An assessment of job hazard analysis and safety performance in indigenous oil servicing companies in Rivers State, Nigeria

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Abstract

The operational activity of the oil and gas industry exposes workers to a wide range of occupational hazards emanating from human error. How to identify a model that would accurately detect, prevent and minimize top events and accompanying consequences as well as building the required skills needed to model attitude of the workforce towards efficient hazard management and improved safety performance was a major concern. The study examined the association among three models of job hazard analysis (JHA) Swiss cheese, Bow-tie and Risk Assessment Matrix) compared with the Human-Factor (H-Factor) modelon some selected organizational safety performance variables in some selected indigenous oil and gas servicing companies in Rivers State, (Nigeria (Airyolk Nigeria Limited, West Energy Limited and Wire Technologies). The socio- technical system theory was the explanatory framework for the study. A pre and post-test design was adopted in each company. A total of 209 staff were selected using a multi-stage sampling technique. The data collected were analyses with the dependent T-test statistical method. The result revealed a significant difference between the mean staff-reported safety performance indicators for all three models and the H-Factor model which implied that the workers consider the H-Factor to be more comprehensive in terms of improving organizational safety performance when compared to the others. The study recommends that indigenous oil and gas firms should consider models that focus on mitigating top events by embedding socio-human factors and safety parameters (organizational shared values, personnel competence matrix, leadership commitment to safety and employee engagement strategies) that would minimize costs to the workers and the organization.

Keywords: Assessment, job hazard, safety performance, indigenous oil servicing companies, occupational health

Introduction

The health and safety performance of an organization is a critical part of any organization's success. The need for improved organizational safety performance has become more important now than ever before because safety and health at work are vital components of descent work embedded among the Sustainable Development goals. The huge cost involved in occupational accidents requires that hazard at work be reduced to the barest minimum (ILO, 2021)

The increasing number of occupational incident rate has become a global concern to organizations, especially the especially, oil and gas companies which are considered high risk organizations. A situation analysis of the occupational health and safety system in Nigeria in the ILO (2016) Country profile report revealed a high level of weakness in terms of Occupational health and safety performance. Although, Nigeria has a number of legislations and guidelines affecting health and safety at the workplace, the health and safety practice related reports are yet to be very impressive (Baltissen, Brouwer, Peters, & Plataroti, (2018); Rantanen, J., Muchiri, F., & Lehtinen, S. (2020).

The International Labour Organization (ILO) estimated that between 1996 and 2017, 2.3 million workers died yearly from work-related accidents. It noted that more than 160 million people suffered from occupational diseases and 313 million non-fatal accidents cases are recorded per year. The safety incident data collated by the International association of oil and gas producers in 2015 showed that the total number of fatal incident increased by 41% compared to the 2014 statistics. The primary causative factor was centered on human error and organizational structure (IOGP, 2015; the mean difference in some key safety performance of against the Human Factor Risk Assessment model (H-Factor).). In Its 2021 report IOGP also showed that fatal accident rate increased by 36% compared to the 2020 rate. The reported cases were categorized as incident cause, caught in under and between, falls from height and struck by object among others (IOGP, 2022; Nwankwo, Arewa, Theophilus, & Esenowo, 2022).

Apart from injuries to the worker, oil and gas related accidents could cause the destruction of biodiversity of the ocean, environmental pollution, loss of lives, economic loss, and the shutdown of rig platform, international condemnation, and community restiveness amongst other negative impact (Sam, Coulon, & Prpich, 2017). Its industrial operations expose workers to complex occupational hazards such as chemical, electrical, mechanical, confined space entry, working at height, human error, and environmental hazards, among other life-threatening hazards. The impact of these operational hazards range from man-hour loss, death of employee, partial/permanent disability, employee compensation fund, machinery and facility damage, work-related diseases, environmental degradation and court litigations among others (Nwankwo, Arewa, Theophilus, & Esenowo, 2022).

From earliest times, job hazard analysis had been conceptualized as an engineering concept so that the models developed do not fully consider or adequately address the social factors intricately embedded in it. Even when the social factors underlying many incidences are known, the models eventually devised were not adequate to detect or deal with the human error components nor could they fully explain why they persist. When they attempt to do so in some cases, they usually gloss over the components of the health and safety issues and lean towards the individualized explanations. Thus the socio-technical variables implicated in many incidents are not holistically evaluated, they blame the individual about what he did or fail to do and are hamstrung when it comes to proffering a comprehensive solution. For instance Niloufar et al (2012) study on structure of human errors in tasks of operator working in the control room of an oil refinery unit, identified eighteen (18) individualized factors responsible for human errors by operators in control rooms such as confusion, memory capacity overload and distraction..

The study assessed the safety performance of the Human-Factor model in relation to some commonly used JHA models (Swiss Cheese, Bow-Tie and Risk Assessment Matrix) using perceived, predictive safety performance indicators (safety climate, personnel satisfaction with outcomes of their usual current JHA model, personnel safety competence, and shared safety norms).

One of the greatest challenges in the oil and gas sector is how to detect human errors in good time before accidents and fatalities occurred. Human error was defined as both unintended and deliberate deviations, whether they occur as skill-based, slips and lapses, rule-based mistakes or knowledge- based mistakes (Mcfalane, 2020). While slips and lapses are caused in the process of performing a function, mistakes are said to be related to the design of the system. In a design related error the worker is only the last straw that breaks the camel's back.

Safety can be depicted as the non-existence or minimization of hazard risk. The international civil aviation organization (2013) defined safety as the state at which the threat of injury to human being or property destruction is minimized to, and sustained at a tolerable degree through the regular use of risk identification and safety hazard management. Occupational safety is not the non-existence of occupational hazard, but the result of taking constructive action to identify potential hazard threats and implement suitable preventive measures (Mcfalane, 2020))

Safety Performance

Organizational safety performance indicators are set down parameters designed by a system to measure its safety performance. Safety performance indicators differ from one organization to another, and are often based on set down safety benchmark. Safety performance indicators can be grouped into leading and lagging indicators. “Lagging” in this context means to identify, report accidents and learn from feedback; while "leading" means to offer opinion on system’s performance before an accident occurs (HSE, 2006). Ideally job hazard analysis should commence with identifying the hazard risk inherent in work scope prior to work commencement. In a complex setting like the oil and gas, various hazard identification tools exist (Vairo, Pontiggia, & Fabiano, 2021).

Models of Job Hazard Analysis (JHA)

There are various models of Job analysis such as Failure Mode Effect Analysis (FMEA), Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Hazard Identification (HAZID), Risk Assessment Matrix (RAM), Hazard Operability (HAZOP) Swiss Cheese Model (SCM), Bayesian Network and Bow-tie model. Each model has its unique characteristics, applications and resources required at different levels of job hazards analysis (Silvianinita, 2011; Taarup-Esbensen, (2020). For the purpose of this study only the selected models were discussed based on the safety parameters selected for the study

Swiss Cheese Model

The Swiss cheese model (SCM) of job hazard analysis adopted a linear sequential analysis of an accident. It was propounded by James Reason, a psychologist. Reason (1990), proposed a layered hazard defensive mechanism. The model was likened to an edible Swiss cheese with porous holes, according to his analogy; each slice of the Swiss cheese represents the organizations safety defense mechanism which is designed to protect the organization against all safety threats. The porous hole on each slice of the Swiss cheese demonstrates the organizations safety weakness, as the hole differs in sizes and appears holes apart in each slice of Swiss cheese, so the weakness in organization safety appears in different size and aspect of the organizational operational activity. The model had been criticized as not meeting up with modern technological demands (Leveson 2011; Larouzee et al 2015; Y Li, et al (2014) argued that the Swiss Cheese Model cannot fully explain failure in highly automated systems. Y Li et al. (2014) further explained also that it glosses over the causative factor and undermines the possibility of learning from past incident causative factors.

Bow-Tie Model

The Bowtie model is said to be an amalgam of fault tree analysis (FTA) and the event tree analysis (ETA) (Vairo, Pontiggia, & Fabiano ,(2021). noted that it focuses on the source of accidents by detecting barriers to safety in order to reduce the impact of top events. It has the shape of a bow-tie. While the left part of the bow-tie depicts inherent job hazard, its potential threats and the preventive barrier expected to forestall potential hazard threat from resulting to top event (accident), the center of the bow-tie is the top event (accident) as a result of unpreventable hazard threat, the right part of the bow tie minimizes the impact of top event from taking a full toll (Lewis et al, 2010). It combines different elements of the hazard management system into a single whole (Anthony et al 2012). It has a capacity to detect causative factor of fire / explosion in natural gas pipelines (Xian et al (2017) as well as address the safety and operational issues in oil and gas

Risk Assessment Matrix has an advantage of systematic hazard identification, and management (Oakman, Weale, Kinsman, Nguyen, & Stuckey, 2020). Its inability to adequately account for residual risks as well as its use of subjective variables in estimating the likelihood of accident occurrence were listed as its major weaknesses. The model assumes that for an incident/accident to occur, hazard threat must pass through the system's safety barriers. The porous holes on the barriers are the effects of the flow of hazard threats.

The Human Factor Model (H-Factor) is extensively described by McLeod, (2004) examined sixteen real life hazard incidences and showed how H-Factor could help. The model was also used by Zarei, Yazdi, Abbassi, & Khan, (2019) in process accident in a hybrid format. Findings from their study showed the model to be quite robust in estimating impact rate (degree) of human factor induced failures, consideration of the conditional dependency, yet had very dynamic modelling structure. This flexibility has made different variants of the model to be designed in consonance with the context and environmental conditions. Wang, Fan, & Niu, (2022) used the model to analyse a hundred and sixty chemical accidents and found many significant associations (21 groups) using fisher's exact test. Its success lies in its ability to detect potential avenues for future top events.

Its prepositions were influenced by the assumptions of the Risk Society of modernity made popular by Becks (1992) who posited that risk is inherent in modern society where technology constantly produces new forms of risks having far reaching impact because of globalization. ds. Though it agrees with the main propositions of the SCM, BT and RAM model of job hazard analysis that potential job hazard must flow through the organizations' safety barrier mechanism before resulting in top event but holds a different opinion on how often top event occurs. H-Factor argues that top event occurs at different time on the same continuum with varying consequences and controls. A single top event could potentially produce sequences of novel top event with varying potential consequences and impacts if not managed effectively at its earliest release of hazard threat. Its uniqueness is its focus not just on preventing the occurrence of accidents (top events) but on looking out for the possibility of sequels of top event emanating from a single top event as a result of the failures inherent with the reactive controls to address top events. Its emphasis on the human component (people) rather than machines sets it apart from the others noting that, failed reactive controls are likely to introduce novel hazards which require further controls.

These variables are the people, leadership philosophy, the managerial organization, shared norms and workers' engagement strategy. Irrespective of safety measures put in place to forestall the occurrence of work-related accidents, a porous hole will continually be present in the safety barrier system if these functional prerequisite are not attained. The functionality of the respective processes of JHA is determined by the leverage of H-Factor's key variables

Materials and Method

The study was focused on the indigenous oil and gas servicing companies in Rivers State, in the South-South geopolitical zone, Nigeria. The Nigerian content act of 2010, categorized indigenous oil and gas servicing companies as any Nigerian owned companies which have demonstrated a minimum of 50% ownership of equipment and personnel of Nigerian nationality as well as registered in Nigeria (Ogunyemi, 2010). The oil and gas servicing companies interface with the upstream and downstream sector of oil and gas industry. They provide specialized equipment, services and technical skills needed for exploration, production, refining, liquefaction, marketing and distribution of crude oil and gas services.

The indigenous oil and gas servicing companies were selected because, their operations were simpler for handling the quasi- experimental design adopted for the study compared to the much larger oil and gas companies. The routine and non-routine operational activities of the industry characterized by complex life threatening hazards which typically emanate from raw materials, equipment, humans, job processes, safety controls, stakeholders interest, political unrest amongst others. Lastly, the companies were selected because they were found to be using one of the chosen job hazard models of the study. The Department of Petroleum Resources (DPR), had a list of 847 operators (indigenous oil and gas companies) in Rivers State (DPR, 2013).

Airyolk Nigeria Limited: Airyolk Nigeria Limited is an indigenous oil and gas servicing company with ninety-eight (98) personnel at the time of the study with its operational and administrative office located at plot 25, New Jerusalem road, Ayambo in Bonny local government area of Rivers state. The company was primarily engaged in welding and fabrication, blasting and painting, pipeline maintenance, inspection services and calibration services. These routine activities could expose personnel to life threatening hazards such as fire, explosives substances, chemical inhalation, fall from elevated height, equipment failure, noise pollution, high pressurization, community restiveness, and radiation among other life threatening hazards. The Swiss cheese model of job hazard analysis was being used at the time of the study

West Energy Limited had an operational office situated at Plot 18, Nkpogu road, Port Harcourt, Rivers State. The company has the staff strength of one hundred and five (105) mainly engaged in oil and gas facility maintenance services. The maintenance services involve hazardous work process such as confined space entry, working on elevated height, high pressure welding and fabrication, Non-destructive testing, rope access entry amongst other hazardous work process. The Bow-tie model of job hazard analysis was being used in managing inherent job hazard at the time of the study

Wire Technologies: Wire Technologies is an electrical company located at Km 15, Eleme-Onne in Eleme local government area of Rives State. The company had a staff strength of eighty-seven (87) personnel. Routine and non-routine operational activity of personnel predisposes them to wide range of hazard which includes fall and trips from elevated height, confined space entry, electrical shock, fire outbreak, explosives, electrical sparks, equipment failure, high temperature, among others. Wire technology was using the risk assessment matrix (RAM) for job hazard management.

The study design was a pre and post-test quasi-experimental design adopted to compare the difference in safety performance of the selected models of job hazard analysis namely Risk Assessment Matrix, Swiss cheese and Bow-tie which were tested against the H-

Factor model. The main indicators were the reported staff-perceived, predictive safety performance indicators (safety climate, personnel satisfaction with the end-results of current JHA model, personnel safety competence, and shared safety norms.

First a pre-test was administered in the respective companies; this was done to establish the baseline safety performance of the respective company's job hazard analysis model. H-Factor model was later introduced after a period of 3 weeks. H-Factor model introduced some changes in the job safety system (Organogram, HSE manual, Work-Site Audit Procedure, Permit-to-work procedure, JHA guidelines, Work instructions, Emergency response plan, corrective and preventive procedures, conflict resolution procedure, performance appraisal plan and eadership plan, of the respective companies.

The principles of H-Factor model were employed for a period of six months along with the existing JHA model. A post test was conducted to measure its perceived safety performance following an interim of six (6) months period. The mean difference in performance between the SCM and the H-factor, the BT and the H-Factor and the RAM and H-Factor were evaluated using the dependent T-test statistical analysis.

A multi stage sampling technique was employed in recruiting elements from the target population; the essence of the method is to certify that each element of the population size is broken down into distinctive groups that bear the distinctiveness of the population size.

The first of stage of the multi-stage sampling process was conducted using cluster sampling technique. The indigenous oil and gas servicing companies in the entire oil and gas producing local government areas in Rivers state were divided into clusters out of which Bonny, Eleme and Port Harcourt) local government areas were selected. Then a company was selected from each set of clusters. Only companies using the selected JHA models were purposively selected. The third stage of sampling was carried out by purposively selecting departments handling high risk, hazard prone jobs. Adequate permission was sought from the management of each company who agreed to make the needed changes for the testing of the H-Factor model. The staff were adequately informed about the new model they were to eventually give a self-reported assessment about.

The questionnaire was semi-structured and consisted of thirty (30) closed-ended questions. It was divided into two sections (A and B); Section (A) dealt with the socio-demographics (sex, age, highest level of education, employment status and model of JHA in use) profile of the respondents while section (B) accessed information on organizational safety performance noting the personnel satisfaction with current JHA model, personnel safety competence, safety climate and shared norm as the study's predictive safety performance indicators.

Copies of the questionnaire were administered face to face or mailed to workers at the rig using the mail back method. A Bipolar Likert 5point scale multiple choice options of "highly effective", "effective, unsure", "ineffective" and "highly ineffective" was employed in evaluating the opinion of respondent on their respective organizational safety performance indicator.

A dependent (Pair Sample) T-test statistical analysis method was utilized in examining the mean difference of staff perceived safety performance of SCM and H-Factor, RAM and H-Factor; and Bow-Tie and H-Factor in the respective companies.

The instrument was then first pre-tested in the maintenance department of some companies that were not selected for the study but share similar characteristics of the staff composition of selected companies. An aggregate of twenty –four (24) workers were purposively selected from three companies, the result of the pre-test was repeated after two-weeks and later used to correlate for reliability. This yielded a reliability score of 0.87 (Pearson's coefficient).

Results/Findings

Table 1: Socio-Demographic Data

Column1						
JHA Model	Swiss Cheese Model		Risk Assessment Matrix		Bow-tie Model	
Company Name	Airyolk Nig. Ltd		Wire Technologies		West Energy Limited	
Gender	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Frequencies	66	14	56	5	59	9
Percentage	82.5	17.5	91.80%	8.20 %	86.8	13.2
Total	**80(100%)**		**61(100%)**		**68(100%)**	
Age Frequency						
21-30 years	21	9	13	3	13	5
31- 40 years	19	5	23	2	25	3
41-50 years	17	0	16	0	17	1
51-60 years	9	0	4	0	4	0
Total	**66**	**14**	**56**	**5**	**59**	**9**
Level Of Education						
Primary	0	0	0	0	0	0
Secondary	4	2	5	1	2	0
Tertiary	47	9	44	3	40	7

Professional Training	15	3	7	1	17	2
Total	66	14	**56**	**5**	**59**	**9**
Employment Status						
Full-time Personnel	42	9	47	5	35	6
Contract personnel	19	3	9	0	21	2
Intern	5	2	0	0	3	1
Total	**66**	**14**	**56**	**5**	**59**	**9**
Duration of Employment						
0-9 years	60	14	49	4	55	8
10 and Above	6	0	7	1	4	1
Total	**66**	**14**	**56**	**5**	**59**	**9**

TABLE 2 Mean Differences in staff reported safety performance

Performance Indicator	SC	H-Factor	RAM	H-Factor	Bow Tie	H-Factor
Personnel level of satisfaction with the model	2.46	4.09	3.03	4	2.41	3.53
Personnel competence capabilities are improved	2.63	4.15	2.85	4.2	2.29	4.1
Model improves Safety performance Climate	2.71	4.21	3.41	4.33	2.93	4.16
Model enhances Shared Norms in safety performance	2.86	4.35	3.34	4.67	2.54	4.21
mean	2.665	4.2	3.1575	4.3	2.5425	4
Mean Difference from H-Factor	1.54		1.142		1.46	

Table 3 Mean difference in the staff-reported safety performances indicators using Swiss cheese model and H-Factor model in Airyolk Nigeria Limited

Column1 **MODEL**	**Mean Difference**	**(Mean difference) 2**	**df**	**t cal**	**t crit**
SCM (PRE-TEST)	**2.67**	**7.13**			
H-FACTOR (POST TEST)	4.2	17.64			
			79	**0.017**	**1.99**

Table 4 Mean difference in the staff-reported safety performances indicators using Risk Assessment Matrix and H-Factor model in Wire Technologies

Column1 **Model**	**Mean Difference**	**(Mean difference)2**	**df**	**t cal**	**t crit**
RAM (PRE-TEST)	**3.16**	**9.99**			
H-FACTOR(POST TEST)	**4.3**	**18.49**	**60**	**0.023**	**2**

TABLE 5 Mean difference in the staff-reported safety performances indicators using Bow-tie model and H-Factor model in West Energy Ltd.

Column1 **Model**	**Mean Difference**	**(Mean difference)2**	**df**	**t cal**	**t crit**
BTM(PRE-TEST)	**2.56**	**6.55**			
H-FACTOR(POST TEST)	**4.01**	**16.08**			

Table 1 shows the socio-demographic data of the study. The three organizations had 209 staff who participated in the study with attrition rate of 7.8% due largely to the nature of the workforce

Tables 3-5 show a statistically significant mean difference between the perceived safety performance of Swiss-Cheese model and H-Factor at the df (79), tcal =0.017 ,tcrit =1.99; p-value =<.05 (95%), Risk Assessment model and H-factor JHA model; df (60), tcal =0.023, tcrit = 2.00 p-value = <.05 (95%) and Bow-tie model and H-factor JHA model; df (67),tcal = 0.0201 tcrit =2.00 p-value = <.05 (95%).

At AIRYOLK NIGERIA LTD the observed mean difference could be attributed to SCM and H-Factor varying methods of job hazard management. While H-Factor agrees with SCM of JHA that human factor and organizational factor directly affect job safety performance they differ in their safety management practices and definition of top event and consequences. H-Factor additionally holds that hazard "consequences" are potential "top events" which can potentially occur on the same continuum that requires controls in order to halt the release of multiple novel hazard conditions. SCM simply analyzed the pre-conditions that predispose the release of Hazard threat but failed to account for the expected conditions necessary for the management of "hazard consequences This is in consonance with the findings of Stringfellow (2010) who conducted a qualitative study using accident report data analyses of various high-risk industries. He noted citing Reason, (1990) that model of hazard analysis should analyze hazards associated with human and organization system right from the design phase to operational phase of a critical safety system. This is an inherent weakness in the Swiss cheese model which depicts it as a linear event chain model rather than a systems model. Hao et al (2014) also noted that owing to the dynamics and complexity of a socio-technical system as supported by the analyses of data on system failures associated with human interface, hazard management method that relies on event chain accident model is inadequate for hazard management that emanates from human and organizational factors.

Y Li et al (2014) stated that SCM glosses over root causative factors of job hazard incidents thereby undermining the possibility of learning from past incident causative factors. The Swiss cheese model (SCM) outlined some safety system failure modes associated with inadequate control of system (design flaws, unsafe supervision, communication gap etc) factors that contribute to inadequate control. In managing the risk distributed by modern technological advancement Levisohn (2011) critiqued Swiss Cheese model for being obsolete in managing the risk distributed by modern day automated technologies. On the other hand, H-Factor model makes provision for objectively addressing hazard release “consequences” as potential “top event” as well as providing the necessary control measures necessary for minimizing human error incidents and improving safety performance.

At WIRE TECHNOLOGIES LTD there was also a significant mean difference between the perceived safety performance of Risk Assessment model and H-factor JHA model; df (60), tcal =0.023, tcrit = 2.00 p-value = <.05 (95%). This is in consonance with Tolbert (2005) who noted that RAM is inadequate for accounting for organizational residual risk. Residual risk is the hazards that exist despite safety actions taken. RAM was also criticized for being overly subjective in its analyses. The analyses of job safety are usually dependent on relative circumstances (work environment, team members’ competences, available incident record, raw material, equipment, machines) which continually vary. It was said to show some weakness in a system where critical safety actions interface and relies on human effort.

Similarly, at WEST ENERGY LTD. The result showed a significant mean difference between the perceived safety performance of Bow-tie model and H-factor JHA model; df (67),tcal = 0.0201 tcrit =2.00 p-value = <.05 (95%). Bow-tie model of JHA, recognizes the need for stopping top event from escalating to consequence but in actualizing that, BT introduced reactive controls which lack the prerequisites competence needed to mitigate hazard threat. Consequently, the reactive control introduces sub-threats and hazard escalating factors which H-Factor model defined as top event and not reactive controls as BT model claims. BT has many advantages as enumerated by Prineas, Culwick, & MEndlich, (2021) which has made it a choice analysis model for the health sector. Its simplicity and colour coding system which connote both escalation of events and differing management priorities at each level as well as its and stability over time made it a choice model. Alizadeh & Moshashaei, (2015) noted that it is a qualitative model which is very useful in the absence of a quantitative approach. It clearly shows the number of safety barriers that exists to forestall or mitigate the existing scenarios, and their nature or quality.

Hamilton, (2012) argues that the bow-tie analogy sets human failure apart from the other safety critical fundamentals and failed to acknowledge the potential relationship between human failures and the top event or the human relationship in the barriers and control measures (Hamilton, 2012 bow-tie hazard analysis). BT failed to acknowledge the potential relationship between technological controls and human failure, its potential of triggering top event and its escalating consequences. The errors associated with human interface and interventions are threats to safety which BT fails to prioritize. failure modes associated with human interface in job hazard analysis, as well as defining the specific human act or condition that can impact positively to the performance of Bow-Tie scenario. The model fails to define the expected prerequisites necessary to optimize human controls in safety interventions. It is not amenable to team work and iterative processes.

In sum the study provides the three models (Swiss cheese, Bow-tie and Risk assessment matrix) of job hazard analysis do not give adequate attention to the socio-human factors accountable for the behaviour of the personnel towards job safety in an organizational setting. It was shown that the H-Factor model focused on preventing top event from resulting in sequences of top event and their respective consequences (complete loss) using socio-human approaches.

It is important to state that the differences identified in this study do not invalidate the three other models but only showed that the H-Factor was more robust on the safety parameters specified in the study due to the fact that the H-Factor model was deliberately selected to test the effectiveness of the other models to demonstrate the weaknesses of the three. The H-Factor model was deliberately designed to deal with the weaknesses of the others in mind.

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