various types of rail-based construction industry so that the findings can manifest in a larger construction context. Malaysia is expecting a lot of rail-based construction industry in the near future, for instance, the MRT Circle Line, LRT Line 3, East Coast Rail Link (ECRL) Project and Kuala Lumpur–Singapore High-Speed Rail (HSR). In addition, social desirability bias might occur during the respondents answer the questionnaires. However, this research was conducted with an assurance of confidentiality and anonymity to control that bias. Furthermore, future studies would need to be conducted in other countries since the characteristics of construction workers in Malaysia might differ because it comprises workers of various nationalities.

Conflict of Interest

None to report

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