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RESEARCH ARTICLE

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A Transactional Approach of Occupational Stress and Behaviour Pivotal to Human Error and Leadership in Maritime

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ABSTRACT

Maritime is a safety-critical industry with total commitment to safety in all shipping operations. New technological advancements in the maritime industry create new kinds of failures and accidents. Although the total number of marine casualties and incidents has steadied over the last few years [1], they raise an ever-growing safety concern of 'human error' being a recurrent contributing factor. Further, the high cost of wreck removal and rising insurance claims also highlight crew negligence as a growing problem. The review of international maritime literature gives evidence of human element essential for the shipping business's safety and efficiency; various maritime factors are posing challenges to the health, safety and environment at sea. Studies into human error have highlighted active and latent failures at different levels, the individual's pre-existing conditions and lack of competence to deal with are critical to errors. It is believed that an individual's perception of stress and coping skills are linked to the likelihood of errors and ineffective leadership, consequently affecting the system's success or failure. This paper draws attention to the transactional approach to the occupational stressors and human behaviour to understand the complex interactivity between the influencing factors causing the probability of human error. It is concluded that the application of the classification of errors, awareness in psychological limitations and psycho-behavioural aspects of individuals, can help address the pre-condition level of unsafe acts and loss of competence to reduce the probability of 'human error'.

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Introduction

The topic of occupational stressors in maritime has been well-researched and psycho-social factors as the source of work-related stress at sea are also well-recognised [2]. Researchers have highlighted increased workload, lack of situational awareness and resulting fatigue, to play a significant role in many maritime accidents [3,4], the experience of stress in varying degrees is influencing the individual's personal and professional efficacy. Another contributing causative factor involved in accidents relates to lack of leadership behind the decision-making failures, poor judgement and improper management of the crisis, all falling under the leader competency problems [5].

Maritime professionals are at the highest risk for stress [6], the term 'human error' can be considered an umbrella term [7], or just the tip of the iceberg. Compliance of maritime safety is highly governed by various regulations laid by the International Maritime Organisation (IMO) however, even the maritime regulatory regime fails to effectively address human factors and safety management challenges [8,9]. International safety management code (ISM) provides an international standard for the safe management and operation of ships and requires shipping company to assess all identified risks to their ships, personnel and the environment; and establish appropriate safeguards. However, 55% of employers survey respondents stated that their companies do not have policies or practices addressing seafarers' mental health issues in the last ten years [10]. It is also argued that rules cannot compensate for knowledge, skills, and abilities [3] to adapt to circumstances as technology is developing

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much faster than the regulations and training modules [11].

For every error to be effectively detected and managed, the role of investigating frameworks hold a significant value in preventing such unpleasant incidents. The investigations also indicate that many undesirable conditions influence and accumulate before an accident that often gets unnoticed or not understood. As a weak link exists between the human factor and maritime safety, there is a need to view the problem of 'human error' as fundamental and deep-rooted [12,13].

Human error and HFACS

According to the UK Marine Accident Investigation Branch (MAIB) and World Maritime Statistics [1], 'human error' is stated to be the major contributing factor ranging between (75-96%) [14] that dominates the Maritime accidents and occupational casualties [15]. The Human Factors Analysis and Classification System (HFACS) system was initially developed to analyse and classify errors in naval aviation accidents and mishaps and other safety-critical industries like aviation and military; it provides insight into the underlying human factors [16] and draws upon Reason's [17] concept of latent and active failures based on two categories: unsafe acts and violations.

The HFACS model classifies four primary levels [18]: Organisational Influences level, Supervision level, Pre-condition level and Act level as shown in Figure 1.

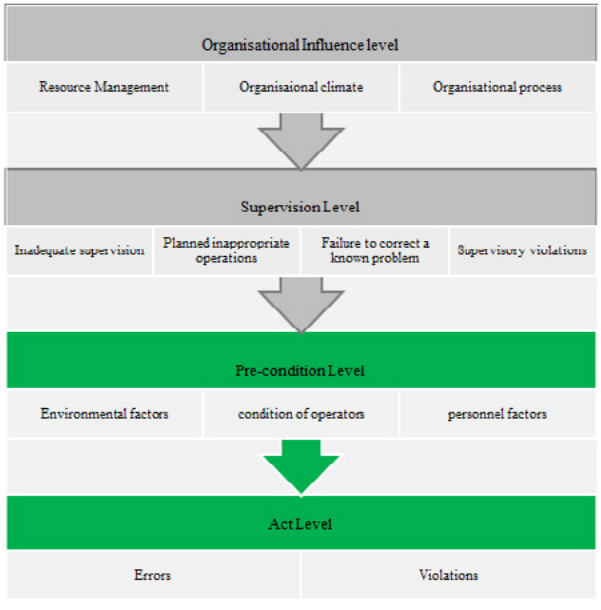

Figure 1. Structure of HFACS Model

The HFACS model is essentially a cascading one, where the actions at upper-level influence actions at the levels below. The pre-condition level comprises of 3 categories: environmental factors, condition of operators and personnel factors. This paper focusses on the error analysis at the pre-condition level for impact at the Act level, which is further categorised into errors and violations. See Figure 2

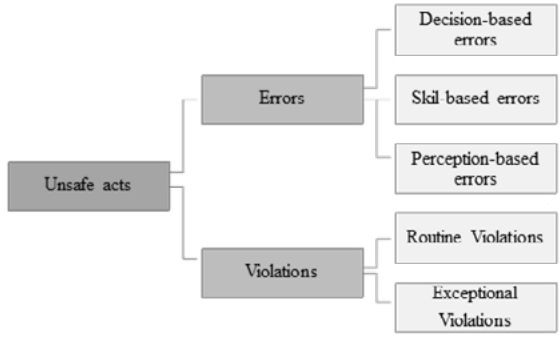

Figure 2. Classification of unsafe acts in maritime [HFACS]

Errors

There are three basic types of errors and are classified as; decision-based, skill-based and perception-based errors.

Decision-based errors refer to the most common ones and occur either due to lack of appropriate knowledge or poor choices. Psychological conditions can negatively impact performance [adverse mental states] predictive decision errors due to time pressure.

Skill-based errors refer to those that occur without significant conscious thought and are thus vulnerable to failure of attention as if working on 'autopilot' without any check. Moreover, these can occur based on individuals' different approach to the task; it is the aptitude and how they carry work that matters.

Perception-based errors refer to the action or inaction due to the wrong perception of the operator about the object, threat or situation resulting in failure or mishap [8] like a visual illusion or erroneous response.

Another form of human errors includes 'team errors' that refer to the errors made by a group of individuals when working as a team or a group [17]. Team errors are categorised into three types: mistakes, lapses, and slips [16], where mistakes and lapses arise in the thinking and planning process

associated with group processes, and action slips arise out of execution processes that are mostly individual-based.

Violations

As errors represent individuals' mental and physical activities that fail to achieve the desired outcomes, violations refer to the behavioural issues as they involve wilful disregard to rules and regulations critical for safety at sea. The violations consist of two types: routine violations and exceptional violations. The routine violation results from habitual action of an individual, while exceptional violations are related to the individual's behavioural repertoire that is difficult to predict. They point at the importance of behavioural aspects in human performance due to automated and risk-based behaviours that together increase the vulnerability of individuals.

Based on Rasmussen [19], the three levels of human behaviour are classified as skill-based behaviour, rule-based behaviour and knowledge-based behaviour. The skill-based behaviour is also addressed as automated behaviour is achieved when skills are well mastered, and mental resources allocation is minimal. On the other hand, rule-based behaviour requires a lot of mental resources. It is argued that some individuals may not be able to take immediate decisions in unexpected events and instead stick to regulations as they build behaviour to see all actions and operations stated in the laws. [20]. The knowledge-based behaviour occurs when one lacks knowledge in applying skills or have knowledge but fail to apply in adverse situations.

It is essential to consider the interactive stress elements interfering in the choice of actions and decision-making that magnifies during crises; the vulnerability factor can be detrimental to individuals' behavioural adaptations. Thus, there is need for addressing the pre-condition level of unsafe acts, resulting in errors that are critical for safety management proactively; and is discussed by the models on occupational stress and human behaviour."

The transactional model of occupational stress

The prevailing theories on 'human stress' reveal that stress arises when the perceived task demands exceed the perceived coping capabilities. Stress among seafarers is related to the triangulation of three factors: perception and feeling, direct consequences and state of health [2]. According to [21], the transactional model of occupational stress it involves three elements of stress: 1) sources of stress; 2) consequences of stress for individuals and organisation and; 3) individual differences in personality and behaviour as depicted in Figure 3. There are both external and internal sources of occupational stressors leading to vulnerability to work-related stress and/or psycho-social stressors among individuals.

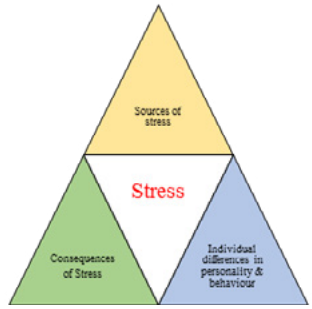

Figure 3. The transactional approach to Occupational stress

Sources of stress

There is considerable information on the highly stressful maritime environment; it is crucial to consider sources of stress [external and internal] at sea, causing work-related stressors and psycho-social stressors unique to the domain. The external sources involve physical hazards of harsh nature of the sea, the ship motion, rough weather conditions, vibrations, heavy traffic areas, low visibility conditions and increased task demands [12,14,22]. The internal sources of stress are related to the working conditions aboard ships, isolated confined environment (ICE) of ships, and reduction in crew numbers [21,23,24].

The long working hours, increased eyestrain, rolling, vibration and noise as work-related stressors are related to psycho-emotional strain like insomnia, depression and sleep disturbances. The additional workload related to increased paperwork, continuous shift work and frequent inspections in ports leading to fatigue and stress issues. The increased administrative reporting requirements have resulted in senior officers having less time for training and mentoring cadets and junior officers; it is argued that lack of quality among new recruits is another source of stress for those who have to train new crew members continuously [25]. Further, due to fast promotions, it does not allow officers

to accumulate sufficient experience, thus having a negative impact on maritime safety [26]. Apart from these stressors, lack of experience and competence contribute further to the vulnerability factor among the maritime professionals [27].

The multinational crews experience isolation among different cultural and national groups on board [28]. Lack of support from family and/or spouse can be a source of mental strain, and cause guilt conscience among crewmembers for being absent during family crisis [24]. Severe stress thereby, resulting in low psychological well-being and emotional strains in individuals, can interfere with an individual's capability to respond to risks, pressures and disruptions leading to different errors.

Consequences of stress

Although the HFACS model provides a general framework for investigating safety issues and the underlying human factors contributing to 'human error', much of the focus has been on the operational failures at the Act level. Exposure to a range of stressors like ship motion, increased task demands, and psycho-social factors; the slips, trips, falls, and errors can be related to physiological and psychological consequences on the individuals' physical and mental health. The study on psycho-emotional stress experienced by Lithuanian and Latvian seafarers reveals the association between environment and psycho-emotional stress factors like frequent depression at sea, disturbed working and resting regimes [29]. The recent seafarer mental health Yale Group Report [30] states that the mental health issues of social isolation, depression and suicide (SID)s can be associated with the likelihood of injury, illness and loss of young seafarers; with suggestions for efforts to reduce depression and other mental health risks, that may significantly impact employers' financial implications.

Moreover, researchers report prolonged exposure to stress can lead to the development of fatigue or burnout [31], lack of concentration, emotional exhaustion or conditions of suicides among those vulnerable to stress [30]. The situations that arise due to a crisis (piracy attacks or explosion/fire), more significant impacts on human health and well-being as the consequences of higher vulnerability and exposure [32] with an increased probability of errors, poor judgements, incorrect decision-making, and ineffective leadership.

Individual differences

The transactional model of stress and coping argues that the experience of stress is ultimately a system of appraisal, response and adaptation [33]. As occupational stress is considered to be dependent on the individual's perception of the situations. The perception and intensity of stress depends on the individual's assessment of stress and the stress tolerance ability. While data indicate differences in psychological well-being between seafarers of different categories [21], those involved in management responsibilities (deck and engine officers) have high levels of stress and anxiety than the crew [34]. Studies report differences found in stress factors like sleep disturbances; pilot and engineers reported less than that by deck crew and master/mates [23].

Thus, individual differences in approaching stressors depend on the individuals' capacity to cope and perform safely; as when they find themselves trapped in activities and experience emotional strain, they restrain their opportunity to make full use of their potential. Those individuals who have a high level of stress tolerance tend to face crisis and stressors more effectively than those with low-stress tolerance levels. It is argued that stress tolerance includes having a set of suitable responses to stressful situations, and is associated with the capacity to stay composed and face difficulties calmly without getting carried away by strong emotions [35]. On the other hand, individuals who do not have clarity and mood repair could be susceptible to developing depression and may remain prolonged due to self-denial. As a result, psychological health due to self-denial or stigma attached to seeking psychological health advice goes unnoticed [36].

Moreover, there are individual differences in leadership approaches, as those and lacking awareness in the applicability of leadership skills and without Non-Technical Skills (NTS) training, can further result in ineffective leadership that can be attributed to the increased likelihood of committing different types of errors, i.e. skill-based, decision-based or perception-based, thus leading to an iterative process of 'human error' as explained in

Figure 4.

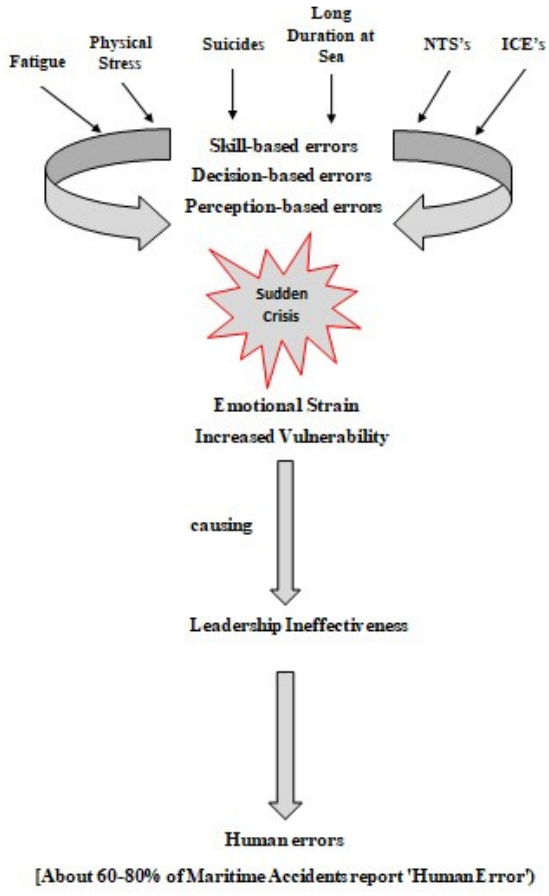

Figure 4. Human Causal Factors and Human Error in Maritime

Bandura's SCT model on human behaviour

As the importance of safety-culture depends on a range of factors of behaviour, attitude and beliefs held by the workforce. Likewise, there are underlying influencing factors related to the individual's capabilities and limitations to cope with risks and pressures at sea. The factors of vulnerability and crisis further impede the capacity to deal with stressors, stress and strain; the strains are further classified as psychological, physical and behavioural entities [37]. The multinational crew involves different nationalities, languages, and diverse cultures and social backgrounds that further affect individuals' safety culture, attitudes, and behaviours in maritime. Many psychological and environmental forces affect human beings during complex situations and degrade the decision-making process [38].

According to [39], human behaviour is defined as a triadic, dynamic and reciprocal interaction between personal factors in the form of cognitive, affective and biological variables, the behavioural pattern and the environment, also supported by various SCLT scholars [40]. In other words, human functioning is influenced by personal, behavioural and environmental factors. In the presence of stress, depression, anxiety, and inexperience, individuals with low esteem are more prone to pessimistic, unsafe behaviours, by aggravating self-doubts about ones' ability and reduced efficacy in crisis handling [41].

Although Bandura acknowledges that in the present e-world the nature, speed, reach, and loci of human influences are different today, yet the fundamental processes remain the same to affect individuals' self-beliefs towards themselves, work and life. Efficacy beliefs affect the individuals' thinking process; whether individuals think optimistically or pessimistically, they will adopt self-enhancing ways or self-debilitating ways accordingly (Figure 5).

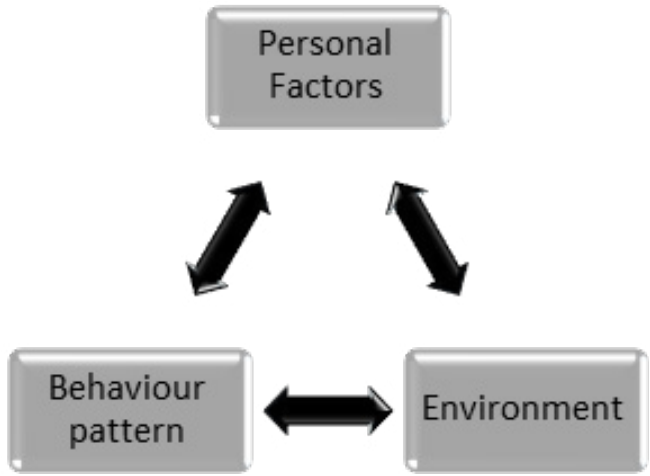

Figure 5. Bandura's SCT model of Human Behaviour

The SCT model states that self-efficacy beliefs do not work in isolation, as they affect both the feeling and thinking part, as well as the individual's behaviour, contributing significantly to human functioning quality. Four psychological processes are identified through which the efficacy beliefs influence human functioning: affective processes, cognitive processes, motivational processes and selection processes. The affective processes are said to allow the individuals, to relate to the personal coping capabilities and capacities to control stress sources. Those who cannot manage threats, experience high anxiety arousal, and have coping

deficiencies, succumb to circumstances. Likewise, cognitive processes and other personal resources underlie the actions selected and the proficiency they are executed to remain task-oriented in taxing situations [42]. The motivational processes are said to motivate themselves and exercise forethought by anticipating and guiding their actions. The selection processes involve the choices individuals make to cultivate competencies that affect their personal development, such as avoiding situations that exceed their capabilities or undertake them as challenges and capable of handling [43].

Studies in other safety-critical industries like aviation indicate that crew resource management skills (CRM) training have effectively contributed to enhanced learning in decision-making, promoted behaviour changes, but also reduced crew coordination errors, decision-making errors, and errors with compliance to standard operating procedures, that minimised airline aviation accidents [44,45].

According to Gestalt theory, it is the heightened level awareness that is both powerful and meaningful, as there is a direct relationship between the degree of awareness and potential for new choices of behaviour [46]. The erroneous behaviours need to be replaced with effective behaviours, as knowing how individuals view themselves, determines what they believe and how they behave, for controlling and tuning personal behaviours vital for displaying effective leadership and safety.

Discussion

Managing and dealing with occupational stress is the basic requirement of today's turbulent environment. By viewing stress as a result of misfit between an individual and its work environment, it is emphasised that occupational stress is dependent on the individuals' perception of stress and dealing with stressors due to the presence of individual differences in personality and behaviours. The safety climate is a psychological phenomenon, which involves perceptions of safety at a particular time [3]. In the presence of job stress demands, under taxing unanticipated situations add to the maritime professionals' vulnerability and managing unrealistic expectations of self or environment can be highly detrimental to maritime safety due to increased likelihood of errors, injuries and risks. It is the efficacy beliefs in one's competence to cope with broad range of stressful and challenging demands [47].

Bandura's SCT recognises the importance of behaviourism's unexpected environmental consequences, the cognitive processes, and other personal resources that underlie the actions selected. There is a need to consider personal factors lying in psychological processes that can contribute to the individual's adaptability and mental readiness by acquiring knowledge, skills, and abilities proactively. Leadership is a complex cognitive and behavioural task in a dynamic social context [48], it is the proficiency with which it is executed [42] particularly in crisis that empowers individuals to manage their professional challenges. A shift of focus of safety-critical organisations towards the awareness of skills can counteract the consequences of stress; and errors in terms of leadership failures. The training decisions directly affect crew workload and their capabilities to perform safely and effectively [12,49-51]. Enhanced stress tolerance, psychological awareness and leadership competence can mean reduced occupational stress and leadership failures, that can be translated into fewer 'human error' and thus fewer accidents.

Conclusion

The transactional model of occupational stress gives awareness of the stress elements, with individual differences involved in the experience of stress that influences the adaptive capacity, critical decision-making abilities, functional expertise and professional efficacy in varying degrees. Moreover, human behaviour explains the psychological processes involved in emotional stability, coping with stress and optimistic beliefs.

Based on error classification, the underlying human factors involved in 'human error', highlights the need for skill-based (NTS) training in leadership, to deal with occupational stress with professional proficiency. The vulnerability issues at the precondition level highlight the psychological challenges among the maritime professionals. Thus, to buffer from the adverse effects of psycho-social stressors and minimise errors, an understanding of effective leadership behaviours and practices should be evaluated and researched.

Research focussing on these psychological and leadership competencies in maritime are currently few and requires further study to add to the current understanding. It is to emphasise that more the

skilled and competent seafarers, fewer the errors and safer the seas. It is suggested that investing in 'Human Capital' by all the maritime stakeholders will contribute to overall maritime effectiveness. In the words of a renowned Economist Gary.S.Becker, who coined the term, 'Human Capital',

"The most successful companies and the most successful countries will be those that manage 'Human capital' most effectively and efficiently".

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