Safety Accidents at the Workplace

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ABSTRACT--- Human factors is an important aspect to consider when designing a safe and healthy workplace. Human errors are usually outcomes of long chains of events, and preventing human error at work calls for preventive actions or safety–related measures that include the human factors in order for it to be effective. Human factors are addressed with regard to safety and health with the goal to optimise human performance and minimise human failures. Accident causation is a very complex phenomenon and need to be understood adequately with the purpose of improving workplace safety. Based on the Swiss Cheese Theory, human error is studied in this paper. Objectives: To study how human errors are involved in safety–related accidents at the workplace; and to study how human factors can be integrate in accident prevention. Methodology: A qualitative study using document analysis method. Results and discussion: Conclusion: workers' individual attributes may also be the source of accidents. People tend to make a lower risk estimation of their own job compare with other jobs; and underestimated the risks within their own job. The availability of information relevant to the hazard, risk estimations, types of exposure, and control measures are useful in helping people to understand risks better.

Index Terms:— Health, human error, occupational.

I. INTRODUCTION

Workplace-related accidents and incidents cause pain and suffering to the victim and his/her family. It can affect an individual's ability to work and their quality of life. The cost of occupational-related accidents can be exorbitant to both the accident victim and employer. Some of the consequences employers have to face are recompensing sick pay, temporary replacement of sick workers, recruiting new employees or retraining workers; repairing damages inflicted on tangible resources; allocating management time to deal with accidents; having an increase in insurance premiums or legal costs; and compensating claims made by accident victims or their family members. A preventive, change-oriented and self-initiated safety and health management system promotes a safer working environment and helps in the prevention of accidents and incidents. Financial priorities can be determined when conducting a risk assessment procedure so that resources will not be wasted. In relation to that, employee's absences as a result of occupational-related injuries or ill-health can be reduced and the probability and likelihood accidents and related costs can be lowered. As the number of accidents and injuries decrease, the cost of compensation claims is subsequently reduced. Safety and health is linked with everyday practice and the approach of employing a sensible and proportionate measure to ensure the facilities provide a safe and healthy place for all who utilise them. It helps to recognise and assess potential risks as well as flaws, which could be leading to adverse consequences and outcomes, into or within the work system. The role of human factors and human errors in workplace accidents are discussed in the paper.

II. MATERIALS AND METHODS

This paper has employed the qualitative research method in which earlier studies and available secondary resources were reviewed in order to meet the objectives of the study. Data were gathered from secondary sources which have included of academic journal papers, relevant books, magazines, periodicals, internet sources, web publications, and government releases. Document analysis was then performed in which preceding studies and relevant documents are identified, interpreted and analysed to give explanation and justification on the paper objectives.

RESULTS AND ANALYSIS

Objective 1: To study how human errors are involved in safety–related accidents at the workplace

The Swiss Cheese Model of Accidents Causation

In [1] proposed the "Swiss cheese" model of human error which described four stages of human failure; where each stage have an effect on the subsequent stage. Each of the stages has holes and accidents or incidents take place when the holes in the "slices" are in parallel. The model is applied by reversing in time after occurrence of the accident. The first stage characterises those Unsafe Acts of operators that eventually cause the accident. Majority of accident investigations have centred their efforts during this stage in which most contributing factors to accidents are subsequently uncovered. On the other hand, it is regularly the act or failure to act that is directly related to the accident that may produce relatively immediate, and possibly severe, consequences. Latent failures can stay in a state or period of inactivity, dormancy, or undiscovered for unknown and unspecified amount of time, until adverse harm is inflicted on the person off-guard. Therefore, Latent failures may be unseen by investigators with even the best efforts. In [1] defined three more stages of latent failures, denoted as Preconditions for Unsafe Acts, Unsafe Supervision, and Organisational Influences. The first stage can be affected by exhaustion, weak communication and coordination skills that may be attributed to unabated actions due to weak or inadequate risk and hazard control by supervisors. The final stage of human errors can be traced to influences in an organisation in which the organization itself can have effects on performance at each stage. Not unexpectedly thenceforward, failures in communication and coordination

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can start to present or unrevealed underlying preconditions that can influence work behaviours and prompt errors. In view of that, it is necessary that both investigators and experts analyse completely the sequence of accident and study it beyond the context.

Defensive layers resemble the slices of Swiss cheese, which contain a lot of holes. The holes allow a trajectory for accident to take place, which hazards are exposed and emit adverse effects to people who come into contact with the hazards. The holes are due to active failures and latent conditions that may eventually combine and lead to negative work outcomes. Active failures are defined as the dangerous work behaviour executed by individuals that have direct contact with the system which comprises of several types such as slips, lapses, errors, mistakes, and violations [1]. They have immediate and typically momentary effects on the reliability of the defences. However, nearly all of these actions have contributing factors that can be traced backward in time and up through the hierarchy of the system. Active failures have a direct effect and are typically caused by front-line workers. In circumstances when error is not tolerated, active failures produce a direct effect on safety and health.

Latent conditions are described as the unavoidable internal elements that exist and produce in the system. Latent failures are due to weak decisions by high-level decision makers or designers they can be imprecise, not always incorrect but has the possibility for bringing problems into the system. It involve two types of undesirable outcomes: they may be interpreted as error inducing conditions in the local work environment, for example time pressure, shortage of employees, insufficient resources, exhaustion, and not having the right competency/capability or produce permanent holes or flaws in the defences, that may be due to repeated false danger alarms and signs, impracticable procedures, design or construction defects. Latent conditions may stay inactive within a lengthy timeframe before merging with active failures and resident causes in the organisation to produce chances for accident to occur. Latent conditions are recognised and fixed ahead of undesirable consequences. Therefore, having a proactive risk management is perhaps preferable compare to reactive risk management.

The Human Factors Analysis and Classification System (HFACS)

HFACS explores the unsafe acts, preconditions for unsafe acts, unsafe supervision, and organizational influences. It is a framework that organised Reason's concepts into the pragmatic setting, classifying 19 causal categories in the four stages of human failure. In HFACS Level 1, Unsafe Acts is categorized into Errors and Violations, each with its own subcategories. Skill-based errors are errors that take place during the worker's execution of a routine such as failure to concentrate, checklist mistakes, and bad habits when performing highly expertise tasks concerning to procedure, training or competency that result in dangerous circumstances. Errors are the resultant of unintentional behaviours, whereas violations are a deliberate ignorance towards rules and regulations. The violation of the rule by the British Highway Code that required motorists to not slip and remain in control of their vehicles at all times is an example of unintentional violation [2].

Decision errors occur when the behaviours or conducts of the workers proceed as what have been planned yet the decided plan turns out to be insufficient or ineffective to attain the anticipated outcome due to exceeded capacity, rule-based error, and incorrect procedure that lead to an unsafe circumstance. Perceptual Errors arise when a worker's sensory input is reduced and a decision is created set upon incorrect information. In Routine Violations are regular actions made by the worker and but condone by the authoritative party. Violations which are an exceptional difference from organisation, neither predictable of the person nor tolerated by the organisation are called Exceptional Violations.

Environmental factors, condition of operators, and personnel factors are three categories in Level 2, The Preconditions for Unsafe Acts, with each group contains subcategories. Environmental factors is characterised as the physical and technical aspects that influence practices, conditions and behaviours of the person that can lead to human error or harmful circumstances. Condition of operators characterises the poor mental and physical conditions; and the limitations aspects that could influence practices, conditions or behaviours of the individual and give rise to human error or dangerous circumstances. Personnel factors involve resource management and individual disposition factors that influence practices, conditions or behaviours of the person, and effect in human error or hazardous situations. In Environmental Factors, Physical Environment describes factors that involve both the work settings and the ambient environmental conditions that the worker is exposed to. Technological Environment includes factors that are relating to design and automation issues such as the design of machines, equipment, instruments, or tools; design of display/ user interface on controls; checklist design; and task related issues and automation. Adverse Mental State is concerning with factors linked to mental conditions such as stress, mental fatigue, or motivation that can influence work. Adverse Physiological State describes factors that involve health or physical conditions such as medical disorder, physical fatigue, and hypoxia that have an effect on work. Physical/Mental Limitation occurs when a worker not has the physical or mental capacities during execution of a task such as having visual limitations and slow reaction time to get by with work situations. Resource Management describes the factors or aspects in communication, coordination, planning, and cooperation. Personal Readiness is related with off-duty behaviours prerequisite in order to carry out a job excellently such as abiding to worker rest requirements, alcohol restrictions, and other off-duty orders.

In Level 3, Unsafe Supervision is break up into four categories. Inadequate Supervision explains the responsibility of supervisors in making sure a task is executed safely and effectively by offering the chance to do well with enough guidance, training, leadership, supervision, or incentives to workers. Plan Inappropriate Operation describes operations that can be acceptable and changed during urgent situations such as risk management, staff pairing, and operation pace, but intolerable during routine operation. Fail to Correct Known Problem defines those occasions when supervisor acknowledge faults, defects, or flaws. Yet, operations are allowed to continue incessantly although there are reports of unsafe tendencies, initiation of corrective action, and rectification of safety related issues. Supervisory Violation occurs when existing rules and regulations are intentionally ignored by supervisors such as enforcement of rules and regulations that may be consequently allowed preventable dangers, and poor documentation.

In Level 4, Organizational Influences is divided three sub-categories. Resource Management involves the allocation of budget and also the maintenance of organizational assets. Organizational Climate defines the working atmosphere in the organization such as organisational structure, policies, or culture. Operational Process includes organizational decisions and procedures run everyday activities such as operations, procedures, and supervision in an organization [3].

Heinrich Law of Accidents

Hazards consist of both evident dangers and latent dangers. Accidents take place through the interaction of risks and hazards. According to Heinrich's Law, there is a rule of thumb that on industrial accidents that for every major accident there are 29 minor accidents and 300 abnormalities [4]. Looking at safety from this angle, the occurrence of similar minor accidents enables us to be aware of the possibilities for major accident. Major accidents could be prevented through the experience of minor accidents as it gives opportunities to learn from the error [5].

The Domino Theory

The domino theory is an accident causation model proposed by [4] which states that of all accidents, 88% are due to unsafe acts of human, 10% caused by unsafe actions and 2% by "acts of God". A "five-factor accident sequence", in which Heinrich depicted the accident sequence in five factors represented as domino blocks. Every factor would trigger the next sequence to topple the dominoes positioned in a row. It is a linear accident sequence of preceding factors resultant in accident and injury. The removal of a domino block or interventions can prevent accidents from occurring.

Human Error

Human error is defined as an action or decision which was not deliberate or intended, which involved a deviation from an established or accepted standard, and which results in an undesirable consequences. It is generally accepted that most safety accidents and incidents were caused by human error [6]. As stated in [7], the definition of human errors is vague as they contain a complex sequence of events and for that reason an elusive occurrence to study. In [1] defined "human error" to include all those events where a pre-planned sequence of mental or physical actions that fails to reach its intended result, and when these failures cannot be due to some actions of intervention. Contrariwise, it has been believed that to err is human. Thus, human error is a component that cannot be completely eradicated, but if the errors are detected, they can also be avoided. Based on the traditional viewpoint, failure and accident attributed to human error while in a contemporary philosophical view it is a sign of failure which indicates the present underlying issues in a system. Human error is therefore attributable and systematically associated to people, tools, tasks, and functioning environment [8], [9]. Human errors can be classified into a few types. Action errors' are errors that are not planned, which can be further classified as 'slips' or 'lapses'. Errors which the actions are intended [10] are "mistakes" or 'thinking errors'. The involuntary characteristics of such errors put them apart from "violations" where deliberate actions occur when people consciously and intentionally take on an incorrect choice of action. Human error can be the results of active failures at the front-end and latent failures which.

Violations

Violations happen where actions deviate from safe procedures standards or rules, whether they are intentional or erroneous [1], [11]. Violation is defined as any intentional or deliberate deviations from rules, procedures, instructions and regulations. The disobeying or violating of safety and health rules or procedures is the primary cause of most work-related accidents and injuries. For instance, detaching the safety guard on heavy duty machines or manoeuvring a vehicle over the permitted speed limit will undoubtedly raise the risk of an accident. Health risks are also greater when there is a disregard for rules. A worker who breaks the site rules on wearing personal protective equipment may increases his/her risk of developing occupational diseases. Knowledge on why people break rules can aid in the evaluations of potential risks from violations and in the design of control strategies in order to manage these risks efficiently. Rules at the workplace are broken for various reasons. Majority of the violations are prompted by a desire to execute the task regardless of the current limitations. Violations are classified into three categories which are routine, situational and exceptional.

1. Routine Violations

Routine violations happen when the regular methods of conducting work tasks deviate from the prescribed rules and procedures. Frequently routine violations are normal among a group of workers that they are no longer seen as violations or believed to be risky behaviour. Violations created on risk assessment are routine violations in general but are complemented by a risk assessment authorised by the management. The investigation on the Clapham Rail Crash presented that routine violations have a major role. Maintenance working practices had been worsened after a period of time to which the prescribed rules and procedures for working were routinely violated and also attributable to the inadequate supervision and training, permitting the circumstances to persist occur [12]. Routine violations can be reduced through assessing risk, reducing risk-taking, increasing the probability of detection and reducing the number of irrelevant rules [13].

2. Situational Violations

Situational violations are characterised by [1], [2], [12]. Situational violations ensue when situations at work necessitate or encourage workers to violate certain rules. Pressures from work such as chasing deadlines, shortage of staffs for the workload, unavailability of the proper equipment, or extreme weather conditions are several factors that contribute to breaking of rules in situational violations. Situational violations can be minimised by looking into some aspects relating to the working environment that can be improve such as adjusting the workplace settings; arranging proper supervision; enhancing work design and planning; and creating a positive safety and health culture [13].

3. Exceptional Violations

Exceptional violations take place in rare situations such as during crisis and might even be unavoidable in those circumstances. It is thought that violation is required to deal with the exceptional situations. Exceptional violations occur infrequently and only ensue when something has taken a wrong turn, gone amiss, and the outcomes turn out badly and are not as what a person required, intended, or wanted; incorrect or inaccurate, unfitting or unsuitable; not according with established standard, method, or procedure; or having flaws or improper. Exceptional violations occur when something is done in a wrong manner, mistakenly, or erroneously; in the wrong course or direction. A person may feel that he needs to break a rule in order to solve a new problem although he is already aware that he will be putting himself at risk by believing in misconceptions that the advantages outweigh the risks. Exceptional violations can be reduced by providing more training for rare and emergency events; and evaluate the potential for violations when conducting risk assessments [13].

A. Errors

Errors can be categorized into three types: slips, lapses and mistakes. Slips and lapses may take place in common activities and do not necessarily require high cognizance demand. These tasks are called ‘skill-based’ and are very vulnerable to errors if attention is diverted and being distracted and unfocussed, even momentarily. Manoeuvring a car is a common skill-based task for most people. Slips and lapses are the errors which are made by even the most experienced, skilful and highly-motivated people or experts [1]. They frequently result in omitted steps in repair, maintenance, calibration or testing tasks. Awareness of these types of errors is crucial and equipment and tasks should be designed as to avoid or minimise their occurrence. The room to identify and fix such errors can also be increased and it can be beneficial to make every individual aware that slips and lapses exist and be taken into consideration in accident investigation.

1. Slips

Slips are failures in executing the actions of a task. Slips happen as the consequence of minor errors of execution [1], [11]. They can be explained as executed actions that are not carried out according to what one has intended to do. Common slips may include performing an action in haste in a work process or holding it off for too long; omitting a step or sequence of steps from a procedure; doing an action with too much or too little effort exerted; or doing the right task but in an inappropriate way.

2. Lapses

Lapses cause people to fail to remember the action to be executed, to forget their position in an assignment or fail to recall the actions they had planned to carry out. Lapses happen whilst a person happen to be unfocused and fails to accomplish a work process or forgets a procedure while carrying out it [1], [11] due to distractions and interruptions to tasks or activities.

3. Mistakes

Mistakes are a more complicated type of human error in which individuals executing the incorrect action believing it to be the appropriate and correct action. Mistakes happen when actions follow to an inadequate plan [11]. Mistakes could be categorised into rule-based mistakes and knowledge-based mistakes. Rule-based mistakes occur when the human behaviour is built on prior knowledge that may include memorized rules or familiar procedures. People are inclined to apply familiar rules or solutions although when the solutions to the problems are not the most appropriate or useful. In unfamiliar context people have to revert to deliberate goal making, and improvement in planning process. Knowledge-based reasoning in which a person relies on experience to solve a task can eventually lead to misdiagnoses and miscalculations**.** However, it is worthy to note that human errors usually ensue if an individual is not experienced; and receive the incorrect or incomplete information on potential hazards. Lack of understanding typically results from the failure to communicate efficiently.

B. Approaches to Human Error

A top-down approach and a bottom-up approach are two paradigms identified to control human error. In a top-down approach, rule violation occur when described rules in safety management systems that meant to regulate undesired behaviours of workers are not obeyed by the workers. In a bottom-up approach, experience and expertise are seen as the most appropriate for which informal ‘procedures’ to follow [14]. In [15] proposed the Skill – Rule – Knowledge model which consists of three levels of human performance to understand human error and human performance in general. Skill-based behaviour characterises sensorimotor performance involuntarily with no conscious control and performance is according to subroutines which are dependent on higher level control. Rule-based behaviour occurs in a familiar work condition, in which performance is goal-oriented but defined by feed-forward control via a consciously controlled stored rule. Knowledge-based behaviour occur in unfamiliar circumstances, in which a goal is explicitly formed on an analysis of the situation and the general aims of the individual where the means should be identified and chosen based on the context's requirements. In [1] linked the types of performance with a the types of error the Generic Error Modelling Systems in which skill-based behaviour comprises of slips and lapses; rule-based behaviour includes rule-based mistakes; and knowledge-based behaviour consists of knowledge-based mistakes. Slips and lapses are defined as automated unconscious failures of automatic processing of attention/memory when carrying out routine actions which are noticed fairly rapidly. Rule-based mistakes is defined as errors of rule-based behaviour by using the wrong rule for a particular condition frequently incline to keep repeating the same wrong action. A knowledge-based mistake is defined as errors of the cognitive or knowledge-based processing in which a problem is incorrectly or not evaluated and this leads to an error.

Several empirical studies presented in relation to human error in various work sectors. A study utilising the Absolute Probability Judgement was carried out by [16] to examine human errors in a Serbian electric power company. The study reported that failure to utilised prescribed tools and unavailability of job authorization was human errors with the highest probability of happening. In the aviation industry, a study conducted by most of the commercial airlines accidents in the United States were–attributable to pilot error, where more than 50% were skill-based errors, more than one third were decision errors, less than one in every ten perceptual errors with final group were violations of regulations [17]. In [18] analysed incident reports and found that the reporting of skill-based errors was more unswerving compare to those of rule- and knowledge-based errors. In 19] also studied a larger data set later and indicated that only skill-based errors were linked to work accidents. In a study analysis of 508 mining incidents and accident in Australia done by [20] found that skill-based errors were identified as the most common unsafe act in mines where unintended or missed operations were the major and common skill-based errors, where they were the consequence of a failure in visual monitoring or the unplanned activation of a control.

C. Failures Causing Human Error

Failures in complying with requirements can be due to inadequate understanding regarding HFACS that may trigger human error. Accidents it's not always about violating the rules, 'ill fate', flaws in equipment, tools, or machines, even though all of these can and do occur and can clarify why accidents happened. When classifying error, omission, commission, and extraneous activity are the three aspects that can be investigated when identifying the causes of error. In [21] categorised human errors into errors of omission and commission. Omissions mean leaving something necessary out when workers fail to execute a required task. Commission is described as carrying out something wrong or doing something correct, but in the wrong context such as when tasks are carried out incorrectly or doing something that is not necessary**.** Extraneous activity is defined as doing something extra within or beyond a task, which is harmful.

D. Managing Human Error

Managing human error comes within two perspectives. The first one involves the individual and his characteristics and traits, such as age, gender, type of learning style, risk taking tendencies and so on; and the second one involves the perspective of the broader, organisational culture, management structures and current climate, training provided, and existing reward systems. Aspects relating to the physical plant, machines, maintenance, upkeep, and housekeeping of the aforementioned are included within both of these sub-systems. When examining human error, one should be able to differentiate between error types and causes. An error type is related to well-defined performance goals and therefore a human task. Causes are linked to the pertinent underlying in a human information-processing model and categorized into either a skill, a rule or a knowledge based error. Causes of error can be attributed to a wrong mental model where an individual sees the way something is best carried out and execute it in that way as it seems instantly as the correct way, while it is not the case. The reason of this can be due to the insufficiency of training and poor re-enforcement of training, outdated procedures or bad modelling. Also that, an error can occur due to one's believes that it's worth it to have a number of errors every week as it is intentionally created for completing work faster. This will eventually lead to risk tolerance in which errors are allowed to happen due to poor supervision in the vicinity, lack of training on safety, lack of both positive and negative reinforcement, and insufficient monitoring. Another cause of error is demand overload. Too many demands and not enough support prompts or lead an individual to make stress-related error that resulted from mistakes during work. A study carried out by [22] on British construction sites, skill-based errors and knowledge-based errors both resulted in nine fatalities, while rule-based errors caused three fatalities. 70 human factors that caused hand injuries were identified by [23] in a study conducted in Mexico. The factors were subsequently categorised into four groups, namely personal factors, human error, unsafe conditions, and organizational factors. Incorrect handling of heavy objects, attempts to reduce time in carrying out work tasks, and disregard of safety rules and procedures were identified as the most common types of human error.

Objective 2: To study how human factors can be integrate in accident prevention

E. Human Factors in Risk Management

Through the risk assessment conducted; hazards and risks could be eliminate or reduce. If elimination is not feasible then the alternative possible mechanisms will be considered. A workplace risk assessment is a continual, on-going process or a basic investigation of what could possibly cause harm to people in the workplace and evaluation of whether adequate safety measures are applied or whether extra precautions should be implemented to prevent injury to persons at risk, employees and members of the public. Accidents and ill health can have undesirable impact on quality of life other than affecting businesses and organisations. Insurance costs or other financial penalties increase when output is lost and machinery is damaged. In many countries, employers are legally required to assess the risks in the workplace with the purpose of preparing a plan to control these risks. A risk assessment is a detailed, continual, and ongoing process to examine of what could cause harm to people or put people at risk in the workplace. Risk assessment allows an evaluation of whether adequate controls are in place or whether additional measures should be implemented to prevent harm to those at risk, including employees and members of the public. While it may be beneficial to use information gathered from workplace inspections when conducting risk assessments, there is a clear difference between risk assessments and inspections even though they are similar. A risk assessment identifies the hazard and the required control measures, whereas an inspection verifies whether the necessary control measures are actually being implemented.

There is no exact definition of the term human factor. In a Swedish study with ten professional accident investigators, the findings indicated that the definitions of human factor always change in the dynamic process of producing and comprehending language, are context-dependent, and appear in discourse [24]. The similar statements are also addressed in relation to safety and health. Proportionate approach to human factors in risk assessment is taken by organisations according to their hazard and risk profile when controlling risks and hazards. However, the risk assessment approach can only be made more explicit when the hazard calls for it, such as when there is a major or significant occupational safety and health hazards that expose workers to considerable size of harm. In both cases, an adequate understanding of the human role in the related task or activity is required. Through risk assessment, tasks or activities which are safety critical or expose people to occupational health hazards are identified. Yet, it should be kept in mind that the approach to human factors in risk assessment should be proportionate to hazards according to the types, sizes, areas of specific expertise, specific social context among so. A qualitative approach may be sufficient for some industries but a quantitative approach may be appropriate for some major hazard industries [25].

F. Accident and Incident Prevention

Accident causation is a very complex phenomenon and need to be understood adequately with the purpose of improving accident prevention. Studies regarding accident causation hold great promise for individuals who are looking into developing the related theories

According to [4], accident is defined as an unexpected and uncontrollable circumstance that can cause individual injury or probability thereof. The unintentional or unexpected circumstance may possibly lead to damages to physical resources, individual injury, work failure and delay, or having multiple or several of these conditions combined and then leads to individual injury [26].

Accident is defined as an event that results in injury or ill health, while an incident is a near-miss or an undesired circumstance. Near miss is an event that has the likelihood to cause injury or ill-health, while not causing harm. Undesired circumstance is a set of conditions or circumstances that have the potential to cause injury or ill-health. On the other hand, the OHSAS 18001 Occupational Health and Safety Management Systems Requirements Standard [27] emphases on the definition of an incident which an incident is indicated as an occupational-related events in where an injury or ill health of any severity or fatality occurred, or could have occurred. An accident is viewed as a specific type of incident where an injury or illness actually happens, while a near-miss is an incident without injury or illness. Thus, an incident can be either an accident or a near-miss. Incident is frequently also defined to, as an event that has the possibility to cause harm, but did not. Incident is then viewed as an alternative word for a near-miss event [28]. These variations in terminology and definitions have to be kept to mind when examining safety literature or accident investigation techniques.

G. Approaches in Accident Analysis

In [29] identifies the tools and methods of analysis of incident and accident investigations into three types; sequential accident methods, epidemiological accident methods, and systemic methods [30]. Simple sequential accident methods describe the accident as the outcome resulting from a sequence of events that take place in a particular order. The accident is unexpected and inadvertent and results in an unwanted end-result initiated by one or more preceding events. Clear causality and distinguishable cause-effect relations are assumed in these models and which also involves a basic event chain model. In [4] domino-effect model is an example of sequential analysis methods. Epidemiological accident methods hold that an accident is the outcome of several factors which exist concurrently as both clear and latent factors. In [1], [31] Swiss-cheese model of incident causation is an example of epidemiological models of incident causation [32], although it has limited information regarding its application in the actual world or everyday settings. Strictly speaking, the theory did not explain or specifies the “holes in the cheese” actually means, from the perspective of daily functions or circumstances. Lastly, systemic methods of analysis define the characteristic performance on the level of the system, rather than a structural decomposition of the system. Accidents are emergent phenomena of the normal functioning of a system where accidents are viewed as common and natural, expected phenomena. Furthermore, systemic models try to explain for assumed non-linear effects, in which a small input or cause into the system can have a much greater amplified outcome afterwards. Several systemic models have designed their own new methods for incident investigation such as Accimap, FRAM, STAMP and Extended [29], [33], [34].

III. DISCUSSION & RESULTS

Although new technologies are included in the process design and implementation phases, the variances in human behaviours and inconsistent functions of machines or equipment frequently cause concerns in the manufacturing industry. Unforeseen human errors and machine failures disrupt the system, creating or leading to fluctuation in the production. Researchers have demonstrated that human errors are mostly identified as the main factor in manufacturing accidents [35]. The accumulation of mental workload or limited allocation of organizations' resources, due to a poor understanding of the damages that could be cause by human errors have worsen the situation [36], [37]. When designing systematic measures or programs for increasing reliability and for adjusting reliability prediction for risks, an investigation on human error in accidents should be considered by including human factors aspects in the working environment that can prevent accidents attributed to human error consecutively [35].

Human errors are usually outcomes of a series of events. Reducing human error at work calls for several kinds of preventative measures or approaches that involve developing safety awareness at the individual and organisational level. It may include technical approaches that require less human engagement [38]. People are generally uptight with performing an excellent job inapprehensive with the safety and health hazards that could be found in the work environment. A hazard is perceived as risky only when it is seen to be contributing towards adverse outcomes or if the individual feels himself vulnerable to the danger.

IV. CONCLUSION

A worker's beliefs on the possibilities of contacting an illness may influence their view towards the hazard whether it is as significant or otherwise, and this can resulting in people to dismiss the threat in extreme cases. Furthermore, assessment of a hazard may also be affected by common biases in individual risk perception as people are poor at approximating the likelihood and especially bad at estimating risk. Hence, this is a critical aspect to look into as the frequency of accidents is likely to be greater when individuals underestimated the risks within their own job. The availability of information relevant to the hazard, risk estimations, types of exposure, and control measures are useful in helping people to understand risks better. Fear-provoking messages are not normally recommended given that people are tend to dismiss a threatening fear-provoking message and to presume and take it for granted that the message is dedicated for a different person. Frequent emphasis is required to ensure that evaluation of risk is reasonable.

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