Improving occupational health and safety (OHS) in construction using Training-Within-Industry method

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Abstract

Purpose – The manufacturing industry is a well-known source of interventions adapted to solve problems in the construction industry. The use of Training-Within-Industry (TWI) is one such intervention adopted in the construction industry to solve the construction problem relating to occupational health and safety (OHS). The objectives of TWI are to help the industry to transfer knowledge and skills from management to the employees. Therefore, the purpose of this paper was to investigate whether TWI can reduce OHS problems by promoting "learning by doing" on construction sites.

Design/methodology/approach – A case-based-research method was used to investigate the reported OHS problems in the construction industry in South Africa. The data were quantitative and qualitative in nature; the questionnaire survey, semi-structured interview and focus group interview techniques were used to collect data in the study.

Findings – The findings provide a better understanding of the human contributions influencing the behaviour of people causing accidents on construction sites. The data show that construction project leaders struggle to promote "learning by doing" because of inappropriate behaviour, lack of communication and inadequate training provided to new workers on construction sites. Also, there is significant scope for TWI deployment in construction because of the inability of supervisors or management to promote "learning by doing" on construction sites.

Practical implications – Based on the research findings, it is discovered that OHS is a serious concern in the construction industry. Therefore, the adoption of learning by doing on a construction site would help to improve OHS outcome.

Originality/value – The study highlights the need to introduce TWI on construction sites to reduce human failure causing accidents. TWI could lead to improving the knowledge- and skills-transfer programmes for construction workers in favour of better safety performance.

Keywords Construction, Safety, Accidents, Training-Within-Industry

Paper type Research paper

1. Introduction

Practitioners and safety researchers have provided extensive evidence to prove that the construction industry is one of the most dangerous industries worldwide. The evidence is recorded in the reports that the construction industry produces a high number of accidents,

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which result in either injuries or fatalities to the victims (Park and Kim, 2013; Awwad *et al.*, 2016; Yoon *et al.*, 2013). Occupational health and safety regulations are promulgated to help organizations to deploy a safety management system (SMS) to prevent the manifestation of accidents (Ghodrati *et al.*, 2018). However, the construction industry has remained one of the most unsafe industry worldwide (Ghodrati *et al.*, 2018). For example, it is reported that between 2010 and 2011, the construction industry in South Korea recorded an accident rate of 0.64-0.94 when compared with all industrial accidents rates of 0.65-0.95 (Yoon *et al.*, 2013). Also, in 2014, 73,000 non-fatal injuries were recorded in the US construction industry (Ghodrati *et al.*, 2018 citing Department of Labor, 2014). These reported OHS statistics extend to developing countries such as South Africa where the construction industry had recorded at least 1.5-2.5 fatalities per week in 2017 (Department of Labour, 2017).

Inadequate OHS is a problem that the construction industry has been trying to solve for decades. For example, in 1981, the Accident Prevention Advisory Unit (APAU) of the Health and Safety Executive (HSE) in the United Kingdom (UK) surveyed the cost of work-related accidents in all industries. From the HSE report, it was discovered that the loss for the companies from the work-related accident was 5-10 per cent of the profit for all industries, and 8.5 per cent of the tender price for the construction industry (Yoon *et al.*, 2013). The reported construction accident could be observed from several project factors, namely, site layout, materials, tools and equipment and trade workforce that made up an unstable construction environment (Park and Kim, 2013). The multiple pathways of accident causations make its elimination a complex task in construction (Health and Safety Executive (HSE), 2009; Reason, 2008).

Therefore, an accident is described as an unplanned incident that resulted in either minor or major injuries, or even fatalities (Manu *et al.*, 2012). An accident could emanate from systemic failure situated in human actions (Reason, 2008; Perlman *et al.*, 2014). Some causes of accidents are rooted in human behaviour that included a lack of maintenance and poor safety culture (HSE, 2009; Chidambaram, 2016). The impact of human behaviour on accident is a severe concern in construction because contractors often fail to use a systemic approach to improve the safety management system on their sites (Kontogiannis *et al.*, 2017). The behaviour of people in construction could be influenced by errors that have far-reaching consequences (Noroozi *et al.*, 2013). Therefore, it is essential for contractors to invest in training and educational programme to avert the safety risk identified in the planning of the projects (Park and Kim, 2013).

The above explanations reinforce the reasons why contractors are keen to reduce the high number of injuries and fatalities in construction (Awwad *et al.*, 2016). The high number of injuries and fatalities in construction had driven the notion that OHS practice in construction is worse when compared to other industry such as manufacturing (Koskela, 1992). Historically, the manufacturing industry has been a reference point and source of innovation to relieve problems in construction for decades (Koskela, 1992). Therefore, to overcome this reported OHS problem, researchers such as Huntzinger (2016) and Graupp and Wrona (2010) proposed the adoption of Training-Within-Industry in the construction industry.

TWI was designed to improve the production output of tools and equipment in the manufacturing industry (Huntzinger, 2006). The origin of TWI could be traced to the manufacturing industry in the USA (Dzubakova and Koptak, 2015). The application of TWI focused mostly on transferring knowledge and skill of work to the leaders, masters, foremen and experienced operators in the manufacturing industry. The philosophy of TWI is to promote “learning by doing” which implied solving production problems with the guidance of a properly trained supervisor (Huntzinger, 2016). For instance, a properly trained supervisor should be able to analyse trade and inform learners on safe work procedures (SWP). Analysing the trade for the learners meant that a supervisor must be knowledgeable with all the topics that the learners must be taught (Allen, 1919).

The purpose of this paper is to report on how TWI could be used to reduce OHS problems through "learning by doing" on construction sites. The next section of this paper provides a brief literature review on TWI. The research method is explained after the theoretical explanatory framework. This is followed by the findings presented through quantitative and qualitative analysis. The discussions of the findings are presented next. The paper concludes by summarizing how human failures linked to safety in construction could be addressed using the TWI method.

2. Training-Within-Industry

TWI was designed in the USA in the 1940s during the Second World War (WW) (Graupp and Wrona, 2010). The purpose of TWI was to help the US military to improve the production output of aeroplanes and weapons to support the allied military war efforts (Huntzinger, 2016). Thus, TWI was designed to help war manufacturing industries to meet their supply demands. The idea behind TWI was to ensure each worker made the fullest use of his or her best skills in industrial operations (Huntzinger, 2016; Graupp and Wrona, 2010).

The philosophy of TWI has long been a "hidden part" of Toyota Production System (TPS) that is adapted as lean construction (LC) in the built environment context (Forbes and Ahmed, 2011). The history of TPS could be traced from the Toyota Motor Corporation in Japan. It is described as a management system used to eliminate waste (non-value adding activities) (Shingo, 2005). Additionally, LC is described as a management system designed to minimize waste of materials, time and effort to generate the maximum possible amount of value for the client (Bashir, 2011). The type of waste that is assessed in this paper is an accident, which in lean theory is described as a non-value-adding activity. An accident is not a project requirement as it stalls the progress of work on site. A non-value-adding activity is called a waste because it consumes resources without advancing the progress of work (Koskela, 1992). In other words, the cost incurred from accidents is unwanted in construction.

The cost of accidents (CoA) in construction constitutes a significant burden for the client and contractors in both financial (direct cost) and non-financial (indirect cost) terms (Rohani, 2015). According to Feng (2015), the study on CoA by Heinrich (1931) described accident as either direct or indirect cost. In construction, the direct cost includes the cash flow that is directly associated with accidents (Feng, 2015), and the necessary investigations (Nahmens and Ikuma, 2009). As an illustration of the significance of CoA, Haupt and Pillay (2016) report that the South African construction industry paid out more than ZAR 287m ($20.46m) on claims for injuries and illness that were work-related in the period ending March 2012. This cost reflects the direct cost of an accident in the construction industry. The problem relating to the direct cost of accident extend to a developed country such as the USA, as it is reported that the employer in the USA pays almost $1bn per week for direct workers' compensation costs alone (Department of Labor, 2019).

The indirect cost constitutes expenses that are not covered by the workers' compensation insurance (Nahmens and Ikuma, 2009; Feng, 2015). For example, the cost about the absence of the injured worker is an indirect cost that is not covered by the workers' compensation insurance. However, the direct cost of an accident could be mitigated by using a standardization of work, which is a component of TWI (Forbes and Ahmed, 2011). To decompose TWI, the literature shows that training procedures in the industry are extensive because of processes that can be placed into two categories, namely, training with absorption and training by intention (Allen, 1919). Training by absorption is a procedure where there is no particular arrangement made for training individuals. An individual learns from co-workers in the same job task. Training by intention refers to a procedure where an instructor teaches new employees how to do the job task. The procedure could be in the form of an apprenticeship or leadership scheme (Allen, 1919).

The context of TWI was grounded on the three J-programme, which includes the job instruction, job methods and job relations (Grip and Sauermann, 2013). TWI can be defined as a comprehensive method to transfer the knowledge and skills of management on instructing employees (job instruction), building good relations with employees (job relation) and improving working methods (job method) (Sinocchi and Bernstein, 2016).

2.1 Job instruction (standardized work)

The job instruction, which is an element of TWI served a purpose to teach the supervisors how to develop a well-trained workforce (Huntzinger, 2016). During the introduction of TWI, it is essential for the supervisors to be skilled on how to supervise or teach new workers (Allen, 1919). Job instruction is the central pillar of TWI, and it is implemented through "training by intention" and always uses a supervisor to transfer knowledge and skills (Allen, 1919). It is important that an appointed supervisor must be skilled or taught how to instruct individuals regardless of how knowledgeable a supervisor is regarding the work. This is because being knowledgeable about the work does not mean that a supervisor will be able to teach individuals how to do the work according to specifications (Graupp and Wrona, 2010). Several authors such as Huntzinger (2016), Grip and Sauermann (2013), Grossman and Janus (2011) and Dinero (2010) have cited Allen (1919) and argued that if an individual has not learned the work, then a supervisor has not taught the person how to do the work correctly. Therefore, it can be concluded that job instruction is related to standardized work (Feng and Ballard, 2012). This is because to standardize work mean to choose the best method out of many and use it to the best ability. Also, standardized work is a type of oriented action procedure that set a basis for job method (continuous improvement) in TPS (Fireman *et al.*, 2018).

2.2 Job method (continuous improvement)

The job method is an element of TWI, and its purpose is to help the supervisors to know how to produce the best quality product in proper scheduled time. In the implementation of TWI, the job method was focused on improving productivity by making the best use of the workers, machines and materials (Huntzinger, 2016). It should be acknowledged that the job method is like the job instruction because the workers analyse a given job task issued by a supervisor. The differences between these two methods are that the job method focused more on improving how the work had to be completed and meeting productivity (Feng and Ballard, 2012). During the application of the job method, supervisors are taught how to schedule work activities into their fundamental processes, reorganizing and simplifying activities to improve production (Graupp and Wrona, 2010). Therefore, the job method requires individuals to think about their product critically. Also, it helps supervisors to continue to improve the production service in the workplace (Kováčová, 2012). In brief, the job method is associated with continuous improvement in the production service. This assisted organizations to continually improve productivity while achieving excellence in quality (Sanchez and Blanco, 2014). The concept of continuous improvement was viewed as a principle that reduced production problems involving waste (Miron *et al.*, 2016). As stated in the previous section, a type of waste that is under investigation in this study relates to the accident and is a source of many injuries and fatalities experienced in the construction industry.

2.3 Job relation

Job relation is an element of TWI, and it relates to respect for people (RfP). Job relation requires supervisors to learn how to improve the skills needed to create a working relationship in the workplace. It endorses collaboration between employers and workers (Grossman and Janus, 2011). The relationship between the employers and the workers are significant in the workplace, especially in the construction industry. It should be known that in construction the working relationship of people contributes either to the success or failure of the projects (Koskela, 1992). Therefore, the application of TWI through job relation allowed supervisors to possess the leadership skills needed to improve the working relationships to deliver the projects (Graupp and Wrona, 2010).

During the introduction of job relations, supervisors should be able to develop a standard for an excellent working relationship (Graupp and Wrona, 2010). The adoption of job relation in the industry influences and improves the handling of individual's problems by promoting unity while treating each worker as an asset (Huntzinger, 2016). In job relations, supervisors are the leaders of the projects and are expected to promote RfP in the industry (Dinero, 2010). In brief, the term "respect for people" promotes unity and equality between management and individuals. In the workplace, individuals are encouraged to be true to themselves and management (Miron *et al.*, 2016). The philosophy of RfP is grounded in the concepts that the duty of respect is not to degrade others to the status of a mere means to an end (Ness, 2010). The outcomes of RfP in the industry will be beneficial to the project team (Dantas-Filho *et al.*, 2018).

3. Methodology

The purpose of this paper is to report on how TWI could be used to reduce OHS problems through "learning by doing" on construction sites. To realize the purpose, a mixed methods research was adopted as illustrated by Creswell (2014). The mixed methods enable the research to evolve a better understanding of the phenomenon through the collection of both qualitative and quantitative data (Creswell, 2014). The mixed methods lead to the realization of depth and breadth of knowledge. For instance, the qualitative data were collected through case studies as illustrated by Yin (2014). A multiple case-based research approach was selected to investigates how OHS can be improved using TWI on construction sites (Table I). The two case projects were selected because of the nature of the construction projects, which exposes the member of the construction projects to different hazards and risks that may cause errors, if ignored or not prevented. The selection of the projects was therefore purposive. Access to interview the member of the construction teams (general workers, artisans, supervisor, site engineers and construction managers) in the selected cases was granted. The data from the two case projects were collected using semi-structured interviews and focus group interviews. The results of the two selected case projects were similar and reflected literal replication advocated by Yin (2014). In total, 31 interviews were conducted on both case projects in which 18 interviewees participated in case project 1 (PNWPEB) and 13 interviewees participated in case project 2 (UFSSCRU).

The research survey method was used to collect the quantitative data for the study. The reviewed literature provides the basis for the formulation of the variables (questions) examined through the survey and interview. The broad concepts that form the golden thread of the questionnaires and interview protocol include human failure and TWI as defined in safety management and human factor corpus. Mixed methods assisted

Table I. Research sample

Code	Case projects	Interviewees	Response (No)	Response (%)
PNWPEB	New Warehouse on Portion in Bloemfontein	Construction manager (1) Site engineer (1) Student site engineer (1) Safety manager (1) Site foreman (1) Artisans/bricklayers (4) General workers (labourers) (9)	18	58
UFSSCRU	University Campus Residents Units	Construction manager (1) Site quantity surveyors (2) Safety managers (2) Site foreman (2) Student site supervisors (2) Artisans/bricklayer (4)	13	42
Total interviewees			*31*	*100*

researchers to understand the reported phenomenon beyond the scope of the selected projects, as recommended by Creswell (2014). For example, the questionnaire survey was submitted to the construction professionals working as construction consultants, and construction contractors in two provinces of South Africa. The survey participants were selected based on their participation in on-going construction projects at the time of the data collection. The purposive approach was used to select construction sites where participants can be identified, and access approval obtained. Once the gatekeeper (manager) for each site gives his approval, construction professionals on site were approached to participate in the study. The survey helped the researcher to investigate the causes of the OHS problems beyond the scope of the selected two case projects. The survey questionnaire was submitted to the construction professionals working in Gauteng Province and Free State Province of South Africa. Some participants were visited on their construction sites and handed the questionnaires, while other questionnaires were submitted via email (safety consultants based on site referrals). The participants were members of the consulting team (civil engineers and health and safety consultants). Also, members of the construction project team that worked for contractors (construction managers, site engineers, foremen and site safety managers) were included. The survey sample is highlighted in Table II. In total, 46 survey questionnaires were validly completed and analysed. The response per province is indicated in Table II.

The survey consisted of two research sub-questions. The first sub-question asked respondents to rate the human factors influencing people's behaviour at project sites. The

Table II. The demographic profile of the respondents

Provinces	Participants Members of the construction project team	Member of the consulting team	Responses (No)	Response (%)
Gauteng Province	10	4	14	30
Free State Province	19	13	32	70
Total participants	*29*	*17*	*46*	*100*

second sub-question asked the respondents to rate factors causing accidents on project sites. The human factors that influenced people's behaviour at project sites were adopted from the HSE report (HSE, 2009). The factors causing accidents on project sites followed the ideas explained in "The human contribution: unsafe acts, accidents and heroic recoveries", by Reason (2008). The construction professionals who participated in the research survey were instructed to answer the survey questions corresponding to an identified practice using a scale of 1-5, as illustrated by Creswell (2014). The survey questionnaire consisted of closed-ended questions. The scale was represented as follows: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. The statistical package for social science (SPSS) was used to analyse the collected data in the form of a mean and standard deviation, and results were used to rank the human factors (Table III) and accident factors (Table V) (Creswell, 2014).

The statistical survey data were supplemented by qualitative data using multiple-case projects (Table I). The purpose of using qualitative data was to help researchers to understand social issues from lived experiences of participants in a study (Tracy, 2013). The qualitative data were collected through open-ended questions, using a semi-structured instrument (Yin, 2014). The interview questions addressed how TWI could improve OHS outcomes on construction sites. The interview period was between 30 and 45 min. The research data for this study were collected between November 2017 and August 2018. The background of the study was introduced to the participants before the start of each interview. This helped the participants to understand the problem under investigation. The selection of the participants was based on a purposive sampling technique, as recommended by Tracy (2013). According to Tracy (2013), the interviewed participants should have the necessary knowledge and experience relating to a phenomenon. The interviews took place face-to-face between the researcher and the participants on multiple construction sites. Throughout the focus group meeting, the reported problem of the study was introduced to the participants. The participants were asked to have an open discussion and were given a fair chance to express their opinion without interference as recommended by Yin (2014). The interviews were recorded and later transcribed to aid analysis. The method of analysing the textual data adopted a thematic analysis technique as illustrated by Castleberry and Nolen (2018). In summary, the use of a thematic analysis provided a platform which helped the researcher to identify themes with the aim of interpretation and explanation. It is notable that any data that failed to answer a theme or respond to the reported OHS problem were deleted.

4. Research findings

The research findings presented in this paper were categorized into two themes, namely, human factors influencing people's behaviour on project sites and improving work-related safety using TWI.

The first theme highlights the quantitative data analysis. The second theme highlights the qualitative data analysis. Based on the quantitative data analysis, 63 per cent of all the respondents represented the construction team (contractors), while 37 per cent of all the

Human factors	Mean	SD	Rank
The individuals (construction workers)	2.93	1.10	1
The organization (construction firm)	2.86	1.34	2
The job (site project)	2.84	1.17	3

Table III. Human factors influencing people's behaviour on project sites respondents represented the consulting team. Also, 70 per cent of all the respondents were working in the Free State Province, whereas 30 per cent of all the respondents were working in Gauteng Province. The second theme presents the data that were collected from multiple case projects, as indicated in Table I. New Warehouse in Bloemfontein (PNWPEB) represents 58 per cent of respondents, and University Campus Residents Units (UFSSCRU) represents 42 per cent of respondents.

4.1 Human factors influencing people's behaviour on project sites

Table III shows the extent of the three human factors influencing the behaviour of people working on construction project sites. The Likert scale of 1-5 was adopted to analyse the statistical data. The survey results provided evidence that the behaviour of the individuals (construction workers) is a significant cause of human factors. This was followed by the organization (construction firm). Lastly, the Job (site project) was the lowest ranked factor that influenced the behaviour of the people on construction sites. The analysed statistical survey data indicated that it was vital for people in the industries to acknowledge the impact of human factors in the workplace. Table IV indicates the intercorrelation matrix of the three human factors presented in Table III. The intercorrelation matrix summarizes the data to determine the patterns of the data. Based on the test results in Table IV, it is indicated that the range of the organization is measured 0.28 and the individuals measured at 0.26. These range of scores are acceptable; they do not represent any biases of the data collected and while the range of the job is measured at 1.00 indicating that the data are almost repetitive.

Table V highlights the ranking of the four factors influencing accidents on project sites. It is observed that the unsafe acts of workers ranked mean is >3.00 and unsafe conditions (human-made physical events), management actions and inactions and unsafe conditions (natural physical events) ranked mean is <3.00. The unsafe acts of workers are ranked first. The unsafe conditions (human-made physical events) ranked second. The management actions and inactions ranked third, and the unsafe conditions (natural physical events) ranked fourth. Table VI indicates the internal reliability of the four factors rating the causes of accidents. The internal reliability results show that unsafe acts of workers are measured at 0.49, unsafe conditions (human-made physical events) at 0.23 and unsafe conditions (human-made physical event) at 0.17. Based on these internal results, it can be concluded

Table IV. Inter-item correlation matrix for human factors

	The job (site project)	The individuals (construction)	The organization (construction firm)
The job (site project)	1.00	0.26	0.28
The individuals (construction)	0.26	1.00	1.20
The organization (construction firm)	0.28	0.20	1.00

Table V. Factors influencing accidents on project sites

Accident factors	Mean	SD	Rank
Unsafe acts of workers	3.48	1.09	1
Unsafe conditions (human-made physical events)	2.96	1.23	2
Management actions and inactions	2.65	1.29	3
Unsafe conditions (natural physical events)	2.22	1.22	4

that the test of the three accident factors are reliable and while management actions and inactions are measured at 1.00 indicating that there the data are almost repetitive.

4.2 Improving occupational health and safety using Training-Within-Industry on construction sites

Based on the interview data, OHS problems in construction are rooted in the project supervision systems created by construction project leaders. The construction project leaders included construction managers, site engineers, foremen or site supervisors and safety managers. It was reported that the responsibility of the project supervisors in construction is to work together with the workers and to improve the organizational safety system. Project supervisors should identify, prevent and control reported OHS problems in construction (Cooper, 2002). This is however not the case all the time.

4.2.1 Job instruction. In terms of safety training or skill transfer, a site engineer in PNWPEB explained that learning or training processes were often carried out inappropriately on a construction site because most of the senior foremen are "old school". This statement meant that most senior foremen are battling to adapt to the use of modern technology to improve construction methods. One of the reasons why they are struggling to make use of technology is because they lacked the requisite educational background and as such, some of them are resistant to embrace technology. They are resisting to learn how to use technological tools to improve construction methods designed for the projects. It is surprising that individual supervisors are resistant to the use of modern technology in construction. This is because, in most developed countries, initiatives to improve OHS with technology are producing results in construction.

Moreover, some interviewees in PNWPEB and UFSSCRU explained that often senior supervisors were depressed when new industry entrants (university or college graduates) use technology with ease to improve site management. Trainee site supervisors and engineers also reported in PNWPEB and UFSSCRU that often senior supervisors did not share their knowledge and skills to the trainee due to anxiety that they might lose their jobs to the newcomers. This created tension and often trainees will experience a lack of support from some foremen and supervisors.

A construction manager in PNWPEB corroborated the statement of a site engineer in PNWPEB that often foremen and site supervisors failed to share their knowledge and skills of work with the trainees. This is because most of the foremen perceive that trainees are there to steal their jobs. The interviewee further explained that the most significant challenge that the foremen were experiencing has to do with the need to compete with the trainees using technological tools. Allegations were made that some of the foremen and site

	Management actions and inactions	Unsafe acts of workers	Unsafe conditions (natural physical event)	Unsafe conditions (human-made physical event)
Management actions and inactions	1.00	0.49	0.23	0.17
Unsafe acts of workers	0.49	1.00	0.34	0.68
Unsafe conditions (natural physical event)	0.23	0.34	1.00	0.45
Unsafe conditions (human-made physical event)	0.17	0.68	0.45	1.00

Table VI. Inter-item correlation matrix for accident factors supervisors sideline and bully the trainees on site. A site foreman in UFSSCRU responded to the allegations that they are maltreating trainees when he says:

> He finds it difficult to understand how some of the learners are thinking, especially those with university degrees. I often ask myself how some learners completed their university degrees. They approach us with the mentality that they are educated, and there is nothing they will learn from us uneducated foreman.

> Also, some of the learners are failing to understand that actual construction work is based on instructions. The foreman issues critical instructions during the execution of projects. Also, they think that the execution of work is as easy as it looks from the design drawing. They fail to understand that people in the workplace make mistakes, and often those mistakes result in loss of production, causing waste and even accidents resulting in either with injuries or fatality.

A construction manager in UFSSCRU further explained that he had several cases, where a foreman was accused of sideling, ignoring and bullying trainees in the workplace. This reported incident often put trainees in an awkward position because they were deemed to make mistakes or errors, which might result in loss of production, material waste and even accidents. Also, some interviewees, including the site supervisors, the construction manager and site quantity surveyors in PNWPEB and UFSSCRU, further explained that foremen or site supervisors are the best people to provide training to new workers on-site. This is because foreman is involved with the technical aspects of projects.

The statement of a site engineer, construction manager and safety manager in PNWPEB and UFSSCRU supported the statistical survey results in Table V. The results ranked "management actions and inactions" as the third highest factor causing accidents on project sites. Most of the interviewees explained that they were struggling to provide detailed training to their new employees as they were not allocated enough money to provide training in their workplace. Furthermore, there was no training facility allocated for the main contractors. A safety manager in UFSSCRU was quoted as saying that her team was responsible for teaching all the employees and site visitors about the safety regulations designed for the construction sites. The interviewee further explained that they were responsible for providing full personal protective equipment (PPE) clothes to all employees. The PPE clothes included safety boots, suits (overalls), helmets, gloves, ear plugs and safety goggles.

In addition, the interviewees complained that their employer is in the habit of breaking training-related problems. As a case in point, the interviewees were promised that the best-performing workers would be sent to attend a scaffolds erection training course at the beginning of a specific project. However, the promised was unfulfilled as no single worker was sent to a scaffold erection training. The reason was commonplace as management told them that they were out of the budget and they had no choice but to cancel the training scheduled for eight workers.

4.2.2 Job relations. Regarding the impact of the safety management system in the workplace. The safety manager in PNWPEB and UFSSCRU had a similar explanation that their main responsibility is to create and promote a non-hazardous working environment. An environment must not harm or cause danger to people in the workplace. A safety manager in PNWPEB emphasized that it was the rights of every individual to work in a safe, well-maintained, and protected construction sites. She further explained that there was no secret that management in the construction industry often put the lives of the workers in danger because of production and profit mandate in the worksite.

Furthermore, a safety manager in UFSSCRU and some artisans in UFSSCRU were quoted as saying that they have experienced a bad working relationship with the construction management team, especially with the foremen and site supervisors. Based on the statement of a safety manager, it can be concluded that there is a lack of a collaborative working relationship on the construction site. For example, often site agents prioritized productivity over the lives of the workers. For instance, they allocated unreasonable time for the safety team to provide safety training to the workers. Also, they experienced challenges where site agents would interfere with their training programme by rushing the safety team to finish as quickly as possible. Site agents would argue that the safety team was not finishing their toolbox in time, and these affected them negatively because they were running behind the schedules.

In other cases, the safety team will decide to stop the workers from proceeding with the activity in a case where the workers have failed to comply with the safety regulations. The site agents would often overrule such decision of stopping the activity without speaking or consulting the safety team. Most of the time, the site agents would threaten to fire the workers, compel the workers to fear them and to ignore the safety instructions and rules. One interviewee contends that:

> The workers are compelled to fear the site agents. Often the site agents issue direct instructions to the workers that they are not paid or hired by the safety manager. They need to understand who the real boss is and who has the real power to fire them.

4.2.3 Job methods. Some interviewees reported in PNWPEB and UFSSCRU that the construction management team was responsible for managing the productivity of the project. They do this by designing an effective construction method to reduce waste and continue improving production without putting the lives of people in danger. They were also responsible for teaching the employees to obey and respect the safety regulations of the construction site. However, this statement of a site engineer and a construction manager contradicts the statement issued by a safety manager in the previous paragraph.

A foreman explained that they were responsible for teaching workers to learn how to work in construction. The interviewee said that the basic rules of working in construction are to promote unity and trust. The new employees must understand that construction work is dangerous and complicated. Their decision-making abilities may either save a life or create a disaster, resulting in injury, causing accidents or even killing other workers.

The textual data reveal that without adequate on-the-job training, new entrants are vulnerable to human errors and violations. Additionally, the evidence of human errors and violations is also presented in Table V. For example, the unsafe acts of the workers and unsafe conditions are one of the factors causing human error and violation in construction. For example, a construction manager in PNWPEB said:

> The biggest challenges that the construction management team is experiencing is to teach people to know the work that they do not want to know. Most of the general workers, laborer's are working in construction because they are struggling to find the work that they desire to have. This is one of the reasons why most general workers are struggling to learn and to adapt to the construction industry.
>
> Another reason is that most of the general workers often come to work under the influence of alcohol or drugs such as 'dagga or marijuana' and this contributes to their decision-making (rational thinking) that often put their lives and the lives of other workers in danger. There are also social problems which are brought to work; they influence the performance of the workers negatively and even put them in danger.

It was discovered that the members of the construction team could not promote "learning by doing" on project sites. Several challenges were influencing inadequate training and skill transfer on project sites. The cited challenges include:

- failure to provide a suitable budget for training programmes;
- lack of training facilities on construction sites;
- failure to share knowledge and skills required by specific tasks;
- putting productivity ahead of the safety of the workers;
- lack of interest to work in the construction industry; and
- social problems brought to sites by the workers.

The general workers in PNWPEB, interviewed through a focus group of six workers, highlighted a few positive and negative comments about the safety practice. Regarding PPE, the interviewees explained that their company had invested heavily in it. For example, they have never run out of PPE clothing. In addition, safety managers always carried out weekly safety awareness through toolbox talks. During the toolbox talks, the safety manager explained the safety risk assessment of every activity they will be working on during the week. They also explained that safety officers and representatives inspect them during the week to audit if they comply with the safety risk assessment plan issued for specific tasks.

The interviewees further explained that they were often put in an awkward position, primarily when there was tension between safety and construction team. They explained that the tension between the two parties affected them negatively because they were both their superiors and they could not afford to disobey them. Tension often arises when the foreman asked them to ignore safety rules so that they can finish the activity on time. This statement corroborates the statement issued by the safety manager that workers were often compelled to ignore safety instruction and rules.

5. Discussion

OHS is a problem that the construction industry must address (Misiurek and Misiurek, 2017; Perlman *et al.*, 2014). The previous section confirms that human factors influence individual behaviours on a typical construction site. According to the HSE (2009), the human factors related to environment, organization and job factors and human and individual characteristics which influence behaviour at work in a manner that affect the OHS negatively. Cooper (2002) says that safety culture was the sub-components of corporate culture and referred to the ranking factors of individuals (construction workers), organization (construction firm) and job (construction project). These three factors affect and influence the health and safety of people in the worksite, primarily individuals. It can be concluded that human factor issues contribute to OHS problems at least in part, through the actions or omissions of people in the workplace (HSE, 2009). The accident could be traced to the safety culture adopted by people in the workplace.

As elaborated earlier, the accident is an unplanned incident that results in either a minor or major injury, or even fatalities (Manu *et al.*, 2012) and that it could emanate from systemic failure situated in human actions (Reason, 2008; Perlman *et al.*, 2014). The statistical results of the unsafe acts of workers and the unsafe conditions (human-made physical-event) corroborate the suggestion by Reason (2008) who says an act need be neither an error nor violation, but it can still turn out to be unsafe and produce accidents. According to Smith *et al.* (2017), unsafe acts of the workers have become a symptom of deeper potential problems on site because management system often influences the results of the unsafe conditions which causes a human error in construction. For example, a construction manager in this reported study said that most of the general workers often come to work under the influence of alcohol or drugs such as marijuana and this contributes to their decision-making (rational thinking) that often put their lives and the lives of other workers in danger. There are also social problems that are brought to work. These problems influence the performance of the workers negatively and even put them in danger. For instance, people often tend to think that safety outcomes are the only goal in the system that must be reached by individuals in the workplace (Dekker, 2014). They tend to forget other factors that influence the system (such as economic pressures). The economic pressures included project schedules, competition, customer service and the public image of the organization (Dekker, 2014). For example, the mentioned factors relating to the economy contributed to the causes of human failure linked to accidents (HSE, 2009). Also, the lack of job security in the construction industry may have compelled most of the foreman to keep knowledge and skills of the work to themselves, especially when dealing with the management of people. This attitude often resulted in injuries and accidents in the workplace. This statement explains why most researchers have reported that work-related accidents, injuries and illness remains a severe problem in construction (Park and Kim, 2013; Awwad *et al.*, 2016; Yoon *et al.*, 2013; Fernández-Muñiz *et al.*, 2017). Fernández-Muñiz *et al.* (2017) elucidates the problem of a bad working relationship that often safety leadership produce negative outcome on work pressure and a positive outcome on environmental conditions and occupational hazards and safety encouragements.

Therefore, it can be concluded that the accident causation pathway is complicated and could occur because of human failure. For instance, it was reported in Table III that human factors influenced the behaviour of people. This could be concluded from the individuals (workers), job (construction activities) and organizations (construction firms). Further, the rating of the causes of accidents in Table IV indicated that the unsafe acts of workers were rated as the highest factor for causing accidents. Human failure is just a single event that requires other conditions to result in an accident, rather than enough cause by itself (Hollnagel, 2005). Therefore, a lean construction tool may be adapted to find answers to the reported phenomenon.

Regarding "learning by doing", Reese (2011) explained that the impact of "learning by doing" is to provide a pathway for new employees to learn from experienced employees (foremen, site engineers and construction managers), as compared with learning from watching others perform, reading other's instructions or listening to other's lectures. Huntzinger stated that the philosophy of the TWI method promotes "learning by doing", which implied solving problems with the guidance of a properly trained supervisor (Huntzinger, 2016). Therefore, it is important to understand the results of training people in the workplace. In all industries, most of the knowledge and skills that people used to do their jobs were acquired at the workplace through "learning by doing". The statement issued by a safety manager that they were struggling to provide adequate training because of budget allocation, was explained by Allen (1919). The author said that providing training placed an overhead charge on the organization. It was also reported that contractors were not allocating enough budget to provide safety training to the workers. Instead, they only allocated budget to design the safety system, employ safety management team and to buy PPE clothes. It can be argued that most of the project supervisors also known as mentors to the trainees are failing to acknowledge training by intention (Allen, 1919). Failure by the trainees to gain knowledge and skills from their mentors might be one of the reasons why the industry is struggling to improve OHS results.

Pfau (2005) explained the problem of learning at work. The author explained that learning at work often happens accidentally, poorly and sometimes in ways harmful to both an individual and the organization. The perception that "learning by doing" often occurred poorly, was supported by several interviewees in this study. The interviewees reported that "learning by doing" do not happen on their project sites. This statement of the interviewees contradicts the philosophy of TWI. The interviewees indicated that their employers fail to provide training to their new employees. For instance, it was reported by one member of the construction team, coded as UFSSCRU in Table I, that their company cancelled a training course scheduled to teach general workers how to erect scaffolding, because of financial difficulties. This statement of the interviewees supports the statement of Dekker (2014) that economic pressure contributed to human failure in the workplace.

It is also reported that there is often tension between safety managers and construction manager. The tension was because the site agents often put the lives of the workers in the danger while chasing high productivity. Also, site management could because of work pressure compel workers to ignore safety instructions. According to Allen (1919), the idea that a man that is good enough for the work is good enough to be a supervisor in the workplace will only lead to trouble. It can be concluded that not all foremen have the skills and ability to lead or instruct the workers in the workplace. It is true that the acts or decision-making by management in the construction industry often put the lives of the workers in danger. For instance, it is indicated in Table V that management actions and inactions were ranked as one of the four factors causing accidents on project sites.

6. Conclusions

It can be concluded that OHS improvement is needed in construction. This is because of the widespread OHS problems articulated in this discourse on human failure. The discourse reiterates the notion that the unsafe acts of the workers and the unsafe conditions of their work leads to accidents on project sites. The unsafe acts and conditions contribute to human failure, which causes an accident in the construction industry. This paper proposes the utilization of TWI to reduce OHS problems in construction. The elements of TWI in the form of job instruction, method and relation offer platforms for site management to revitalize existing SMS on sites. These elements would assist site management to learn how to overcome the reported challenges influencing inadequate training and skill transfer in construction. This is because TWI would promote learning by doing in construction. For example, site managers must learn how to make the best use of the workers, machines and materials to meet their production target. Concepts inherent in TWI should be deployed to revise a failure to provide a suitable budget for training programmes, the lack of training facilities on construction sites, a failure to share knowledge and skills required by specific tasks and putting productivity ahead of the safety of the workers.

This will help management to promote 'learning by doing' on their construction sites. Learning by doing should be promoted in construction for its labour-intensive nature of work. The ethos of TWI should also help new workers, especially the general workers to have the skills and knowledge of construction work and to promote a safe working environment. The learning by doing impact on construction sites will not only set a pathway for new workers to learn from experienced workers but also set a pathway to improve the work behaviours of workers regarding OHS and the well-being of people working in construction. Therefore, it can be concluded that TWI could be adopted by site management to improve OHS on construction sites. This process of improving OHS on sites would be achieved through learning by doing. Learning by doing would allow site management to transfer the knowledge and skills to construction workers in favour of better safety performance.

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