

**OCCUPATIONAL SAFETY AND HEALTH HAZARDS ASSOCIATED WITH  
REHABILITATION OF SEWER RETICULATION PLANTS; A CASE OF DRAWCARD  
CONSTRUCTION COMPANY SITES IN REDCLIFF, ZIMBABWE**

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**Abstract**

*This research examined the occupational safety and health hazards associated with rehabilitating sewer reticulation plants at Drawcard Construction Company sites in Redcliff, Zimbabwe. The study used a descriptive research design which triangulated both quantitative and qualitative approaches. Questionnaires, interviews and field observations were used to gather primary data on occupational safety and health hazards associated with rehabilitating sewer reticulation plants. Secondary data was obtained through company's site Safety, Health and Environment (SHE) documents, Occupational Safety and Health (OSH) journals, newspaper articles, and past research papers. Data was analyzed using the Statistical Package for Social Sciences version 20.0 (SPSS). The major findings from this research showed that failure to identify hazards; inadequate training; inadequate PPE and shortage of portable running water were the main causes of high prevalence of biological, physical, ergonomic, chemical and psychosocial hazards amongst workers in the study area. The research revealed that OSH accidents have negative effects to employees, their families and the organization. Measures that have been put in place to reduce the impacts of the hazards include job rotations, safety and awareness training, safe working procedures, PPE, work and equipment inspection. However, these have not been effective in managing hazards as accidents are still prevalent amongst workers. The research recommends that medical surveillance should be done to ensure fitness of workers at the sewer plants.*

**Key Words:** *Accident, Occupational safety and health, Sewage reticulation, Rehabilitation*

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**Introduction**

Biological hazards such as typhoid and cholera attributed to poor management of sewer reticulation plants that treat waste water and supply clean water have claimed many lives. According to Manayiti (2018), sewer reticulation equipment has an average life span of 15

years and from this period pipe systems succumb to deficiencies as a result of system aging and structural failure. Before industrialization, wastewater was directed to rivers but due to increase in population it became more imperative to develop sophisticated techniques for the efficient collection of discharged untreated

wastewater for public health, aesthetic, public recreation and economic reasons (Brewer Maine, 2018). Population increase affect the carrying capacity of many sewer systems. To effectively and efficiently manage these sewer systems there is need for regular maintenance and rehabilitation of sewer plants to avoid pollution from leakages. Globally, the rehabilitation of sewer reticulation plants has significantly risen, as the desire to reduce pollution, sustainably manage and conserve water at all cost has become a paramount goal (Research Corridor, 2017). This contributes to a rise in the prevalence of accidents amongst workers during the rehabilitation processes. The fact that sewer rehabilitation works are undertaken by contracting construction companies which are usually project based increases the number of work-related accidents and illness. This is so due to the desire of completing projects within a specified time frame hence worker safety becomes compromised.

Major hazards faced during sewer rehabilitation works include chemical, ergonomic, biological, physical and psychosocial hazards. Accidents have an immense impact on a nation's economy as they result in loss of productive hours, loss of money through compensation, skilled manpower, and affliction to the victims as well as their families (Hyrnak and Peregoncalez, 2007). In developed countries, the prevalence of OSH accidents associated with rehabilitating sewer reticulation plants is lower compared to less developed countries. This is mainly because better rehabilitating techniques and necessary working conditions are met in developed countries. In Germany and China, they use the trenchless sewer rehabilitation whereby damaged pipe systems are

repaired without excavation thus reducing the exposure to hazards and accidents (International Labour Organization, 2014). In Australia, during the construction and maintenance of sewer reticulation plants, workers are exposed to trench collapses, drowning, working in confined space, falls and exposure to harmful hydrogen sulfide or chlorine gas. These resulted in contusions, sprains, bruises, musculoskeletal injuries, nausea among other reported illnesses. Theobald (2016), states that severity and frequency of sewer work related injuries is reduced through pro-active monitoring and regular maintenance of sewer reticulation systems.

Unlike in most African countries, South Africa has a strong Waste Water Treatment Policy which has strict regulations that safeguard the safety and health of sewer workers thus reducing accidents in sewer rehabilitation works (Small Waste Water Treatment Design, 2012). In Southern African countries such as Zimbabwe, Mozambique and Malawi, sewer rehabilitation works exposes workers to worst unhealthy working conditions, for example, direct exposure to human faecal matter (Tiwari, 2008). Redcliff has a severe water and sanitation crisis as the municipality's sewage treatment plants have not been functional for the past three years. In pursuit of rectifying this problem, the United States Water Reticulation Resources has sponsored for the rehabilitation of Redcliff's Reticulation plants. These are situated in three different sites namely; Redcliff, Torwood and Rutendo. Bio digesters in sewer reticulation plants are confined spaces, filled with muddy sludge rich in hydrogen sulphide and methane which are highly flammable and toxic to human life when inhaled. According to

Drawcard’s February 2018 OSH Statistics reports, 10 Medical Treatment Cases, 4 Lost Time Injuries and 9 First Aid Cases were recorded during the month. These statistics were mainly of diarrheal outbreaks; dislocating ankles from sinking in sludge, mires, sewage ponds; skin rashes (dermatitis); back aches from awkward postures in the bio digesters, a confined space; falls from heights among other hazards. It is against this background therefore that this study seeks to analyze the OSH hazards associated with rehabilitating sewer reticulation plants.

**Study Area**

Redcliff is a small town that is found in the Midlands Province of Zimbabwe. It

is located approximately 10 kilometers south west of Kwekwe town. Redcliff lies in agro ecological region 3 and receives moderate rainfall of about 650 – 800 mm per year. The area experiences warm conditions with an average annual temperature of 25 degree Celsius. The area around Redcliff is underlain by Archaean rocks of the Basement Complex. Redcliff is extremely rich in iron and has a hilly terrain with a ridge that separates Torwood and Rutendo. The dominant vegetation includes *Heteropogon*, *Aristida* and *Hyparrhenia* grass species as well as the *Brachystegia colophospermum* and acacia tree species.

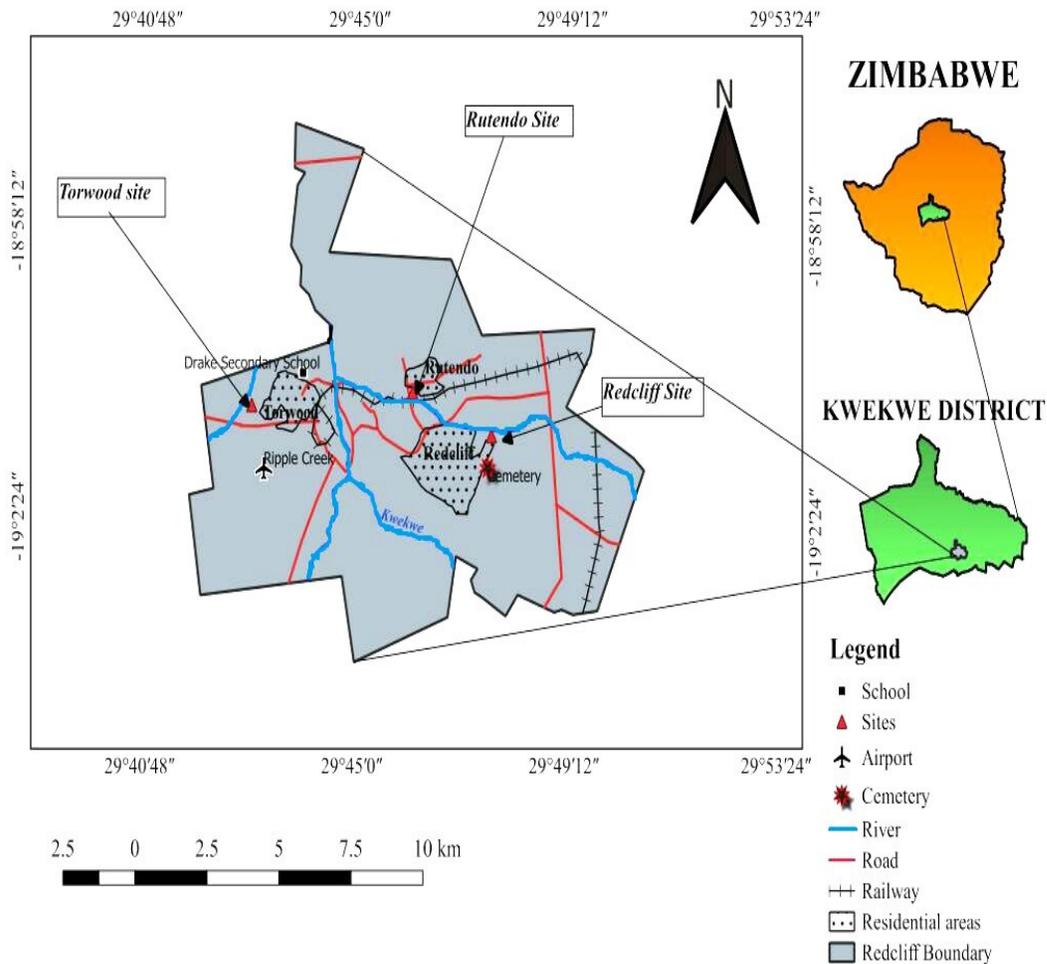


Fig. 1: Map of Drawcard’s construction company sites at Redcliff

There are four residential areas in Redcliff namely Redcliff, Rutendo, Torwood and Simbi Park. Gold panning, buying and selling of gold; coal; scrap metal; vegetables and small groceries are the dominant economic activities in Redcliff. Furthermore, few grocery, butchery and clothing shops are the only outlets open for business. Redcliff, exhibits severe symptoms of infrastructure deterioration indicative of low investment. The town has witnessed a decrease of its population as a result of the shutdown of a major firm, Zisco Steel in the early 2000 following the disputed fast-track land reform program which led to international sanctions imposed on Zimbabwe, severely debilitating the country's economy. This led to lowering of living standards of the majority resulting in high male out migration.

### **Materials and Methods**

The researchers employed the descriptive research design that triangulated both qualitative and quantitative approaches. Mixing both approaches enhances the quality of results and allows for corroboration, complementarity and expansion of results. Field surveys were carried out between 13 January to 20 July 2018 using a combination of qualitative and quantitative methods. The target population comprised of employees from Drawcard Management, SHE and HR departments at Drawcard Redcliff Project, NSSA, Redcliff community leaders and public respondents from the area close to the sites.

The stratified random sampling technique was used to determine the sample size and a proportional sample of 70% was allocated to each subgroup in relation to the size of its population. A

sample size of 88 was selected from a target population of 120. The researchers self-administered 78 questionnaires to sewer workers in their varying sub-groups using the stratified sampling technique. Saturation sampling technique was employed to solicit information from 10 households within 300m radius from the working sites as this was considered close enough for residents to feel the impact of OSH hazards associated with rehabilitating sewer reticulation plants. Questionnaires were used to gather data on types of OSH hazards incurred, effects of the hazards and the effectiveness of existing OSH measures put in place by Drawcard at the working sites. Purposive sampling technique was used to select representatives from Drawcard SHE, Management and HR departments as interviewees.

Semi-structured interviews were purposively carried out with the Site Manager responsible for ensuring workers safety and signing all safe procedures and safety health documentation; SHE Officer responsible for trainings, inspections and implementation and maintenance of site safety and health systems; Human Resources Manager responsible for enrolling and keeping records of workers; community leaders of Redcliff, Torwood and Rutendo because they possessed information on baseline conditions of the area before site operations started hence they were best positioned to give information on types and effects of hazards associated with rehabilitating sewer reticulation plants. Direct observations were used to compliment and compare data from questionnaires and interviews.

Qualitative data that was collected using interviews and open-ended questionnaires was subjected to content

analysis to check for relevancy. Quantitative data collected using closed ended questionnaires was coded and analyzed using SPSS version 16.0 and was presented in the form of bar graphs and tables. Statistical tests of significance were done using the SPSS package and was presented using tables. The researchers observed a set of principles that govern research including seeking consent before carrying out data collection and assuring research participants that the provided information was solely for academic purposes.

## **Results and Discussion**

### ***Biological Hazards***

Figure 2 indicates that biological hazards had the highest frequency (45%). This is mainly due to the fact that sewer plants are the hub for pathogenic, bacterial and viral diseases a situation also observed by Chingwere (2015) in a separate study conducted in Redcliff. The respondents explained that during desludging, pipe rehabilitation, dewatering process, plumbing works and re-opening existing manholes, workers are exposed to raw sewer which results in respiratory, skin and gastro intestinal disorders. Sludge drying beds often provide habitats for insects and other wild animals such as rodents and snakes which exposes workers to zoonosis due to bites from wild animals and enteric infections transmitted by insects an observation also made by Poole and Basu (2017). The SHE officer revealed that exposure was mainly through inhalation of dangerous fermented sewage in bio-digestors and through accidental oral ingestion via splashes into the mouth. This was supported by the NSSA inspector who added that stomach pains, skin rashes and headaches are inherent to workers in

sewer plants. The risks of biological infections amongst sewer workers are very high with 47.5% of respondents confirming once having work-related diarrhea and skin rashes. Another contributing factor to biological hazards was inadequate sanitary facilities and lack of running water to wash off contaminated PPE thus the high record of biological hazards.

Residents surrounding the sewer reticulation plant in Torwood also revealed that biological hazards were the dominant hazards in their residential area as sludge droppings from sludge contaminated vehicles have been noticed. Furthermore, the town Engineer supported and added that cases of sewer back-flows due to Drawcard's failure to complete its tasks on time have been recorded. Thus, residents are exposed to biological hazards emanating from these sewer pools.

### ***Physical Hazards***

As depicted by Fig 2, the second most prevalent type of hazards are physical hazards (35%). These include noise, heat or cold stress, burns, cuts from sharp objects such as sharp edges of tools, broken bottles and corroded scrap materials around the sites, being struck by falling and or moving objects, electricity shocks, fires and falls. Theobald (2016) and OSHA (2009) stated that slips and trips are the most common hazard sewer workers experience in rehabilitating sewer plants. In a study carried out at Kisumi sewer rehabilitation project in Kenya, 60% of the workers reported that cuts, bruises and contusions were the major types of injuries caused by physical hazards. This was the case at Drawcard's Redcliff sewer plants, SHE accident reports as well as response from questionnaire survey results revealed that

cuts, bruises and contusions were the major types of injuries and they resulted from poor housekeeping around the sites thus workers succumb to these types of injuries.

Residents from Torwood and Rutendo who live within 300m radius from the sites revealed that physical hazards were also prevalent in their residential areas.

Unguarded open trenches left by Drawcard Redcliff employees and poor housekeeping contributed to a number of trips and falling into pits cases in the residential areas. Another physical hazard revealed in an interview by the city Engineer was excessive noise from plant machinery and vehicles.

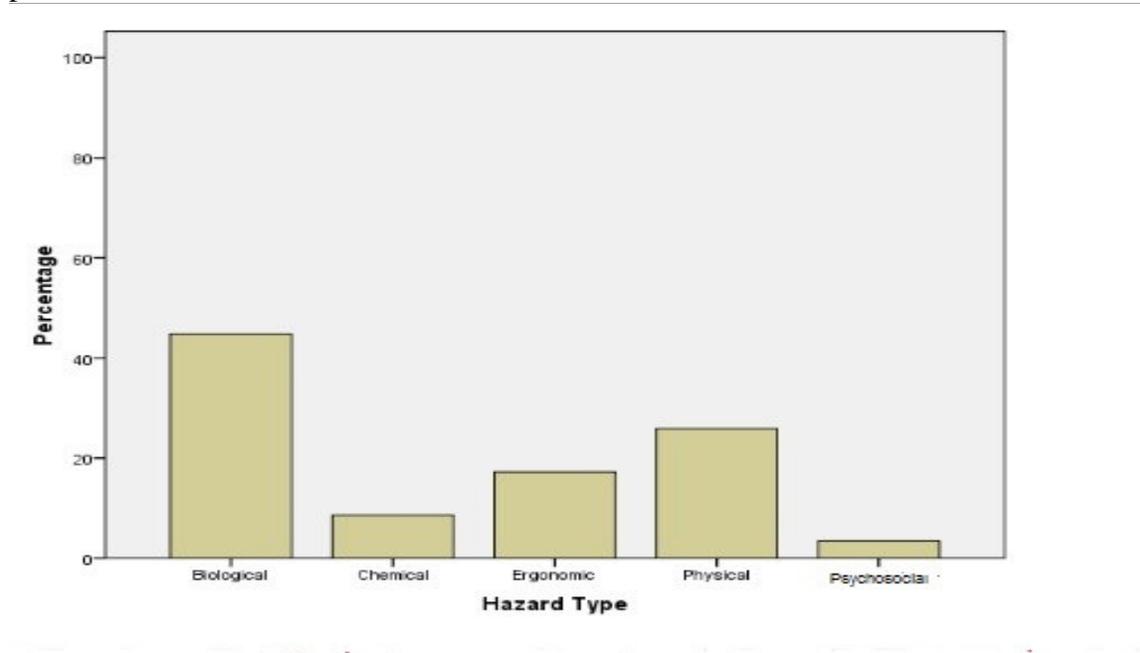


Fig. 2: Types of Hazards

### ***Ergonomic Hazards***

Questionnaire responses revealed that 17% of workers experienced ergonomic hazards which resulted in acute back pain, strains and painful joints (Figure 2). Ergonomic hazards were more common among plumbers and general hand workers who worked in confined spaces and were regularly exposed to awkward postures during execution of their day to day tasks. Ergonomic hazards among general hand workers were amplified during activities such as manual lifting, pushing, pulling, and offloading of materials and maintaining awkward postures during excavation works.

Interview responses from the SHE officer showed that workers mostly suffered from back aches due to lifting heavy loads, work overload and shortages of mechanical aids at the working sites.

### ***Chemical Hazards***

During the survey, 10% of the respondents revealed that exposure to chemical hazards is mainly through presence of various gases such as methane, hydrogen sulphide and ammonia in sewer environment. This finding concurs with Tiwari (2008), who observed that these gases react to form more toxic gases and they are more concentrated in confined spaces. Workers in confined

spaces succumb to asphyxiation. Chlorine is another chemical hazard that is used in sewer treatment. Gaseous chlorine is extremely dangerous to lungs. Responses from questionnaires indicated that workers are exposed to chemical hazards through inhalation and skin contact with chemicals. Workers were affected by chemical hazards during working in confined spaces such as bio digesters, pipes and manholes as well as when using or handling chemicals such as paints, tile adhesives among others.

#### ***Psychosocial Hazards***

Drawcard Redcliff workers are also exposed to psychosocial hazards though in rare cases (5%). Psychosocial hazards such as stress, work overload, harassment, fatigue, public perceptions of working in a sewer environment and the little to no rewards for the monotonous work are prevalent amongst sewer workers. Society discriminates people who work in sewer environments and in some cases, they avoid physical contact with them as they are perceived to be sewer contaminated or carriers of different forms of bacteria in the sewer plants (Brophy, 2011). This view was supported by the workers and surrounding residents through data collected from questionnaires as well as from interviews. The majority of workers attributed stress to late remunerations and the current economic crisis. An interview the NSSA inspector confirmed that sewer gases and fumes cause psychosocial hazards as they cause headaches which increases occupational stress among workers.

#### ***Effects of Occupational Health and Safety Hazards Associated with Sewer Plants***

Figures 3A and B show the effects of OHS hazards associated with rehabilitating sewer plants. Occupational hazards have detrimental effects to the victim, the victim's family and the organization. The immediate effect that occupational hazards have is injury and illness. Injuries could be temporary or permanent depending on their severity. Injuries and illness bring about a lot of effects to both the victim and the organization. Injuries and illness have the greatest effect to the victims at the sites. As a result, they lead to stress and marital and financial problems to the victim and the victims' family. An interview conducted with a worker at one of the sites revealed that permanent injuries lead to psychological, financial, social and marital problems. A study carried out in the United Kingdom by Tiwari (2008), showed that cases of post-traumatic stress disorder, anxiety and depression were the major effects of occupational injuries. OSH injuries lead to delayed completion of tasks, reduced production, loss of skilled personnel which tarnishes the organization's image. OSH hazards have long-term effects to victims which in most cases are realized later in life. Such hazards include excessive noise which causes hearing loss, exposure to chemicals and biological pathogens which could cause cancer, hepatitis B. Thus, OSH hazards have detrimental effects to both the organization and the workers.

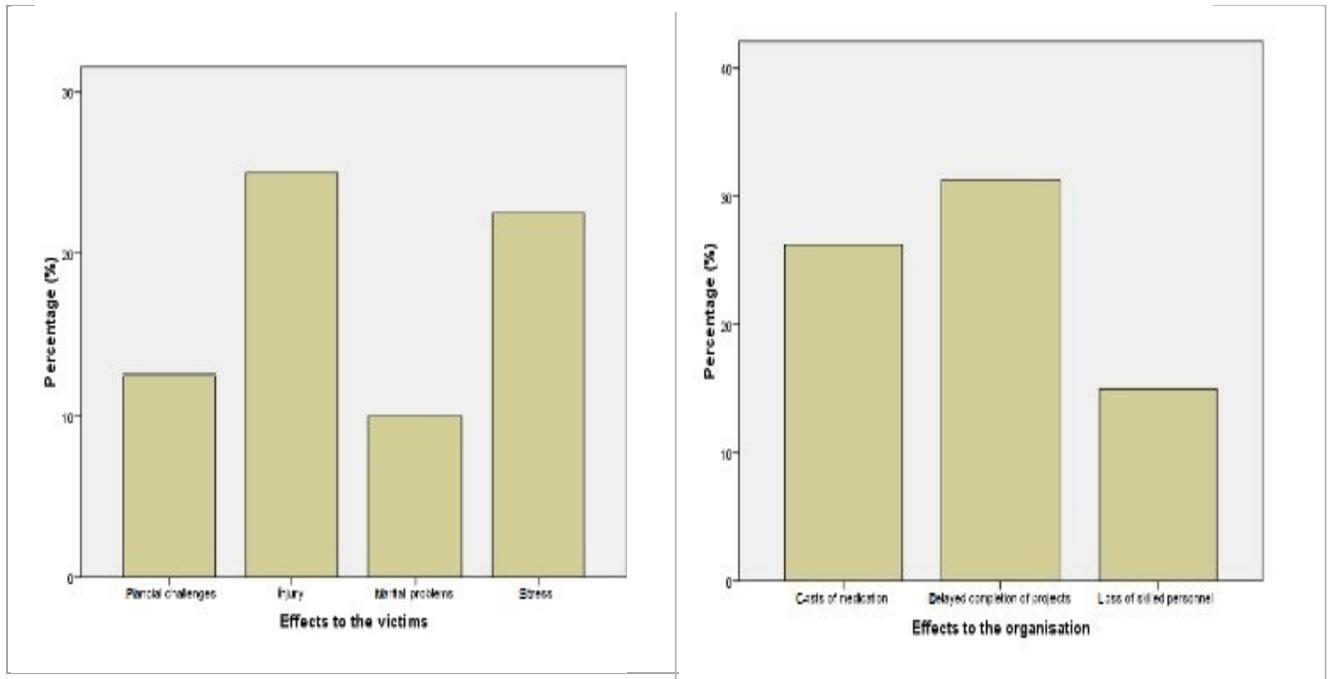


Fig. 3A: Effects of OSH hazards to the victims.

Fig. 3B: Effects of OSH hazards to the organisation

### ***Effectiveness of Existing Measures***

The measures that Drawcard has put in place to combat the impacts of OSH hazards include safety and awareness training, PPE, rotating tasks to reduce extreme exposure to the hazards, Work inspections, completion of pre-tasks risk assessments, appraisal on good acts, accident reporting and investigating, and implementing and monitoring adherence to safe working procedures. However, despite the effort made to curb the effects of OSH hazards, accidents remain prevalent at the sites.

### ***Frequency of Occupational Training and Occurrence of Injuries***

According to Rout and Sikdar (2017), training of workers is an effective tool in managing the occurrence of occupational injuries and illnesses. Chi-square test results ( $p=0.64$ ) showed that there is no association between frequency of training and frequency of injuries at work place. This means that safety trainings do not

reduce the number of OSH injuries and illnesses because trainings alone do not stop occupational accidents. An interview with the SHE officer indicated that some injuries such as cuts, bruises and backaches are not recorded due to lack of knowledge, inadequate SHE personnel monitor the working conditions. This is also worsened by the fact that the sites are not located at one place, hence employees tend to forget to report accidents when they have contact with the SHE officer.

Chi-square test results ( $p=0.01$ ) showed that there is a relationship between provision of PPE and the occurrence of injuries at workplace. This means where inadequate PPE is provided exposure to hazards also increases hence more accidents. The researchers observed that some workers at the Torwood site did not use or wear their PPE while carrying out their tasks. An interview with one of the workers revealed that overalls were not comfortable to work with in such a hot

environment. Malakahmad *et al.* (2012) echoed the same sentiments that PPE helps to reduce biological, chemical and physical hazards amongst sewer workers.

#### **Clarity of Strategies Used by the Management in Ensuring Safety at Workplace**

Among those who agree that the strategies are not clear, 28 % strongly

agreed. The researchers then noted that in as much as the management wanted to solve safety and health related issues associated with the workers, their strategies are not clear which resulted in more accidents at work. Fig 4 shows responses given by the employees in relation to the clarity of strategies being used at work.

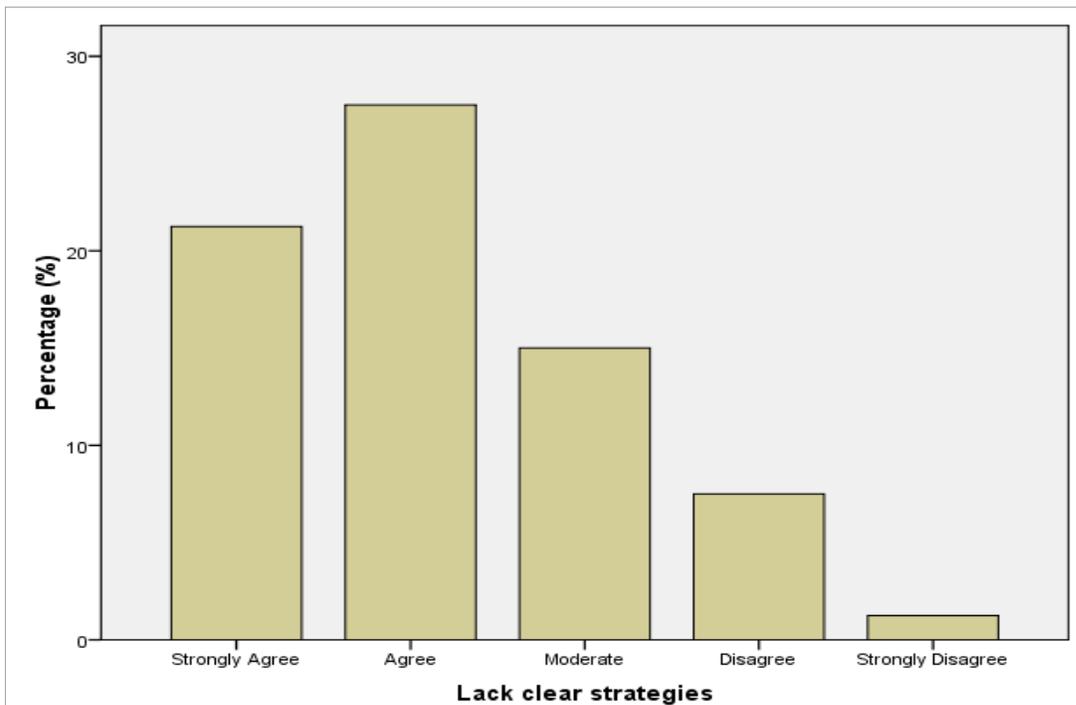


Fig. 4: Clarity of strategies used by the management in ensuring safety at workplace

The strategies that Drawcard has put in place are quite effective, however, there is need for reviewing of the strategies so that they become clearer to workers. This will help in reducing OSH accidents and illnesses at Drawcard Redcliff Project.

#### **Conclusion**

OSH implementation and strict adherence to OSH management systems is vital for any organization's productivity and healthy workforce with regards to creating an accident free workplace. In view of the results obtained, workers at

Drawcard Redcliff Project encountered a myriad of biological, physical, ergonomic and chemical with a few cases of psychosocial hazards. Findings have indicated that workers did not follow hazard identification and risk assessment process thus workers were exposed to injuries and illnesses. The major cause of OSH problems at the Drawcard Redcliff Project was absence of adequate SHE personnel at working sites to assist with carrying out regular inspections, monitoring sound implementation of SHE strategies, conducting regular awareness

and training sessions with employees. This has impacted heavily on managing of occupational safety and health hazards as the SHE system is more reactive rather than proactive hence workers succumb to many hazards. Occupational injuries and illness have long-term effects which are in most cases not fully compensated as they not only affect the workers but the family as well. Results from the study revealed that OSH accidents cause stress, financial challenges and permanent disability. A close investigation on the effectiveness of measures Drawcard put in place to curb existing hazards has showed that the measures are not very effective hence there is need to improve. The major safety intervention at the sites was use of PPE which is basically the last form of defense in the hierarchy of accident control as it does not eliminate hazards. Job rotations were quite helpful as pointed out by the SHE Officer. Interventions proved to be ineffective because Drawcard Redcliff was not consistent in providing regular trainings, monitoring and adequate protective equipment which are the basics of attaining an accident free working environment.

### **Recommendations**

In light of the above findings, the research makes the following recommendations:

- The National Social Security Authority (NSSA) should conduct more regular site inspections, OSH awareness campaigns, offer affordable safety trainings and to cater and all interested stakeholders.
- The management of Drawcard Construction should recruit more qualified SHE personnel to assist in the day to day implementation and

monitoring of OSH issues to reduce accidents.

- The top management at Drawcard should apportion an adequate budget to cater for SHE needs for the entire site from a project's commencement up to its decommissioning. This will ensure ready and adequate provision of SHE resources which will help to reduce biological hazards at sites.
- The management at Drawcard Redcliff project should subject workers to periodic medical tests before and during the project so as to maintain a healthy workforce through detecting diseases at earlier stages, earlier treatment and removal from tasks that expose victims to inherent danger.
- Drawcard should embark on regular safety talks and campaigns so as to keep the people aware of potential dangers likely to be faced in the field. Inspections should be done throughout the day and if any worker is found misbehaving, he/she should be heavily fined.
- The SHE department through the SHE officer should prioritize the development and communication of the hazard profiles, for example, through safety signage.

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