

Human factor and accidents prevention



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Introduction

In the oil and gas industry, people are involved in all aspect of work which is why we recognise the importance that Human Factor (HF) can play in reducing or totally avoiding accidents which have devastating long time effect on humans and their environment and are very expensive in economic terms. In the early part of the last century, industrial accidents were believed to have been caused mainly by technological malfunctions without recognising the human elements in them. However, in the later part of the 20th century, studies into the reduction in the rate of technological failures or accidents have revealed the contribution of human error in these accidents. Investigations into major accidents like piper alpha, Chernobyl and Three Mile Island by psychologist, reliability Engineers and human factor specialist have pointed out human factor as the root cause of most accidents. Likewise the performance of a highly complex socio technical system have also been identified to depend upon the interaction of technical, human, social, organisation, managerial, and environmental elements.

Human Factor being a professional discipline that can be considered as a process of designing or evaluating equipment, tools, procedures , environment and system of work for the use of human involves systematic application of information on human characteristics and behaviour to improve the general performance of the Man-Machine System.

Human limitations and errors are generally present at all stages of a system i. e. Design, Construction, Operation, risk assessment and management and emergency response stages, they are highly interwoven and can not be separated. “ History indicates clearly that the safety of an offshore structure

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is determined primarily by the human and organisation responsible for these structures during their design, construction, operation, maintenance and decommissioning”

Human Factor And Legislation

In the UK health and safety at work place is managed through the Health and Safety at Work Act (HSWA), 1974 which established The Health and Safety Commission (HSC), providing it with the power to propose health and safety regulations and approve codes of practice. The Health and Safety Executive (HSE) was also set up to monitor and enforce health and safety laws. The HSWA Act concentrated on individuals and their duties being the primary safety legislation in the UK under which most subsequent regulations were made.

Owing to the need for health and safety improvement, additional regulations (some of which include human factor element) were made from HSWA 1974 by the HSE. These include:

- The safety case regulation for offshore installations (SCR), 1992
- The supply of machinery regulations 1992
- The manual handling operations regulations 1992
- The health and safety (display screen equipment) regulations 1992
- The workplace (health and safety welfare) regulation 1992
- The protection of fire , explosion and emergency response(PFEER), 1995
- The management and administration regulations (MAR), 1995
- The design and construction regulations 1995

- The provision and use of work equipment regulations 1998
- The personal protective equipment regulations 2002
- The work at height regulations 2005
- The working time regulations.

Further more the influence of the European legislation which requires member states to particularly encourage improvement in health and safety of workers as regards working environment has brought about the implementation of further regulations. These regulations known as frame work regulations provides general duties on all stake holders and aims at improving health and safety management system making more explicit that which is required from employers, therefore any company having a health and safety management system under the HSWA Act and the frame work regulations is required to be able to comply with any future directives that are enforced.

Aims And Objective Of The Dessertation

Owing to the fact that human factor contribute a great deal to accidents from the outcome of investigations into the causes of accidents, it has become a compulsory practice for industries with high operational risk (oil and gas, aviation, nuclear etc) to critically analyse the elements of human factor which can have very serious impact on the overall safety performance of the company. Across these industries, application of human factor in safety has witnessed an increasing trend over the years yet many companies are yet to embrace the integration of human factor into their safety management system (SMS).

This dissertation aims at reviewing the development of human factor over the years in the oil and gas sector and how it has been effectively integrated into safety management systems and its application in a project from conception, design and procurement through the operation to the decommission stages of a project.

The objective of this dissertation is to point out the importance of human factor integration into safety management systems and risk management highlighting how these has help reduce the rate off accident occurrence over the years.

Methodology And Scope Of The Dessertation

In this dissertation literature works on human factor and its elements by various authors will be reviewed, HSE regulations on health and safety at work place, HSE guidelines and procedure for managing risk and HSE publications on safety management system will all be reviewed. Industries approach to reducing or completely avoiding accidents through integration of human factor into safety management system and risk management programs will be looked into.

This dissertation will be based mostly on literature review of past work on human factor in the oil and gas sector and also on HSE policies on risk management, procedures and guidelines for managing human error from concept stage of a project through the operational stage to decommissioning stage or the project.

Literature Review

Human Factor And Human Error

The present interest on human factor is as a result of the fact that technological developments have dramatically focused awareness on the need for human beings to be considered in such developments. Human Factor and Human Error (HE) are normally used interchangeably in the oil and gas sector as the cause of accidents linking to human activity rather than mechanical failure with unclear definition of their real meaning. In this work Human Factor and Human Error are discussed separately overlooking any link between them.

Human Factor

Gordon (1998) traditionally defined HF as the study of the interaction between human and machine which was extended to include the effect of the individual, group and organisational factors on overall safety.

Mark S. Sanders and Ernest J. McCormick (1993) approached the definition of human factor in terms of the following areas.

IN TERM OF FOCUS; human factor focuses on human dealings with product, equipment, facility, procedures and the environment which the work is performed, it lays emphasis on human beings (and not on technical engineering issues) and how they are affected by the design of things.

Human factor aims at improving the things people use and the environment in which they are used to match with the capabilities, limitations and needs of the people.

IN TERMS OF OBJECTIVE; there are two main objectives of human factor, firstly is the improvement of the effectiveness and efficiency of which work is performed which brings about reduced error, increased convenience of use and productivity. Secondly is the improvement of certain desirable human values which includes improved safety, quality of life and job fulfilment.

IN TERMS OF APPROACH; the approach of human factor to design is a methodical application of essential information on human characteristics, capability, limitations and behaviour to the design of things and procedures used by human and the environment they are used. This information provides the

basis on which the design recommendations are made this area also involves the

assessment of design to be certain they meet the intended objectives.

Mark and Ernest (1993) also defined HF concisely stating that “ Human factor discovers and applies information about human behaviour, ability, limitations and other characteristics to the design of tools, machines, systems, tasks, job and environment for productive, save, comfortable and effective human use”.

NAC first report, June (2000): further defined HF “ as a professional discipline concerned with improving the integration of human issues into the analysis, design, development, implementation, and the operational use of work systems.”

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According to Tanja 2008 HF was defined by HSE as written below “ Human factors refers to environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work in a way which can affect health and safety.”[15] She suggested that a simple way to view human factors is to think about the job, the individual and the organisation and their impact on people’s health and safety behaviours. She further classified it as follows.

THE JOB;

- Task
- Workload
- Environment
- Display & Controls
- Procedures
- Mismatches between job requirements and people’s physical and mental capabilities provide the potential for human error.

Physical match includes the design of the whole workplace. Mental match involves the individual’s information and decision-making requirements as well as their perception of the tasks and risks.

THE INDIVIDUAL;

- Competence
- Skills
- Personality
- Attitudes
- Risk Perception

The effect of individual characteristics on job performance may be negative and may not always be mitigated by job design. Characteristics like personality are fixed but skills and attitudes may be changed / enhanced

THE ORGANIZATION;

- Culture
- Leadership
- Resources
- Work

Organisational factors have the greatest influence on individual and group behaviour. Organisations need to establish their own positive health and safety culture. In HSE, 2005, Inspector report, HF was represented diagrammatically in the figure below.

Scope Of Human Factor

The type of system and its function determines the range of human factor issues which can affect the effective performance of the system, it is important then to concentrate on the issues needing attention in a particular system with development activity tailored accordingly. Human factor like the name goes is concerned with both human dealings with the technical components of a system and human activity needed to keep the system.

Represented on table 1 below is the full range of human factor which lies in a number of areas, putting into consideration the importance of an area to a system is a good check if all human factor activities are being accounted for . In HFI process they are classified into 6 human facto domains as represented below.

Table 1: Human Factors Integration Domains

Domain	Issue	Topics to consider
Staffing	How many people are required to operate and maintain the system?	Staffing levels Workload Team organisation, Job specifications
	What are the aptitudes, Experience and other human characteristics necessary to operate and Maintain the	Selection, Recruitment and Career Development Qualifications and experience require General characteristics (body size, strength,
Personnel		

system? eyesight, etc.)
 Identifying
 How to requirements
 develop for new skills
 and Documentatio
 maintain n Training
 the courses
 requisite Requirements
 knowledge for specialist
 Training , skills and training
 abilities to facilities
 operate Individual and
 and team training
 Maintain Skill
 the maintenance
 system? (e. g. refresher
 courses, drills)
 Human How to Equipment
 Factors integrate design
 Engineeri human Workstation/co
 ng(HFE) characteri nsole design
 stics into Workplace
 system layout
 design to Maintenance
 optimize access and

ease of
 maintenance
 User interface
 design (e. g.
 computing
 performance facilities and
 ease within screen
 the design)Function
 human/man allocation
 chine (between
 system. humans and
 automation)W
 orking
 environments
 (e. g. climate,
 lighting, noise.

Health What are Exposure to:
 Hazards the short ___ Toxic
 or long- materials___
 term Electric
 hazards to shock___
 health Mechanical
 resulting injury___
 from Musculoskelet
 normal al injury (e. g.

heavy lifting;
 repetitive
 movement) __
 Extreme
 operation heat/cold __
 of the
 system? Optical
 hazards __
 Electro-
 magnetic
 radiation

How to
 avoid the
 safety
 risks which Sources of
 humans human error
 might Effects of
 cause by misuse or
 operating abuse External
 or and
 maintainin environmental
 g the hazards
 system
 abnormall
 y?

Redrawn after Amanda Widdowson and David Carr

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Human Error

Theories Of Human Error

Human Error was defined by Gordon (1998) as the ‘ human acts which are judged by somebody to deviate from some kind of reference act they are subjective and they vary with time.’ these acts are definite and grouped into active errors and latent errors.

According to some psychologist such as Reason (1991), Rasmussen (1980) and Hudson (1991) et al who studied HF in detail, their findings suggest that by trying to deal with or rather understand in dept the meaning of HE it's consequences could be drastically reduced. HE was categorized into three groups by Reason 10 Based on Rasmussen's theory of human performance as

- Skill based slips and lapses: At the skill-based level, error is brought about by distraction or preoccupation with another task and task monitoring fails.
- Rule-based mistakes: At the rule-based or knowledge-based performance level, problem solving failures may occur, when the incorrect rule is applied.
- Knowledge-based mistakes: At the knowledge base level, error occurs when the person is not familiar with the problem at hand.

The figures below are used to diagrammatically represent Human Error showing the different types of Human Error as represented by HSE October 2005: inspector toolkit, Distinguishing Slips, lapses, and mistakes and demonstrate the different types of Skill based Slips and Lapses.

Reason (1991) also described violation in addition to slips, lapses and mistakes as unsafe act of deliberate deviation from procedures deemed necessary to maintain the safe operation of a potentially hazardous system. He did based his error types on psychology theories describing errors in high risk sectors though they appear like an ideal model to use in accident reporting forms they are complex and need considerable training to understand and use on a regular basis. HE was simply summarized by Kontogiannis and Embrey (1992) into six categories as listed below.

- Action errors: This type of error occurs in situations where no action is taken at all, where the wrong action is taken or where the correct action is taken on the wrong object.
- Checking errors: This type of error occurs in situations where the checks are omitted, where the wrong checks are made or where the correct check is made on the wrong object.
- Retrieval errors: This type of error occurs in situations where information that is required is not available, or the wrong information is received.
- Transmission errors: This type of error occurs in situations where information has to be passed onto someone else, where either no information is sent, where the wrong information is sent, or where it is sent to the wrong place.
- Diagnostic errors: This type of error occurs in situations where an abnormal event arises or where the actual situation is misinterpreted.
- Decision errors: This type of error occurs in situations where the circumstances were considered but the wrong decision is made.

Comparing this classification with the work of Reason above matches the first two error categories, 'action' and 'checking', with Reason's skill-based slips and lapses, 'retrieval' and 'transmission' errors relate to Reason's rule-based mistakes, and 'diagnostic' and 'decision' errors relate to Reason's knowledge-based mistakes.

Active Versus Latent Errors

Looking at HE in system disasters, involves two types of error. Firstly, active errors which have an instantaneous effect (such as using the wrong rule or omission) this error are usually associated to front line operators (such as production operators and control-room crew). Operators are in most cases targeted in safety programs to avoid active failures in order to lessen specific causes that are unlikely to occur in the same combination and secondly, latent errors which have their adverse consequences lying latently within the system for some time until they combine with other factors to destroy the system defence (such as training or design). They are mostly caused by those not involved in direct control interface (e. g. designers, high-level decision makers, construction workers, managers and maintenance personnel).

Human Factor And Accident Analysis.

Accident could be defined as an impromptu and uninhibited event that led to, or could have led to: injury to persons, damage to property, plant, equipment, and destruction to the environment or some other loss to the

company. Accidents are of different types depending on the nature and magnitude below is a list of some types so accident as classified by Paul Craythorne, Health, Safety & Environmental Advisor.

- Minor dangerous occurrence
- Near miss
- Plant/equipment damage
- Minor injury
- Lost time injury
- Disablement/fatality

In the HSE successful health and safety management publication accident was defined as “ any undesired circumstances which give rise to ill health or injury; damage to property, plant, products or the environment; production losses,

or increased liabilities”. The same publication suggested that “ incidents” in related terms includes undesired circumstances and near misses with the potential to cause accident emphasizing on “ potential” as the key term here. It is then very important to investigate incidents which had the potential to cause severe harm even if the actual harm caused was trivial it also described “ injury-accident” to involve injury to person which may include property damage and “ non-injury accident” to involves property damage but no personal injury”

Human Involvement In Major Incidents.

According to Felix Redmill (1997), Humans contribute considerably to incidents in four ways, all not leading to negative outcome. Namely,

Initiating event;

Accident may occur as a result of direct human failure having an immediate consequence or as a result of indirect human failure which is not felt for some time and then becoming difficult to investigate.

Escalation or control;

Humans can sometimes take disastrous decisions knowing the danger that is awaiting their action, they can also misinterpret a situation and take decisions that are inappropriate. Fortunately, humans can as well intervene to alleviate probable disaster this are not well reported in some organization but others have established records based on human recovery of high - potential incident.

Emergency evacuation, escape and rescue;

The no of casualty or loss of life in an accident can be reduced by the effective emergency response of workers. Emergency planning including appropriate training has a significant impact on rescue missions they are particularly relevant in the off-shore activities.

Latent failure;

As will be discussed in later chapter, management can lay the foundations for accidents when they make decisions either because the decision have the potential to cause failure and perhaps, a breach of safety, or because they create the conditions in which more junior staff are likely to fail or commit violations. Management decisions when flawed, are usually termed “

latent failures” safety management system are the ways by which such failure are monitored and managed. Below

Is a diagram showing the Stages of development of Organisational accident due to decisions made by the management.

Accident Investigation

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