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HAZARD PREVENTION AND RISK CONTROLS IN CONSTRUCTION SITES AND EQUIPMENTS

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Abstract:

The construction industry is an important part of the economy in many countries and is often seen as a driver of economic growth especially in developing countries. Owing to its relatively labor intensive nature, construction works provide opportunities for employment for a wide range of people skilled, semi-skilled and unskilled. The findings of the study show that all responsibility on risk management is with the contractor, and it is carried out only during construction phase. Statistic has shown that the number of fatality and permanent disablement cases due to accident at the Indian construction sites is one of the highest as compared to the other sector. Even though the number of industrial accidents decreasing but the benefits paid to the accidents victims are ever increasing. Hence, there are three basic steps that should be taken namely identifying the hazard, assessing the risk and controlling the risk to ensure a safe and conducive working condition. Implementation of effective hazards control methods may require different approaches due to changing of working environment at the construction sites. Therefore, this document is intended to identify and highlights the hazards that are most commonly founded in construction sites. The data collection was being carried out through site investigation using a structured questionnaires form regarding hazards in construction. The sites vary from infrastructure works, high rise building, housing development, industry building and institutional building. The study based on the various major groups of hazards in relation to works at construction sites such as power access equipment, ladder, roof work, manual handling, plant and machinery, excavation, fire and emergency, hazardous substances, noise, protective clothing and protection to public. The study was conducted on various construction sites and the results showed that the most common hazards for the project around the study area are associated with the protective clothing, noise and fire and emergency.

Key Words: Compliance, Construction Workers, Health and Safety & Project Performance

1. Introduction:

Sterling & Wilson was formed in 1927 as Wilson Electric Works and subsequently became Sterling & Wilson in 1971 when the Shapoorji Pallonji Group. With a 90 year presence in the industry, S&W has established itself as a trusted EPC solution provider in the infrastructure and energy space in India and overseas. Our diverse portfolio includes MEP, Co- Gen solutions, Transmission and Distribution, Turnkey Data Centers, Diesel Generators, and Renewables – namely Solar, Wind and Battery Storage solutions. In addition to this, S&W also has a dedicated team that offers Operation and Maintenance services for its clients. Since its inception, S&W has shown exceptional growth. With operations all over the globe as well as an expansion in its range of services. From being a predominantly India-focused company till 2010, S&W now operates across the globe in more than 25 countries with a strong presence in regions such as the Middle East, Africa, Europe, the Americas and Australia. With manpower strength of more than 4600 people from 20 different countries, S&W is today a leading home- grown multinational EPC company Development of safety for personnel in construction environment is recognized as a major factor for tranquility of staff and should be adhered precisely in accordance safety regulations. Despite the mechanization, the construction industry is still based on labor intensive, while working environments are often changing and include several different parties. The construction workers are one of the most vulnerable members in a project and are faced with a wide variety of hazards during their work. A common approach for prevention of construction accident is to predict the upcoming event under given circumstances.

The accuracy of such predictions is based on knowledge about past accidents. It has been proved that the main reasons for accidents in the construction industry are resulted from the unique nature of the industry, human behavior, difficult work-site conditions, and poor safety management which result in unsafe work methods and procedures. The main purpose of this paper is to identify main factors which contribute to safety development and provides a continuous approach to reduce risk and potential hazard of elements by six stages which will be discussed later. For the purpose of this study, at first the causes of accident are explained from literature. The second part describes the eight factors influencing safety performance level in construction project and finally an applicable approach is discussed to obtain safer workplace.

2. Literature Review:

Summary of Literature:

Ravi Patel, Urvesh Barot, Keyur Shah [1], in this paper Construction Industry in India and other developing countries faces a wide range of challenges, one of which is the frequent occurrence of accidents in the work areas. This Paper presents results of a research that concentrated on investigating causes of accidents on construction projects in India. During the last few years several accidents have occurred on various construction projects all over the country, of which have been fatal. The main

focus of studying this topic is to identify the major reasons which are responsible for occurring construction site accident & their mitigate measures. Method which will help to management to understand the problem. The main purpose for prepare this study is to identify the factor affecting for construction site accident, also guideline for avoiding them.

Eduardo Diniz Fonseca, Francisco P.A. Lima, Francisco Duarte [2], the construction industry is responsible for one of the highest incidences of work-related accidents in Brazil, as well as in various other countries. In spite of the dissemination of prevention programs and the proposals for developing safety design for the construction industry, construction sites remain dangerous and unhealthy places. Recently, safety has been proposed to be considered from the development phase of the design (Construction Hazards Prevention through Design), but with little effectiveness in practice. In addition to these more recent proposals, we will demonstrate that the integration between safety and production can proceed through anticipations occurring at several levels of the construction phase, not only in the design phase. Through narratives emerged through techniques of activity analysis at the construction site, it was possible to highlight and categorize 25 cases with implications for the production process development. The results show that this integration between production and safety is possible through anticipations occurring at several levels of the construction phase, from the design analysis conducted by the construction engineer to the implementation. This will allow the development of design situations for implementing safe work situations. The contribution and originality of this paper are based upon the presentation of a model in three levels of anticipation of problems during the construction phase and its effects on improving production and safety.

KA Shamsuddin, MNC Ani, AK Ismail, MR Ibrahim [3], the construction industry involves risky and unhealthy operations which result in many human tragedies, discourage workers, disrupt construction, delay progress, and adversely affect cost, productivity, and reputation. Construction managers focus mainly on productivity in terms of cost, quality, and time. Construction project can never achieve its objectives unless construction professionals become aware of the safety-related issues. Workers working in the construction industry are incessantly bared to unsafe working conditions and have to confront several kinds of hazards. This embraces exposure to sound, dust and toxic substances, issues of ergonomics, stress etc. Every construction should involve in safety practices to reduce injuries in their respective sites. Workers behavior is an extremely important factor in workplace safety as many accidents are often caused by insecure actions, in which combinations of human behavior are the consequence of such perceptions. The Occupational Safety and Health Act were passed in 1970 to protect employees by stating that employers have a legal obligation to provide their employees with a safe working environment safety protection in construction area.

This is especially important in construction, as there are a number of hazards and risks to site workers that are experienced every day. All parties with full support of Malaysia government should play major roles and responsibilities by making sure that appropriate safety practices are carried out to minimize the accident rates in the construction sites. Accidents in construction sites are unplanned occurrence involving movements of person, objects or materials which may result in injuries, damages and losses to properties or human. The majority of accidents happen as result of unsafe acts and unsafe condition. Since all hazards in construction are not always possible to be identified and eliminate therefore through effective accident investigation, construction accidents can be prevented just by identifying the main root cause of those accidents. The main objective behind this paper was to create awareness among construction workers about various safety-related protections in the construction industry.

W. A. Asanka and M. Ranasinghe [4], As the construction industry is carried out in hazardous environments, it experiences accidents in differentlevels of severity, some causing minor and major injuries with even some resulting in fatality. In addition to the human cost involved, it also causes bad publicity to the profession. Worldwide, authorities have tightened up safety standards, which have enhanced the performance in construction sites. However, accidents are still happening and there is a need for further research on this important subject. From construction organization's point of view, accidents are unexpected events and unplanned costs. Some accidents may change the organizational goals or it could even make the company uncompetitive in the industry. A good understanding of accident forecasting is vital in construction project management. This research explores four questions that arise in accidents in construction sites. Namely, (1) What are the impacts of accidents on construction work? (2) What are the uncertain contributory factors in these accidents? (3) How are human and financial aspects linked to accidents? (4) What are the possible project performance enhancements under uncertainty factors of the accident? The objectives of this research paper are (i) to investigate construction site accidents to identify the critical causes and effects; and (ii) establish relationship of accidents with additional project cost, additional time, project scope, company reputation, and impact on national safety indexes. While human errors were identified as the main cause for construction accidents, negligence or mistakes can happen due to the uncertain circumstances. Hence, unavoidable accidents have to be expected in the construction industry. The commitment of all humans involved, from the project manager to the laborer towards good practices would enhance the safety performance in construction sites.

Raymond Kemei, Julius Nyerere [5] Construction accidents don't just happen, they are initiated by unsafe acts, unsafe conditions or both. The construction industry in Kenya plays a vital role in achieving social and economic development goals, providing shelter, infrastructure, and employment. A study was carried out to identify the common accidents in construction sites and to examine the characteristics of the injured and deceased workers and evaluate factors that cause these accidents in Nairobi County, Kenya. The study cross examined data from Directorate of Occupational Safety and Health (DOSH) from Nairobi County ranging from 2010-2014. The study also utilized on-site questionnaires that were administered to 60 contractors in 9 administrative regions in Nairobi County. They constituted all class NCA2 contractors in the county as well as a few NCA3 and NCA4 contractors. Some 41 questionnaires were returned. Accidents were classified by the age of workers, time and month of the accident, location of an accident, causes of accident and management factors affecting the accident. The study established that 65% of all reported accidents occurred to workers below 37 years old. The accidents peaked between tea break (10am), lunch

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break (1pm) and after lunch (3pm) and during the months of June and July. The study determined that most construction site injuries were as a result of workers falling from heights (37%), being hit by falling objects (28%) and accidents occurring as a result of workers operating equipment (20%). Relative Importance (R.I) index of construction hazards were calculated for 24 factors contributing to construction site accidents. The top five hazards identified were: (1) reluctance to provide resources for safety (0.820); (2) lack of staff training (0.814); (3) lack of a safety policy and enforcement of safety regulations (0.795); (4) poor safety consciousness among workers (0.766); and (5) lack of strict operational procedures (0.756) in construction sites. The study concluded that in order to improve safety in the construction industry, each company should have a health and safety policy which is to be implemented in each contract. Furthermore, construction companies need to provide workers with the necessary Personal Protective Equipment (PPE), such as safety belts, retaining belts, safety ropes, and safety harness, and catch nets to prevent workers from being hit by falling materials and to secure them against falling from heights.

3. Problem Identification:

Hazard Identification:

The construction industry has been identified as one of the most hazardous industries in many parts of the world, as measured by work-related mortality, workers' compensation, injury and fatality rates. Accident is the main issue to consider in any industries, construction industry is no exception. It is a high-risk industry that covers a wide range of activities involving construction, modification, and/or reparations There are three major factor which affecting project EHS performance i) human factor ii) physical condition iii)management factors and analysis the incident happened at multiple construction industries. Due to the above risk in the construction sites the new method called risk management systems its work on the principle by converting log indicator to lead indicator techniques by the program like C++ and java by this technique we can prevent the human error and enhance the safety.

Causes of Accidents:

Nowadays statistics of accident in construction industry encourage researchers to find new way for improving or enhancing safety performance in construction industry. Furthermore, both of direct and indirect cost of accident adds more expenses to construction projects that are because of improper safety performance in construction site. Most of these accidents near 99 percent are caused because of unsafe act, unsafe condition or both. In order to improve safety performance in construction industry we require to identify the root causes of construction accident. This kind of equipment and machineries, site condition, nature of the industry, management attitude and method, and human elements can directly influence the safety performance in construction industry. Working at height, in adequate safety devices, poor management, lack of obedient on site, negligence of worker, and employing unskilled worker is so common in construction industry that cause to increase the risk of accident and making damage and injuries. The stated that the causes of accident are related to worker turnover and wrong act, lack of safety performance, unsuitable or unclean materials, no maintenance tool, and weak supervisory and inspection.

On the other hand, we can divide the causes of accident to human and physical factors. Human factors are related to personal duty and responsibility such as neglect to use protective equipment, utilizing machines and equipment without permission, rushing in operating and doing work, personal factors, service moving and energized equipment, remove safety device, select unsafe position in working, utilizing improper equipment and other unsafe act. While, physical factors were addressed to wrong act of another person, unconsidered to accident source, disregard to special procedure, clothes hazard, environment hazard, fire hazard, wrong method or arrangement, assignment of personnel in wrong position, no safety guard in site and other unsafe condition. the cause if the accident in construction site is directly related to inadequate safety regulation, no force to use the regulation in site, no safety consideration by personnel on site, no encourage professional people to work in site, mechanical problem of construction machinery and equipment, and chemical or physical disturbance. We can exhibit the cause of accident according above statement in fishbone model.

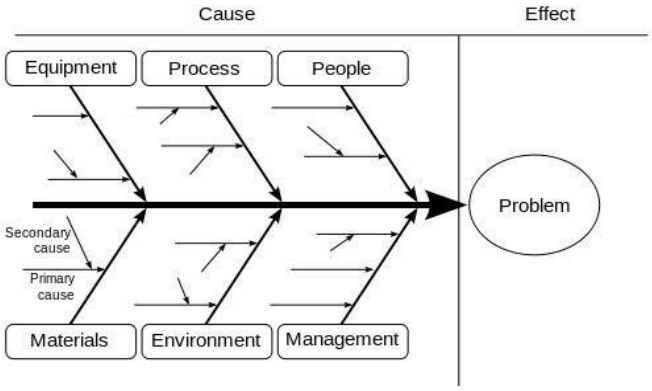

Figure 1: Root Causes of Accident

Major Factor for Accident:

There are three major factors which affecting project EHS performance

- Human factor
- Physical condition
- Management factors and analysis the incident happened at multiple construction industries.

Causes of Accident by Human Factors:

According to accidents are caused due to poor safety awareness, lack of training, lack of organizational commitment,

poor technical supervision, uncontrolled operation, unwillingness to input resources for safety, shortage of skilled labor, unsafe equipment, lack of first aid facilities, lack of safety regulations, lack of personal protective equipment, lack of innovative technology, and poor information system. Physical hazards are present in every construction project. These hazards include noise, heat and cold, radiation, vibration and barometric pressure.

Construction work often must be done in extreme heat or cold, in windy, rainy, or foggy weather or at night. Ionizing and non-ionizing radiation is encountered, as are extremes of barometric pressure. The machines that have transformed construction into an increasingly mechanized activity have also made it increasingly noisy. The sources of noise are engines of all kinds (e.g., on vehicles, air compressors and cranes), winches, rivet guns, nail guns, paint guns, pneumatic hammers, power saws, sanders, routers, planers, explosives and many more. Noise is present on demolition projects by the very activity of demolition. It affects not only the person operating a noisemaking machine, but all those close-by and not only causes noise-induced hearing loss, but also masks other sounds that are important for communication and for safety.

Pneumatic hammers, many hand tools and earth-moving and other large mobile machines also subject workers to segmental and whole-body vibration. Heat and cold hazards arise primarily because a large portion of construction work is conducted while exposed to the weather, the principal source of heat and cold hazards. Roofers are exposed to the sun, often with no protection, and often must heat pots of tar, thus receiving both heavy radiant and convective heat loads in addition to metabolic heat from physical labor. Heavy equipment operators may sit beside a hot engine and work in an enclosed cab with windows and without ventilation. Those that work in an open cab with no roof have no protection from the sun. Workers in protective gear, such as that needed for removal of hazardous waste, may generate metabolic heat from hard physical labor and get little relief since they may be in an air-tight suit. A shortage of potable water or shade contributes to heat stress as well. Construction workers also work in especially cold conditions during the winter.

The principal sources of non-ionizing ultraviolet (UV) radiation are the sun and electric arc welding. Exposure to ionizing radiation is less common, but can occur with x-ray inspection of welds, for example, or it may occur with instruments such as flow meters that use radioactive isotopes. Lasers are becoming more common and may cause injury, especially to the eyes, if the beam is intercepted. Strains and sprains are among the most common injuries among construction workers. These, and many chronically disabling musculoskeletal disorders (such as tendinitis, carpal tunnel syndrome and low-back pain) occur as a result of either traumatic injury, repetitive forceful movements, awkward postures or overexertion. Falls due to unstable footing, unguarded holes and slips off scaffolding and ladders are very common.

Carelessness of the Workers:

In this case, both the workers and the supervisor might be convinced that the risk is low. Its human nature to assess risk based on experience, so each time you take a risk and don't get injured, it reinforces the idea that the task was safe or the risk was too low to matter. Young workers, such as apprentices, may be prone to take more risks to prove they are good workers or they may be less likely to speak up about hazards. Because of these factors, young workers tend to have higher injury rates. The challenge for safety professionals is convincing people to take precautions for risks they may never encounter, but are nonetheless very real dangers.

Figure 2: Carelessness of the Workers

Labeling a worker's injury as mere carelessness oversimplifies a complex issue. Workers are often constrained by their environment or employer just as supervisors are often asked to balance safety with productivity. Rather than blame the worker or blame the employer, we should be examining the root causes on both sides that led to the incident. The next step is examining the incentives that promote unsafe behavior and finding ways to stop positively reinforcing unsafe actions. Changing behavior is never easy. It's not as straightforward as setting strict rules and enforcing them, since this can lead to people obeying the rules when management is watching and ignoring them when they are not. Rules have to make sense for workers to buy in and follow them. As much as possible, rules also should not interfere with the job or productivity. If so, people will be pressured to cut corners. Understanding the human aspects of safety takes time, but in the long run, may prove more effective than the top-down command and control model so prevalent in construction today. Workplaces are getting safer, but we are never going to reach our goal of zero injuries and fatalities until we understand why people do what they do. Only then can we address the root causes of unsafe decisions.

Persons Fall Due To Poor Concentration:

The poor concentration in construction site is very impact for human. The Centers for Disease Control and Prevention states that falls can happen in all occupational settings, and "circumstances associated with fall incidents in the work environment

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frequently involve slippery, cluttered or unstable walking/working surfaces; unprotected edges; floor holes and wall openings; unsafely positioned ladders; and misused fall protection.

Figure 3: Persons Fall Due To Poor Concentration

"To reduce the risk of falling at work, CCOHS recommends paying attention to your surroundings and walking at a pace that's suitable for the surface you're on and the task you're performing. Additionally, walk with your feet pointed slightly outward, make wide turns when walking around corners and use the handrails on stairs.

Ignorance of PPE:

In the safety world hazard recognition plays a vital role in keeping your people safe from unsafe behaviors and/or conditions. Some hazards are easily recognized, for example an employee climbing up a 20 foot ladder with tools held in both hands. At a minimum, each employee is required to wear a hard hat and safety glasses. High visibility safety vests with reflective striping are required when employees are exposed to vehicular traffic.

Figure 4: Ignorance of PPE

In the absences of vehicular traffic, high visibility shirts should be worn at all times. All workers must wear shirts with sleeves, long work pants, and sturdy work shoes or boots when working on a construction or renovation site. Sleeveless or tank top shirts, short pants, sweatpants, sneakers, sandals, and high-heeled or open-toed shoes are not permitted.

Failure to Follow Safety Rules:

Failures by employers or contractors to follow state and federal safety regulations too often result in death or injury to workers, or even to worksite visitors or passersby.

Falls from High Heights or Scaffolding:

Fall hazards are present at most worksites and many workers are exposed to these hazards on a daily basis. A fall hazard is anything at your worksite that could cause you to lose your balance or lose bodily support and result in a fall. Any walking or working surface can be a potential fall hazard. Any time you are working at a height of four feet or more, you are at risk. OSHA generally requires that fall protection be provided at four feet in general industry, five feet in maritime and six feet in construction. However, regardless of the fall distance, fall protection must be provided when working over dangerous equipment and machinery. The importance of fall protection cannot be stressed enough. Fall hazard incidents are injuries produced by impact between the injured person and the source of injury when the motion producing contact was generated by gravity. Fall hazards in construction cause accidents such as the following: A makeshift scaffold collapsed under the weight of four workers and their equipment, seriously injuring all four. A worker carrying a sheet of plywood on a flat roof stepped into a skylight opening and fell to the level below. A roofer, while attempting to remove a roof opening cover, fell approximately 21 feet to the concrete floor below and was killed. A construction worker was working from a carpenters' wall bracket scaffold without fall protection. The worker fell 19 feet to the ground, sustained blunt trauma to the head and later died. Construction workers are often required to work at very high heights, on scaffolding and ladders, in windows and on roofs. A fall is categorized when a person is injured after falling or jumping from a ladder, scaffold, building, roof, or other elevated place or working area landing, with impact, on the ground or surface below According to the Bureau of Labor Statistics, these accidents account for 34 percent of all on-the-job deaths of construction workers.

Causes:

- Unprotected roof edges, roof and floor openings, structural steel and leading edges, etc.
- Improper scaffold construction

- Unsafe portable ladders
- A safe system of work for scaffold dismantling was not provided
- The tubular scaffold was not horizontally and securely erected on the inclined floor
- The worker overstretched his body from the working platform resulting in the imbalance of the tubular scaffold
- The steel plate underneath the tubular scaffold failed to balance and secure the scaffold
- The overall structure of the boatswain's chair was unsafe The whole structure was not inspected by a competent examiner before use
- The fall arrestor and independent lifeline were not properly installed, thus failing to prevent the worker from falling

Slips, Trip and Falls:

From stray tools and materials to uneven ground or holes, there are many hazards on a construction site that could lead to a dangerous slip, trip, or fall. Slips happen when there isn't enough friction or traction between your feet and the surface you're walking on. Common causes of slips include wet or oily floors, spills, loose or unanchored mats, and flooring that lacks the same degree of traction in all areas, CCOHS states. Trips happen when your foot strikes an object, causing you to lose your balance. Workers trip due to a variety of reasons, including clutter in walkways, poor lighting, uncovered cables, drawers being left open and wrinkled carpeting or rugs. To help prevent slips and trips, CCOHS recommends the following:

- Clean up spills immediately. If a spill can't be cleaned up right away, place "wet floor" warning signs for workers.
- Keeps walkways and hallways free of debris, clutter and obstacles.
- Keep filing cabinets and desk drawers shut when not in use.
- Cover cables or cords in walkways.
- Replace burnt-out light bulbs promptly.
- Consider installing abrasive floor mats or replacing worn flooring.
- Encourage workers to wear comfortable, properly fitted shoes.

Falls:

The Centers for Disease Control and Prevention states that falls can happen in all occupational settings, and "circumstances associated with fall incidents in the work environment frequently involve slippery, cluttered or unstable walking/working surfaces; unprotected edges; floor holes and wall openings; unsafely positioned ladders; and misused fall protection. "To reduce the risk of falling at work, CCOHS recommends paying attention to your surroundings and walking at a pace that's suitable for the surface you're on and the task you're performing. Additionally, walk with your feet pointed slightly outward, make wide turns when walking around corners and use the handrails on stairs.

Causes:

- spills of liquid or solid material
- wind-driven rain or snow through doorways
- change from wet to dry surface
- dusty and sandy surfaces
- the incline of a ramp low light levels
- use of unsuitable footwear , with wet, muddy, greasy or oily soles
- Wet or greasy floors, Loose flooring, carpeting or mats
- Uneven walking surfaces
- Missing or uneven floor tiles and bricks
- Damaged or irregular steps; no handrails
- Electrical cords or cables
- Ramps and gang planks without skid- resistant surfaces
- Metal surfaces – dock plates, construction plates

Electrocutions:

Due to the fact that construction sites are a work in progress, there is often exposed wiring, power lines, and unfinished electrical systems around. Coming in contact with these could lead to electrocution or shock. In many of the electrocutions, electrical workers and other construction workers touched metal objects that had become energized through contact with live electrical equipment and wiring or with overhead power lines. Thus, 42 (12%) of the electrocutions of electrical workers and 88 (32%) of those of other construction workers that involved electrical wiring and equipment involved these contacts. The most common contacts were with metal ladders, metal pipes, metal wires that were deliberately cut or stripped or were accidentally cut by electric drills or other tools, wires that were energized by contact with live wires, and energized trucks and other vehicles.

Electrocutions as a result of metal objects contacting overhead power lines involved 26 electrical workers and 167 of other construction workers. The most common examples involved metal ladders, cranes, aerial lifts, trucks or heavy equipment (such as water well drillers, backhoes, concrete pumpers and dump trucks), wires, metal poles, and metal scaffolds or scaffold parts. Working in cramped areas was a contributing factor in 97 electrocutions (6%), about 8 deaths per year. For electricians, working in attics or above drop ceilings was a risk and for other construction workers, working under houses, in basement crawlspaces, or in attics. Standing in water or having equipment such as trouble lights and extension cords touching water was a contributing factor in at least 51 electrocutions. Low voltage (600 volts and under) was involved in the electrocutions of at least one-third of electrical workers and one-quarter of non-electrical workers. At least 14% of all electrocutions involved 120/220 volts (household current). (The voltage was not known in more than one-quarter of electrocutions.)

- Electrocution when Using Hand Tool
- Electrocution when Carrying Out Electrical Works

Causes:

- The workplace was damp and with water pools
- The electric saw was not properly earthed
- The power socket was not fitted with any residual current device (commonly known as earth leakage circuit breaker)
- There was leakage current from the electric saw
- The power supply had not been disconnected before the works were carried out
- The insulations of some of the wires had been damaged Injuries type Shock, Burns, Falls due to contact with electricity, Electrocution (death)

Struck By Object:

Struck-by injuries are produced by forcible contact or impact between the injured person and an object or piece of equipment. Having said that, it is important to point out that in construction, struck-by hazards can resemble caught–in or –between hazards.

- Struck-by flying object
- Struck-by falling object
- Struck-by swinging object
- Stuck-by rolling object

Causes:

- The catastrophic failure of equipment on the oil rig
- Objects falling off the rig's superstructure, the tops of tanks, building roofs, scaffolding, aerial lifts, cranes and forklifts can strike employees working nearby
- tripping pipe in and out, the derrick man or the floor hands
- Semi-tractor trailers, crew trucks, service vehicles, end loaders, excavators and forklifts can pose

Falling Debris, Materials or Objects:

A construction worker injured by falling debris, materials, or objects at a construction site should call an experienced personal injury lawyer for a free consultation. When mandatory construction site safety rules are followed such "accidents" do not generally happen. On construction sites, objects do not fall from the sky absent negligence. On projects with multiple levels, it is common for falling tools, building materials, or beams to strike workers below.

- A metal bar falling from height
- Bricks falling from height
- Metal pipes falling during lifting operation
- Formwork panels being knocked over
- Toppling over of precast concrete building unit

Causes:

- The metal bar was liable to fall as it was placed at the window edge on an upper floor
- The falling of the metal bar might be inadvertently caused by someone at work
- No secure fenders/bracings had been installed at the external wall of the building near the podium
- The concrete bricks were neither properly stacked nor securely tied
- The platform of the hoist was not installed with any enclosures to prevent loose materials from falling during lifting
- The frame of the hoist was unfenced
- The metal pipes were not properly tied before lifting
- The materials were lifted past an area where workers were working
- The lifting operation was carried out despite insufficient communication between the crane operator and signaler
- The vertically placed panels lacked sufficient support and proper storage to prevent them from toppling over by accident.

Getting Caught In-Between Objects or Materials:

According to OSHA, caught-in hazards collectively are one of the four deadliest dangers found on a construction site. Although it seems like common sense to never place yourself between a piece of heavy equipment and an immovable object, when you're concentrating on the job at hand sometimes you find yourself in unexpected danger. Here are some tips to prevent becoming a victim of caught-in/between accidents. Construction sites are filled with heavy machinery, tools, and materials. Often, workers find themselves stuck in between immovable objects, machinery, or fallen debris.

- Trapped During Lift Maintenance
- Caught between a vehicle and another object,
- Pinched between equipment and the rig's substructure, and
- Crushed between a load of pipe that fell off a trailer and forklift.

Causes:

- The stopping switch in the machine room as well as the emergency stop
- switch and the maintenance switch on the maintenance work
- No warning sign was posted to warn other people not to use the lift

- work involving moving equipment
- inadequate training or preparation
- completing a task under physical or mental pressure
- being absent-minded
- working with unreliable machinery

Fires and Explosions:

Because of unfinished piping, leaking gases, and incomplete electrical systems, fires and explosions are a common occurrence on construction sites. Data from the Occupational Health & Safety Administration (OSHA) indicate that there are on average 36 fire and explosion deaths per year in the construction industry. From underground gas lines to temporary heating devices to electrical systems, construction sites in South Carolina are full of hazards that can turn a day's work from routine to explosive in an instant.

Causes:

- The use of flammable liquids
- Welding or abrasive cutting techniques used in places not specially prepared for such works
- Liquid gases used with an open flame;
- Flammable and combustible materials (e.g. petroleum, timber and packaging).
- Gas leaks;
- Chemical leaks;
- Electric sparks/malfunction;
- Welding;
- Static electricity;
- Combustible dust;
- Lack of training/negligence;

Over Exertion:

Hours of hard labor, often in extremely hot or humid conditions, can cause workers to overexert themselves and even fall victim to heat stroke accidents. The condition can lead to dehydration, exhaustion and reduced mental clarity. Simple mistakes can lead to devastating accidents that can quickly end the lives of one or more individuals. Overexertion is a major cause of construction accidents, and is possibly involved in far more accidents than has been reported. Recognizing and handling overexertion when it occurs is extremely important to avoiding serious accidents. Some of the signs of overexertion include fatigue, dizziness, significant sweating, chest pain, weakness, and sore muscles, tightening of muscles, a burning sensation, nausea and excessive thirst. Overexertion is the No. 1 cause of non-fatal injuries according to a study carried out by The Center for Construction Research and Training overexertion creates stress on the joints and muscles in the body. Other ways overexertion injuries happen is because of repeated bending at Take the time to position your body correctly before you lift or move anything. It only takes a few seconds to position yourself correctly in order to prevent an overexertion injury form occurring. Bend at the knees when lifting. These will reduce the strain that is put on you back when lifting heavy objects. The waist and poor posture. These strains happen and can result in stretched or torn muscles. Construction workers are very susceptible to this type of overexertion, especially when they work outside on days that are hot and humid. Overexertion can be avoided, by taking breaks, staying hydrated, and using proper lifting and other techniques to reduce body stress.

Causes:

- Reaching over the worker's head;
- Working in small spaces;
- Reaching and leaning to pick up objects;
- Shoveling dirt, rocks, or other materials; and
- Bending over to grasp objects.
- Overexertion occurs when the load, whether lifted, carried, pushed, pulled or otherwise handled, exceeds the limits of the human joint system doing the work

Machinery Accidents:

Construction workers use a lot of heavy machinery in their work. From cranes and bulldozers to jackhammers and nail guns, an error or accident with these tools can be very dangerous. Making a single mistake while operating construction machinery can result in a very serious injury or even death. Some of the worst construction accidents are caused by heavy machinery malfunctions. The most catastrophic construction accidents involving machinery often result in life changing injuries such as amputations, traumatic brain injuries and even death. Surviving family members who've lost a loved one due to a machinery accident at a construction site may be able file a wrongful death lawsuit against whoever was responsible for making sure this type of accident does not occur. Construction equipment and machinery is often to blame for construction worker accidents. Actually, not the equipment itself, but those who designed it, maintained it, or used it improperly. Forklifts accidents, backhoe accidents, scissor lift accidents, masonry machinery accidents, hydraulic jack accidents, crane accidents, front-end loader accidents, boom accidents --- all these and many more construction machines and equipment cause innumerable accidents and injuries every year in New York and elsewhere. But almost all circumstances, these accidents are not just "accidental". They are caused by someone's negligence or carelessness. Construction machinery and equipment is safe only when (1) it is designed and manufactured safely; (2) the workers who use the construction equipment and machinery are properly trained and supervised; (3)

the workers who use the construction equipment and machinery do so safely and properly; (4) the construction equipment and machinery is properly maintained; and (5) the construction equipment and machinery is equipped with proper warnings.

Causes:

- Accidents and injuries caused by faulty or unsafe work equipment.
- falls from height due to defective or unsuitable ladders, working platforms or scaffolding
- Injuries caused by sharp edges or broken parts on work equipment
- Injuries sustained whilst using work equipment without proper protection
- work accidents and injuries caused by lack of proper training to use work equipment
- Injuries caused by the unsafe use of work equipment
- Workplace injuries caused as a result of unsuitable work equipment Injuries type
- Amputations, traumatic brain injuries, hand and bone fracture

Trench Collapses:

Trenches are often a necessity on construction sites. If a trench collapses while a worker is inside, it could cause them to be hit with tools, machinery, or materials or bury them in the surrounding dirt. Trenches have been used and formed by people for hundreds of years for many different purposes including, agricultural uses, and installing utilities and pipelines. The construction of trenches is not simply digging in the soil, as it comes with risks and hazards. Some of the feared dangers associated with Trench construction are the trench collapses, cave-ins and side wall collapses. There are also some invisible dangers of trench contractions are asphyxiation inhalation of toxic fumes and suffocation. Out of these risks, trench collapse is the frequently happened incident on construction sites. If a Trench collapse happens unfortunately it does cause a lot of injuries to the workers digging the trench. Such injuries include broken leg or arm, death due to lack of oxygen when weight of collapses trench is on the buried worker leaving very little or no space for the proper supply of oxygen. Construction workers working on trenches face high risk of Trench collapse dangers and there are many reasons contribution in Trench collapses. Some of the commonly recognized reasons are that trench walls are not supported by shoring or trench boxes, trenches dig on previously disturbed soil, vibration of the land around the trench area due to the vehicles running too close to the trench, unsafe distance between spoil pile and the lip of the trench, dried trench walls that make trenches weak and heavy rain falls.

Occupational Safety and Health Administration (OSHA) has many rules to minimize the Trench collapses and risks associated with it. For example as per OSHA regulations trenches deeper than five feet must be shored for support; this is because of the fact that most of the Trench collapses happen in trenches less than 12 feet deep. While most employers hesitate to use supportive trench boxes due to the added cost and put the lives of labors at higher trench collapse risks. Trench collapse incidents should not be taken lightly but there should be effective trench collapse preventive measures. Trench collapse risks can be minimized by shifting the soil weight away from the trench opening. Trench collapses can also be minimized by placing trench sheets on both sides of the trench. The party responsible for carrying out construction work for trenches should carefully examine the soil conditions should employ a person qualified in trench safety to carry out tests to ensure there are no poisonous gases inside the soil prepared for trenches. The responsibility to reduce risks associated with trench collapses lies on the shoulders of both employer and workers. It is wise if both undertake necessary training on trenches collapse before executing work for the construction of trenches.

Causes:

- Moving machinery near the edge of a job site excavation can cause a collapse of a wall within the excavation.
- A rainstorm or flooding from a broken water main could increase the risk for injury.
- Improper shoring or bracing can cause catastrophic injury to workers.
- Contact or sever underground utility lines.
- Flooding;
- Improper shoring;
- Equipment defects;
- Machinery resting dangerously close to the trench;
- Inadequate safety equipment; and
- Poor digging.

4. Causes of Accident by Physical Condition:

Light (LHT): Light linked to visibility related accident in workplace. In some occasion, insufficient lighting and blind spots can cause accidents. Sometimes glare reflected from equipment and tool can disrupt visibility in a person field of vision causing run over accidents.

Weather (WTH): Working environment and variety of natural phenomenon can cause fatalities on site, as most of these are unpredictable. This includes rain, wind, earthquake, flooding and landslides.

Sunlight (SUN): Working under direct sunlight for a long period of time may cause heat rashes, heat exhaustion, and heat stroke. This could lead to a more serious health-related issues, and accident.

Ventilation (VEN): Working in an enclosed space with no ventilation making it hard to breathe.

Dust (DUS): Dust that builds up when cutting, drilling or grinding material on the construction site can cause serious effects inside the body if exposed to for a long period of time.

Noise (NOS): Frequent exposure to high level of noises either from the environment or from equipment can cause hearing damage.

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Layout (LAY): Inadequate space or difficult entry to perform a certain tasks was recognized as 15% of the accident studied therefore leading this to one of the major case whereby the delivery vehicle partially overturned due to the lack of sufficient room to extend the stabilizers.

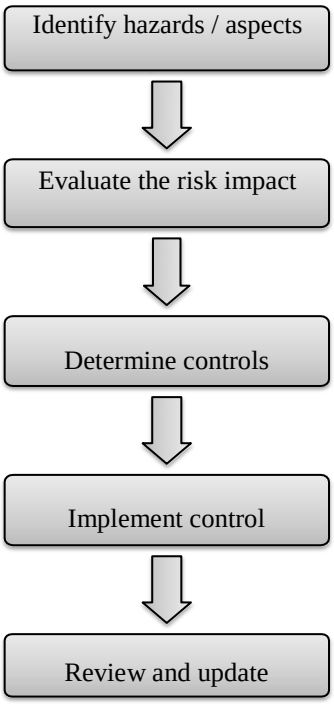
Electrical Hazard (ELC): Electrical hazard causes 44% of all fatal electrical accidents from all industry. Mismanagement and poor protection of electrical system leads to fatalities.

Vibration (VIB): Working with operating machine or equipment that vibrates at a high frequency could cause workers to become exhausted and stagnant.

5. Effects of Accidents in Construction Site:

As the construction industry is carried out in hazardous environments, it experiences accidents in different levels of severity, some causing minor and major Injuries with even some resulting in fatality.

6. Risk Assessment Process:



EHS Risk Management Process

Step 1: Identify Hazards / Aspects

The first step involves the identification of hazards / environment aspects associated with the activity. The following points shall be taken into account while identifying the health & safety hazards and environmental aspects:

- Activities of all persons having access to the workplace;
- Human behavior, capabilities and other human factors;
- Hazards originating outside the workplace capable of adversely affecting the health and safety of persons under the control of the organization within the workplace;
- Hazards / aspects created in the vicinity of the workplace by work-related activities under the control of the organization
- Infrastructure, equipment and materials at the workplace, whether provided by the organization or others;
- Changes or proposed changes in the organization, its activities, or materials;
- The design of work areas, processes, installations, machinery/equipment, operating procedures and work organization, including their adaptation to human capabilities during this process, identify the particular hazard or aspect (source / situation/ act) and ascertain the possible outcome and people at risk.

Step 2: Evaluate the Risk / Impact

The risk evaluation shall be done by

- Identifying the existing risk control measures;
- Determining the likelihood of occurrence (probability);
- Assessing the potential severity of the health & safety hazards, environmental aspects;
- Ascertaining the risk / impact level based on the likelihood and severity

Likelihood of Occurrence (Probability):

Probability Descriptions (The highest category will always be used)		
Value	**Status**	**Description**
4	Very Likely	The event is almost certain to occur and has occurred repeatedly in the construction industry
3	Likely	The event will probably occur in most circumstances
2	Unlikely	The event may occur only in exceptional circumstances

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1	Very Unlikely	Very unlikely but remotely possible

Severity Probability Description:

Severity Descriptions (The highest category shall always be used)	
Value	**Result of Hazard to Personnel / Environmental impact**
4	Fatality
3	Reportable Injury or illness resulting in more than 2 days off work / Permanent Total isability /Major Pollution
2	*Non-Reportable Lost Time Injury or Illness resulting in less than 2 days off work
1	Injury or illness requiring First Aid treatment. Minor Pollution

Matrix for Risk Assessment:

- Once the likelihood and severity have been established, the risk / impact level can be determined.
- To determine the risk / impact level, select the appropriate row for Severity and the appropriate column for Likelihood; the cell where they intersect indicates the Risk / Impact Level.

Probability (P) \ Severity (S)	1	2	3	4
1	1	2	3	4
2	2	4	6	8
3	3	6	9	12
4	4	8	12	16

Figure 5: Matrix for Risk Assessment

Step 3: Determine controls

Risk Rating	Risk level	Recommended actions
1 to 3	Low Risk	No additional risk control measures may be needed.
4 to 8	Medium Risk	Work can be carried out with Risk controls in place
9 to 16	High Risk	Don't start work. Risk level must be reduced to Medium / low before commencing work.

- When determining controls, or considering changes to existing controls, consideration shall be given to reducing the risks according to the following hierarchy:
- Residual risks / impacts are the remaining risks / impacts, for which the planned controls are not able to effectively remove or control. It shall be ensured that the residual risks / impacts are acceptable and manageable.

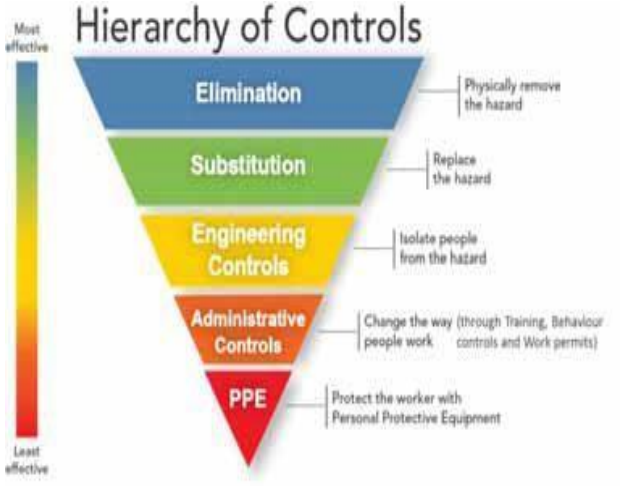

Figure 6: Hierarchy of controls Residual Risks / Impact

Step 4: Implement controls

- Commence work as per the approved Safe Work Method statement. Ensure availability of adequate resources to implement the controls while work execution.
- Work Permit System
- Work permit systems shall be implemented for the activities which are required to be performed under controlled environment. Follow the Work Permit System procedure (IM 14).
- The following work permits shall be followed as applicable
  - Working at height permit
  - Confined Space work permit

- Hot work permit
- Excavation work permit
- Radiography work permit
- Permit to work on Plant & Machinery
- Electrical work permit
- Blasting permit

Step 5: Review & update EHS Inspection

- Engineer In charge and Project EHS In charge shall conduct periodic inspections to verify the implementation of controls stipulated in the Safe Work method statement.

Periodic Review & Update of EHS Risk Assessment:

- The EHS risk management system shall be reviewed periodically taking into consideration of field audit findings, incident reports and feedback from projects. This shall be carried out at all levels (cluster/project) during the EHS committee meetings. The EHS Risk Assessment shall be maintained up to date.

7. Conclusion:

In my project is the Risk management system using software's like C++, JAVA. To improve the EHS performance, project performance to lead factor. The EHS performances lag indicator shall be converted to leading factor my implementing following risk management system. All incident / accidents are preventable unless good safety culture follows at project.

- All near miss / First aid case report shall be reporting and investigate in time.
- All near miss / first aid case shall be circulated to all staff.
- Near miss campaign shall be conducted once in a month.
- Rewards shall be given to staff and workmen for reporting near miss.
- Reporting system shall be simple and easy to all.
- All NM and FA case shall be discussed in EHS committee meeting.
- Effective EHS committee meeting shall be conducted once in a month.
- Workmen rewards shall be issuing for safety conscious.

Engineer In charge and Project EHS In charge shall conduct periodic inspections to verify the implementation of controls stipulated in the Safe Work method statement. The EHS risk management system shall be reviewed periodically taking into consideration of field audit findings, incident reports and feedback from projects. This shall be carried out at all levels (cluster/project) during the EHS committee meetings. The EHS Risk Assessment shall be maintained up to date.

8. Future Scope:

In the use of hazard analysis methodology Risk Analysis for identifying hazards and its consequences by analyzing all the processes. Risk Analysis contributes to the prevention of accidents and helps to make the system a safe place to work. Thus in this analysis has been performed in every section of the plant. Here Potential hazards associated to in different section have been identified and given proper corrective Action taken place to all type of Hazards.

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