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Psychological Wellbeing and Safety in a Global Context

A Rapid Evidence Assessment

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Psychological wellbeing is a key dimension which impacts on the productivity and work experiences of employees within safety-critical sectors. This rapid evidence assessment has reviewed the academic and grey literature globally to establish key factors that impact on mental health across five sectors responsible for critical social and economic infrastructure – maritime/energy; construction; engineering; food and digital. Structural factors in the organization of workplaces and safety practices impact upon the psychological wellbeing of employees and are in turn affected by the emotional and behavioural consequences and diminished psychological wellbeing. The Power Threat Meaning Framework (PTMF) provides a way of modelling this relationship that avoids some of the difficulties inherent in global approaches to mental health.

The evidence clearly shows that psychosocial factors play a central role in mediating the relationship between structural aspects of the working environment and psychological wellbeing. Whilst there is wide variability in the efficacy of interventions attempted across the sectors explored, in general, strategies which employ a holistic approach to psychological wellbeing generally demonstrate better outcomes. On the basis of the available evidence, we recommend that interventions proceed by identifying and modelling the specific configuration of psychosocial factors within a given sector or organization. We further recommend that participation in interventions is facilitated collaboratively, and designed across all levels within the organization.

The 4th Industrial Revolution offers many challenges to all the sectors explored and is generally considered in terms of the direct and indirect threats it poses to psychological wellbeing through exacerbating existing workplace inequalities. However, technological changes also offer innovative means through which mental health may be monitored. The evidence base also provides some key lessons for the transitions every sector will have to make during and in recovering from the COVID-19 pandemic.

Executive Summary

Psychological wellbeing in relation to work is an idea which is easily understood but very difficult to define with precision. It concerns the range of changing positive and negative emotions that all employees may experience on a daily basis. Psychological wellbeing is heavily impacted by structural factors such as the ergonomics of the work environment, the ways in which work is organized, and behavioural norms within the workplace. When psychological wellbeing is diminished for prolonged periods of time, employees are prone to forms of distress which are likely to negatively impact their mental health and impair their ability to perform to their full potential. There has been a tendency across many sectors to focus on immediate physiological concerns, with psychological factors often deemed to be either separate concerns or placed much lower down the list of occupational health priorities. However, there exists an extensive body of evidence demonstrating that mental health is a major factor in reducing productivity and increasing costs within organizations. Critically, mental health can be seen to provide a good index of the overall safety climate of an organization and how it is experienced by employees.

This report details a rapid evidence assessment of the global academic and grey literature to establish current understanding of key factors which impact on psychological wellbeing across five sectors which are responsible for the critical infrastructure underpinning modern societies – maritime/energy; construction; engineering; food and digital. These sectors share many common structural features in terms of how work is organized and how safety is managed and practised. These are sectors where work is often both physically demanding (e.g. long working hours, shift work, difficult working conditions) and emotionally demanding (e.g. lack of control, job insecurity, poor job satisfaction). The way that workplaces within these sectors are organized directly impacts upon the psychological wellbeing of employees through creating challenges and inequalities within and between distinct groups of workers. This results in variable impacts on psychological wellbeing, which give rise to distinct emotional and behavioural consequences. These, in turn, shape the safety climate of an organization, creating a continuous reciprocal feedback loop.

The Power Threat Meaning Framework (PTMF) provides a way of modelling this relationship that avoids some of the difficulties inherent in global approaches to mental health. This is a non-diagnostic approach to understanding how mental health issues arise and the ways in which they become expressed and managed. The PTMF draws attention to the structural issues within an organization and the ways in which they are informed by broader social and cultural factors. It also provides a focus on the central role that psychosocial factors play in mediating the relationship between structural aspects of the working environment (present in each sector), and psychological wellbeing. For example, long working hours are physically exhausting for workers, but they can also be interpreted as evidence that the organization could take better care of its employees.

Unfortunately, there is no 'silver bullet' to be found in the literature which can reliably inform all interventions within the five safety-critical sectors considered in this report. However, the evidence does indicate that strategies which employ a holistic approach to psychological wellbeing generally demonstrate better outcomes. Based on the evidence base, we recommend that these kinds of interventions should be attempted through identifying and modelling the specific configuration of psychosocial factors within the particular workplace or occupational setting being addressed. Interventions should also be sustained over time in a focused way, rather than treating psychological wellbeing as a temporary or low priority issue. Facilitating participation across the whole organization is also key to successful interventions. Employees must feel that their psychological wellbeing is of genuine concern, rather than secondary to other business

considerations. In general, there is a need for far better systems for recording and monitoring data around psychological wellbeing in the workplace, and better understanding of how safety climate and safety culture relate to mental health issues.

The challenges to all sectors from the so-called 4th Industrial Revolution (or 4IR) come in the form of threats posed to psychological wellbeing through exacerbating existing workplace inequalities and increasing production strains, to the continuous 'hyper-connection' of workers to workplace activities. However new technologies also offer innovative means through which mental health may be monitored. This report also explores the evidence base to provide some key considerations applicable across policy and enterprise following the global outbreak of COVID-19. This is especially important when considering the wellbeing of workers and their families who are working through the pandemic, not to mention the workforce which is expected to return to any degree of 'normality' once a resolution is found to this pandemic.

The Global Incidence and Prevalence of Poor Mental Health

Mental health refers to a person's emotional, psychological, and social wellbeing; it is the blend and functioning of 'feeling good' and being able to carry out their daily lives effectively. Psychological wellbeing does not, however, require people to 'feel good all the time' in order to be sustainable¹. Individuals are bound to experience a range of both positive and negative emotions as a part of daily life. Indeed, long-term psychological wellbeing instead relies on being allowed to manage and effectively process these emotions. When there are structural features within both our working and personal lives that impede this management of emotions, poor mental health is likely to follow as a consequence.

In 2017 it was estimated that around 792 million people worldwide were living with at least one form of mental health condition; this is slightly over 10.7% of the global population². Psychological health issues are considered one of the main causes of the overall illness burden worldwide³. Major depression is also considered a significant contributor to suicide and ischemic heart disease around the world⁴. Few countries across the world have adequate resources for coping with mental health issues for the general population⁵. The availability of specialist mental health services tends to mirror broader existing inequalities between and within countries. For example, urban areas tend to provide greater access to services than poorer and rural areas. Even where access is possible, nearly two-thirds of people with a known mental health issue may never seek professional assistance.

The flagship study 'Global Burden of Disease' produced by the Institute for Health Metrics and Evaluation provides evidence for the following observations⁶:

- **Current data on mental health is poorly defined, measured, and understood**, with psychological ill health typically under-reported, and under-diagnosed;
- **Conditions associated with poor mental health and substance abuse are common**, with 'every 5th or 6th person' likely to experience them;
- **The global prevalence of mental health issues has not been seen to have increased as significantly as was previously suggested** due to wide variability across populations and countries;
- **Mental health issues follow gender lines**, with data suggesting that some key diagnoses (i.e. depression, anxiety, bipolar and eating disorders) may be much more prevalent in women than men, whereas males are seemingly more prone to drug and alcohol issues for example⁷;
- **There are a number of socio-economic factors which may be relative to the prevalence of mental health disorders** including education level, wage and employment status⁸.

1 Huppert, 2009
2 Ritchie & Roser, 2018
3 Vos et al, 2017; Mental Health Foundation, 2017
4 Whiteford et al., 2013
5 WHO, 2001
6 Ritchie & Roser, 2018; Ritchie 2018
7 Kupers 2005; Kartalova-Doherty & Doherty, 2011
8 Ritchie, 2018

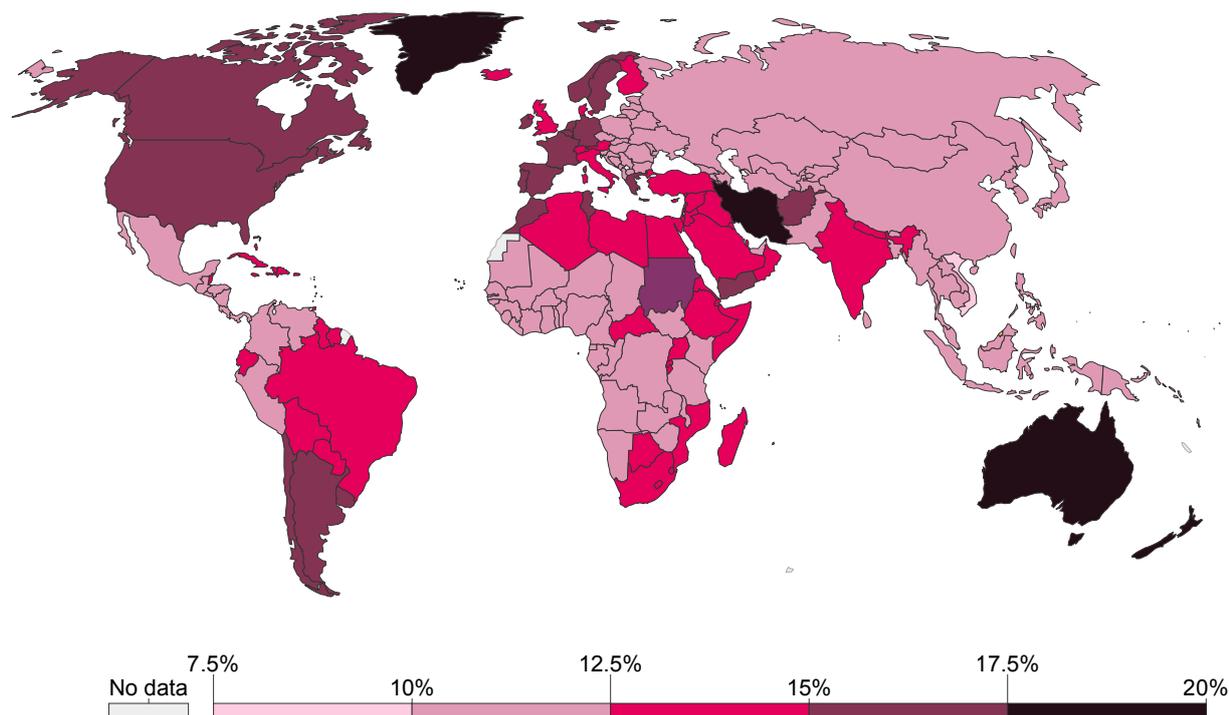


Figure 1. Heat map demonstrating share of population with any mental health or substance use disorder; this includes depression, anxiety, bipolar, eating disorders, alcohol or drug use disorders, and schizophrenia (Our World in Data, 2017).

Global mental health is a field of research in its own right, supported by numerous foundations and campaign organizations⁹. Advocates argue that the stark differences in mental health service provision across countries require a global effort to intervene. For example, in Zambia there are only four full-time psychiatry positions, supported by around 42,000 clinical officers trained to high school level, for a population of roughly 11 million people. However, it has also been strongly argued that the diagnostic categories commonly used in mental health – based on classifications drawn from DSM-5 (Diagnostic and Statistical Manual) and ICD-11 (World Health Organization (WHO) International Classification of Diseases) – reflect the cultural understandings and biomedical practices of the Global North, which are not sensitive to how distress may be experienced and treated locally¹⁰. Again, in Zambia there are as many spiritual healers as clinical officers. It is critical that any global overview of mental health is balanced with attention to local cultural differences.

To this end, national statistics on mental health can be collated along cultural rather than strictly geographical lines. Cultural similarities between nations may allow for better comparison in estimates of the prevalence of mental health given the local complexities in how distress is culturally recognised and managed. Table 1 (overleaf) uses ten cultural clusters to provide an exemplar comparison across different nation states. These clusters are derived from the GLOBE project – an international study of leadership and organizational behaviour¹¹.

9 Patel, 2014; Patel et al., 2013

10 Mills, 2013

11 Global Leadership and Organisational Behaviour Effectiveness (GLOBE), 2020

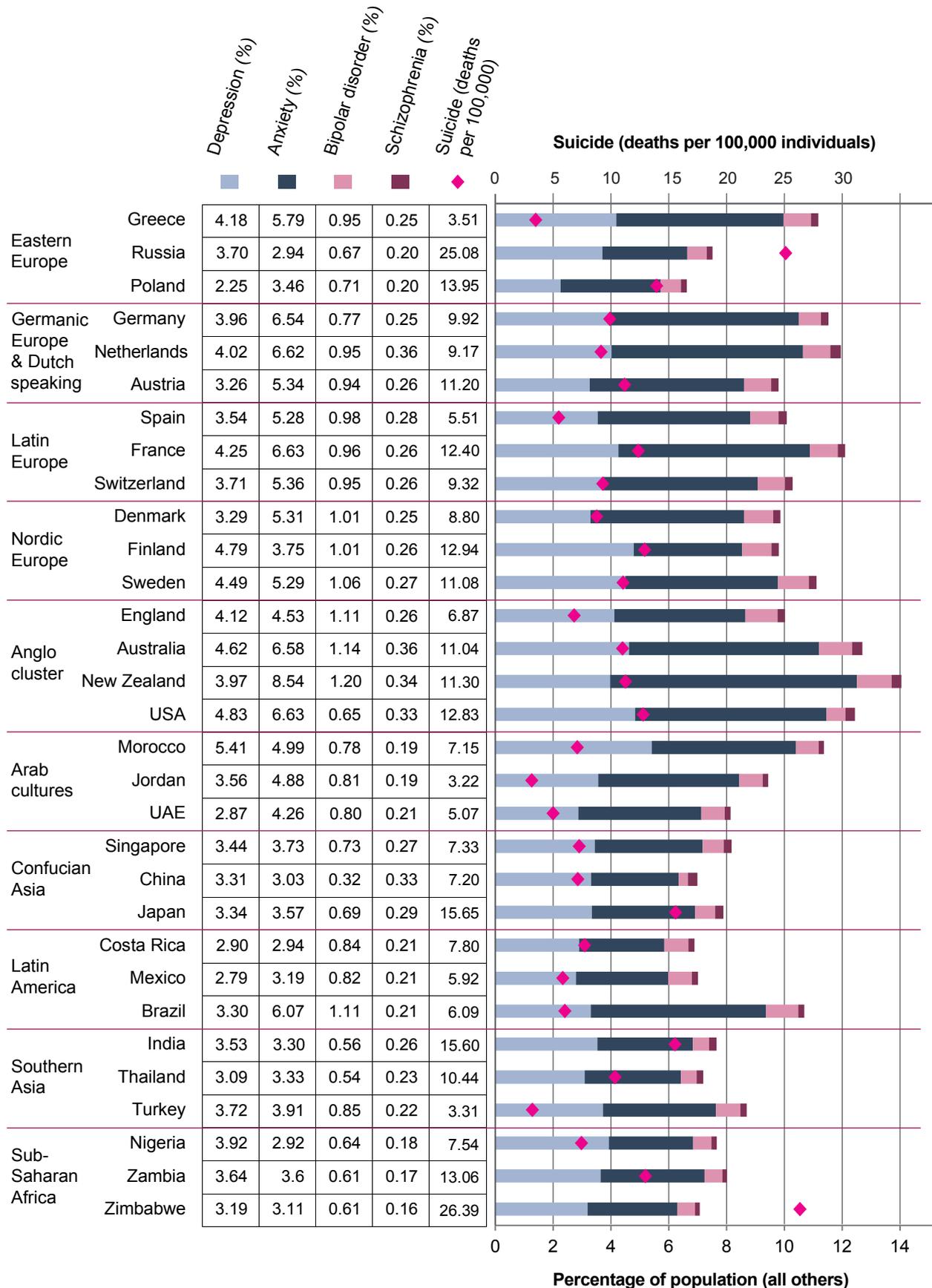


Table 1. Psychological wellbeing by country (within regions). (Data drawn from Our World in Data, 2018)

The table demonstrates that transient forms of distress, such as depression and anxiety, are considerably more common than severe and enduring distress, such as schizophrenia, by an order of at least 15:1. There is a general trend that higher overall estimated rates of mental health issues are accompanied by larger numbers of estimated suicides – for example, a progressive decrease appears when the Anglo cluster, the Confucian Asian cluster and the Latin American cluster are compared in turn. But there is also variability within clusters – New Zealand, Japan, Russia and Zimbabwe are all out of step with other members of their respective clusters. From this it can be concluded that whilst mental health is most certainly a global issue, the precise shape and form this takes varies considerably at regional and local levels. This might be conceptualised as a mosaic of differences rather than a uniform pattern.

The problem of diagnosis in mental health

The two most common tools currently used to diagnose mental health issues are the Diagnostic and Statistical Manual (DSM) – currently on its 5th revision – produced by the American Psychiatric Association and the 11th version of WHO's International Classification of Diseases (ICD). These taxonomies provide a common international language for grouping mental health issues and making global and regional estimates and comparisons of incidence. However, these tools are controversial¹². It has been strongly argued that a term like 'schizophrenia' has very little explanatory value since it is used to refer to an idealised cluster of 'symptoms' in the absence of any universally agreed underlying mechanism¹³. Experiences of distress tend to be far more socially and culturally variable, complex and multi-faceted than these broad diagnostic categories suggest. In many countries, the diagnosis of mental issues also draws upon local practices for understanding and managing distress. In the UK, for example, clinical formulation is used alongside or sometime in place of diagnosis, where a variety of biographical information is synthesised to develop a treatment plan for a person's mental health issues¹⁴.

An important observation is that with a majority of people spending one-third of their adult life at work, and around 1 in 4 people experiencing mental ill health each year, workers are likely to experience an extensive amount of time dealing with a wide spectrum of mental health issues¹⁵. It has already been estimated that the cost of depression and anxiety to the global economy was somewhere in the region of 1 trillion US Dollars per year in lost productivity¹⁶. The precise proportion that is directly related to safety issues is not clear, in part because statistical data around safety accidents and incidents tends to focus on physical illness and injury¹⁷. Nonetheless, it is clear that psychological wellbeing is both an indicator of how safety is experienced at work and underpins behaviours which impact upon safety.

This rapid evidence assessment deals with five sectors – maritime/energy, construction, engineering, food processing and digital. These sectors are central to the current mission and strategy of Lloyd's Register Foundation, 'engineering a safer world'¹⁸. All five sectors are based

12 Cromby et al., 2013

13 Boyle, 2014

14 Cromby et al., 2013

15 Jaman & Staglin, 2019

16 https://www.who.int/mental_health/in_the_workplace/en/

17 Rajgopal, 2010; Gilbert & Bilsker 2012; Zwetsloot et al., 2017; Oswald et al., 2019

18 <https://www.lrfoundation.org.uk/en/2019-strategy/>

around the ‘critical infrastructure’ which defines modern societies (e.g. safety at sea, safety of food, safety of physical infrastructure, safety of digital systems etc). As such, ensuring the safety of persons and resources within each sector is pivotal to the sustainability of contemporary social and economic life.

Suicide rates of employees within each sector may provide a very general insight into levels of psychological wellbeing. There is evidence to suggest that compared with national norms, there are somewhat elevated rate of suicides within the maritime and energy, construction and food processing sectors¹⁹. The evidence within engineering and digital sectors is mixed and inconclusive. However suicide rates are not necessarily a clear indicator of general psychological wellbeing, since death by suicide tends to be under-reported or mis-reported due to cultural norms around self-harm and the desire to protect the status of living relatives²⁰. There may also be contextual factors involved in both the reporting and recording of rates within occupational settings. **However, the evidence does suggest that feelings about the work environment rather than the physical nature of the work itself are critical to psychological wellbeing.** For example, suicide in the maritime sector appears to be associated with feelings of lacking control over the work rather than exhaustion or physical illness suffered as a consequence of working patterns²¹. In these sectors, work is both physically hard and emotionally hard, with the latter having more significant consequences.

The Power Threat Meaning Framework (PTMF) forms the basis for the following conceptualisation of the relationship between safety and psychological wellbeing. The PTMF is a non-diagnostic approach to mental health published by the British Psychological Society. It conceptualises distress as a series of embodied responses which are made to threats perceived to emerge from social inequalities and other forms of disempowerment in a person’s life²². Safety practices feed into working conditions that create inequalities in workplace experience (e.g. disproportionately expose certain groups of workers to added risk; reinforce behavioural norms that sanction unfair or abusive behaviour; compound the existing physical and mental challenges of work). Workers perceive these inequalities as psychosocial threats that negatively impact on their psychological wellbeing (e.g. poorly paid work and long shifts experienced as not being valued by the organization). They then respond with emotions and behaviours that reflect both their broader cultural background and particular life experiences (e.g. continuous anxiety; poor mood and lack of enthusiasm) which reciprocally feeds back into workplace conditions (e.g. contributes to the emotional atmosphere of the workplace; decreased productivity). In the following sections PTMF will be used as the basis for understanding the specific ways in which psychological wellbeing is affected within the five sectors.

19 Roberts, 2005; Roberts et al., 2009; Roberts et al., 2012

20 Sainsbury & Jenkins, 1982

21 Hetherington et al., 2006

22 Johnstone & Boyle, 2018

The Impact of Psychological Wellbeing on Occupational Health & Safety

The most widely used definition of wellbeing is that provided by the WHO, and is described as the state in which 'every individual realises [their] own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to [their] community'²³. Psychological wellbeing is a broadly similar concept referring to 'subjective satisfaction' based on an individual's 'perception of their health, happiness and sense of purpose'. It is increasingly studied across a wide range of occupational and geographical contexts, although remains a concept that is sometimes difficult to both precisely define and evaluate across all cases²⁴.

Psychosocial factors are critical determinants of occupational psychological wellbeing. These factors underpin how employees experience or feel about the various dimensions of the work they do. Poor working conditions typically contain a range of psychosocial factors that impact upon psychological wellbeing to produce negative mental health outcomes amongst employees²⁵.

Types of psychosocial factors

Psychosocial factors may be defined as 'social, cultural, and environmental phenomena and influences that affect mental health and behaviour'²⁶. The most commonly studied psychosocial factors in relation to occupational health and safety include:

- Job security and satisfaction
- Excessive workloads
- Conflicting and unreasonable demands
- Lack of control and influence
- Unclear communication
- Poor effort-reward management
- Qualitative underload (e.g. boring or repetitive work)

The PRIMA-EF framework developed by the Institute for Work, Health and Organizations provides a good overview of the range of psychosocial factors²⁷.

Globally, accident and incident data tends to capture physiological or biomedical factors (such as physical injuries or ill-health through exposure to specific working conditions) rather than psychological factors²⁸. The UK Health & Safety Executive (HSE), for example, calculate 1.4 million people suffering from a work-related illness in 2017/18 at an estimated cost of £15 billion, but do not divide this into physical and mental health²⁹. To gain some sense of the scale of the issue in the UK, the Stevenson/Farmer report claims that 300,000 persons with long-term mental health conditions lose their job each year, at an annual cost to employers of between £33 and £42 billion³⁰. This implies that an overlap exists which includes safety incidents, brought about (in part) through poor psychological wellbeing, and mental health issues which arise as a consequence of physical

23 WHO, 2004

24 Litchfield et al., 2016

25 Harries et al., 2015

26 <https://dictionary.apa.org/psychosocial-factors>

27 WHO, 2008

28 Rajgopal, 2010; Gilbert & Bilsker 2012; Zwetsloot et al., 2017; Oswald et al., 2019

29 HSE, 2020

30 Farmer & Stevenson, 2017

incidents. **Further knowledge regarding this overlap is required, together with better systems for recording the psychological components within accident and safety incident data which can improve understanding in this area.**

This is particularly relevant across the five sectors primarily covered by this report (maritime and energy, construction, engineering, food and digital). In agriculture for example, it is claimed that the first study of the relationship between mental health and occupational accidents was conducted just 14 years ago³¹. Practically all studies which have evaluated the mental health of hired farm workers – this is globally a substantial population – have occurred since the year 2000³². In some cases, this is because the workers involved are geographical widely dispersed and ‘hard to reach’ (e.g. Australian outback farm workers)³³. In some sectors, such as construction, studies are limited in size and scope due to the reticence of participants to discuss mental health issues³⁴. This extends to employers in many instances. Across the board, there are only a tiny minority of industries who have embraced the notion of psychological wellbeing wholeheartedly, and there exists concern that psychosocial factors often tend to be placed outside of the established hierarchy of risk management for many organizations³⁵. Despite the limitations and partial nature of existing studies, in this report we pull together what is known about the impact of psychological wellbeing on occupational health and safety within these five safety-critical sectors.

Farming and wellbeing in the UK

Psychological wellbeing within sectors tends to be related to psychosocial factors which are particularly acute because of the nature of the way work is structured within that sector. The Health and Wellbeing Research Report prepared by the University of Lincoln and Rose Regeneration (2019)³⁶ found a number of stressors unique to farmers and farming families in the UK. Many of these arise from factors which are inherently unpredictable and lie outside of farmers control (e.g. changing consumer habits, climate change). Lack of control at work is a psychosocial factor that is strongly correlated with poor mental wellbeing³⁷. The research draws attention to the need for interventions tailored towards these specific psychosocial factors in farming, in ongoing support for rural groups, and the need to establish a nationwide programme which can promote wellbeing among farming families and rural communities³⁸. There is data from Wales, UK which points to the particular psychosocial challenges that recent events, such as Brexit, have had on the farming sector³⁹. This includes financial pressures, regulatory and administrative burdens, difficulties with succession planning, isolation and loneliness, along with anxiety about the future viability of farming as a business. The traditions of farming culture can also be a barrier to seeking advice and support from others.

31 Glasscock et al., 2006
32 Hovey & Seligman, 2006
33 Brew et al., 2016
34 Oswald et al., 2019
35 Litchfield et al., 2016
36 WCF et al., 2019
37 WHO, 2004; Arcangeli et al., 2019
38 Lunner Kolstrup et al., 2013
39 Davies et al., 2019

Work related stress is one way of conceptualising the link between psychosocial factors and mental health. Stress can be thought of as the ‘conflict’ between the demands of work and the capacity of the worker to manage, control, or cope with these demands⁴⁰. The overall impact on safety at work can be conceptualised using multifactorial model, where numerous sources of demand contribute to a range of psychosocial factors that stressfully impact on psychological wellbeing⁴¹.

Figure 2 below draws upon the key principles and mechanisms from the Power Threat Meaning Framework (PTMF) to summarise and illustrate the key findings of this Rapid Evidence Assessment. We position inequalities (or ‘power’) as emerging from a range of ‘structural factors’ that are relevant to the organization of work within an occupational setting. These give rise to a series of specific psychosocial factors (experienced as ‘threats’) which challenge employees and impact upon their psychological wellbeing (the ‘meaning’ the employee makes of the threat).

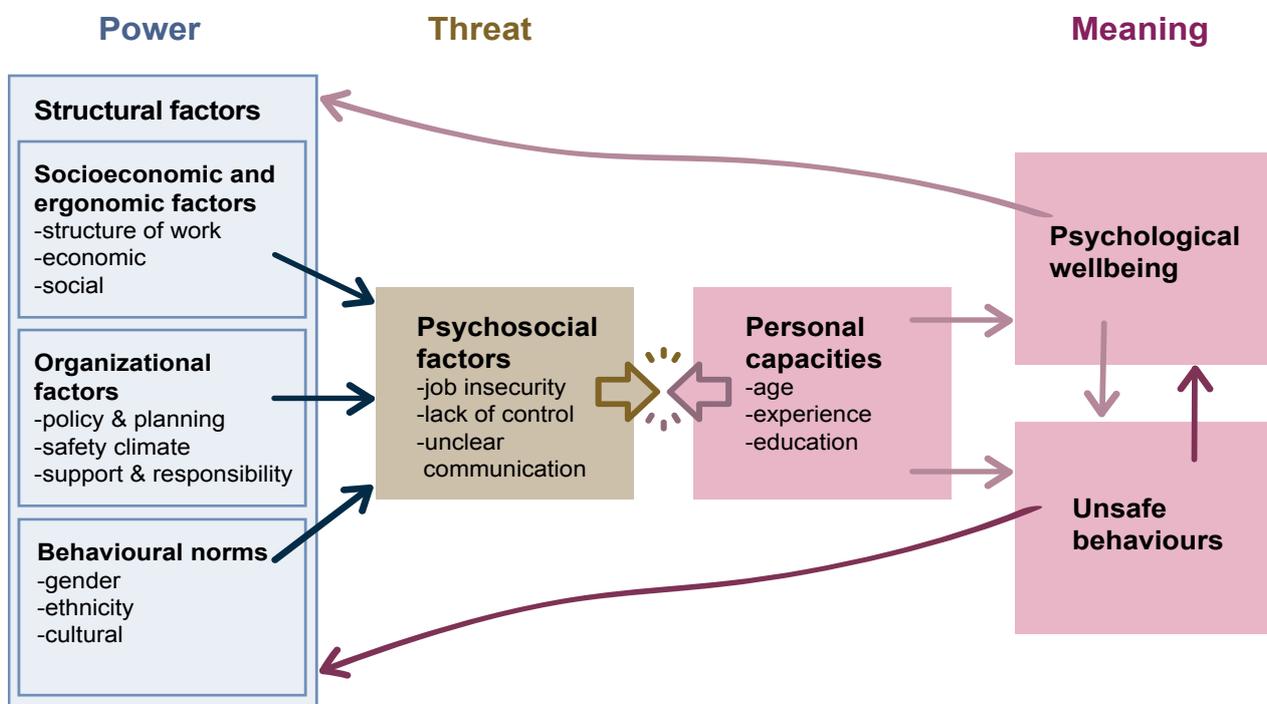


Figure 2. Multiple factors impacting psychological wellbeing and safety

Applying this model to a given occupation setting allows us to describe how unsafe behaviours and involvement in accidents or safety incidents occur as a consequence of how employees experience various psychosocial threats – such as employment insecurity, long working hours, lack of autonomy – as stressful demands in conflict with their personal capacities. Employees interpret these threats in ways which diminish their psychological wellbeing. They then respond in ways that can give rise to unsafe behaviours and other impacts on safety. **This would suggest that any interventions aimed at improving safety would need take a holistic approach to address all the relevant factors, rather than focus solely on buttressing personal responses to stress⁴².**

40 Cox et al., 2010; HSE 2018

41 Khosravri, et al., 2015

42 Buffet et al., 2013; Daniels et al., 2017

There are also ‘crisis incidents’ such as extreme violence or workplace death, which can exacerbate all aspects of the model and can create sudden and overwhelming sources of distress⁴³.

Different sectors have unique combinations of structural, organizational and behavioural factors. For instance, dairy farm operators are faced with physically demanding work and production methods and economic pressures, along with added social and ‘environmental responsibility’⁴⁴. There are also a number of broader structural factors, including disease outbreaks, taxation, and notably ‘negative societal attitudes’ in relation to the farming industry in general. **This unique combination of factors appears to be shared across countries and cultures.** The structure of working patterns within a sector leads to the emergence of similar psychosocial factors across regions. For example, job insecurity appears to be a predominant psychosocial factor within the construction sector due to the project-based nature of much construction work.

Combinations of factors may also persist over time. Bus drivers for example, currently tend to suffer similar levels of ill health and diminished psychological wellbeing to those reported over five decades ago⁴⁵. Various longstanding structural features of the work, including poor cabin ergonomics, rotating shift patterns and inflexible running times, have impacted on generations of workers, particularly in relation to physical (cardiovascular disease, gastrointestinal disorders, musculoskeletal problems, fatigue), psychological (depression, anxiety, post-traumatic stress disorder) and behavioural outcomes (substance abuse). This presents clear links to employee absence, labour turnover and accidents. Whilst it may be expected that there have been improvements over time, these factors have in fact been compounded by new work stressors, such as increased traffic, and levels of passenger violence.

The contribution of individual factors might also be considered to be shared across sectors⁴⁶. For example, international studies have claimed that younger workers tend to be more prone to workplace accidents than older peers⁴⁷. There is evidence that this is particularly the case in the transportation and fishing industries⁴⁸. However, data from the Chinese farming industry and Finnish local authorities directly contradict these findings, and even suggest that the opposite may be the case in these geographical and cultural regions⁴⁹. **This serves to indicate that individual and social/cultural factors interact in very specific ways in relation to safety and accidents**⁵⁰.

The role of ‘safety climate’ within organizations is a key factor within the model. A negative safety climate is where employees perceive that safety has been ‘deprioritised’. This is unsurprisingly associated with negative safety outcomes⁵¹. There is evidence that where there are dominant masculine norms within a sector – such as within construction, maritime or engineering – this impacts on how employees perceive and accept health and safety risks, resulting in a poor safety

43 Kendall et al., 2000; Michie, 2002; Better Health, 2012

44 Lunner Kolstrup et al., 2013

45 Tse et al., 2006

46 Daniels et al., 2017

47 Root, 1981; Laberge & Ledoux, 2011

48 Chau et al., 2014; Bull et al., 2001

49 Nenonen, 2011

50 Breslin et al., 2006

51 Clarke, 2010

culture⁵². Evidence from the UK occupational healthcare sector demonstrates that burnout – a negative condition which arises from excessive stress – also negatively impacts on safety climate and is associated with poor patient safety outcomes⁵³.

Safety climate and safety culture

Safety climate is a term for the ways that employees perceive and feel about safety within an organization⁵⁴. It encompasses values, attitudes and perceptions, based on experiences over time. Safety culture refers to what people do, based on the practice and norms – formal and informal – within and beyond the organization. Safety climate provides a ‘snapshot’ for how the current state of safety culture feels to those working within it at a given point.

Safety culture and safety climate can also be seen to influence one another. Evidence from the Ghanaian Oil and Gas Industry for example, demonstrated that the absence of safety systems ‘distracts employees’ regard for psychological well-being; therefore impeding ability to perform tasks and observe procedure⁵⁵. Additionally, a lack of safety knowledge on the part of employees was shown to increase the frequency of accidents, but also resulted in the intensification of psychological and emotional vulnerabilities of workers, with negative impact on their overall quality of life⁵⁶. **Despite the range of existing evidence, a comprehensive understanding of the ways in which safety climate is shaped at organizational level (and of the mechanisms through which this leads to individual outcomes) remains elusive⁵⁷.**

Precarious workers face greater risk of occupational accidents and poor outcomes for wellbeing overall

New and re-emerging forms of employment contract and the trend towards ‘lean’ production (producing goods and services with apparent ‘less waste’ of resources) together with outsourcing (i.e. using outside organizations for certain tasks/projects), has been found to impact wellbeing and affect workers’ health and safety. Among the findings of a report on occupational stress from the European Agency for Safety and Health⁵⁸, workers on precarious contracts (such as zero hours, fixed term, seasonal, agency etc.) were said to be more likely to carry out the most hazardous jobs, work in poorer conditions and receive less health and safety training. In addition, workers faced heightened risk of marginalisation as a result of successive short-term contracts and the resulting discontinuity in careers. Emerging patterns of isolation caused by new working patterns such as teleworking or temporary work were also highlighted. In unstable labour markets these developments are thought to increase workers’ feelings of job insecurity, which augments the level of work-related stress they face and may have a negative impact on workers’ health. Additionally, the rise of home-working and the normalisation of individuals with multiple jobs contribute to increased significance of non-standard forms of work. This echoes findings from a substantial body of literature across the social sciences that workers on non-standard contracts face higher job insecurity, poorer job conditions, higher job demands and a higher risk of occupational accidents⁵⁹.

52 Stergiou-Kita et al., 2015

53 Hall et al., 2016; Kao et al., 2019

54 Colley et al., 2013

55 Liu et al., 2020

56 McCaughey et al., 2013; Mearns & Yule, 2009

57 Clarke, 2010

58 European Agency for Safety and Health, 2002

59 Elcioglu, 2010; Arnold & Bongiovi, 2012; Institute for Policy Research, 2015; Muntaner, 2016;

Jethwa & Armstrong 2017; Choonara, 2019

There is a significant body of work on high risk and safety critical industries which demonstrates that maintaining psychological wellbeing plays an important role in maintaining safety standards⁶⁰. A wide range of interventions are reported in the literature⁶¹. Within the construction and retail sectors, for example, these include health and wellbeing programmes which offer features such as gym access/fitness at work; stress management; the aiding of smoking cessation; back/neck care; slimming and weight reduction/nutrition; and medication for chronic conditions⁶². Despite the popularity of these kinds of programmes with employers and employees, the overall effectiveness of promoting long-term improvements to psychological wellbeing is difficult to establish⁶³.

Interventions which are both more tailored to the nature of the work and take a more sustained approach appear to be more successful. For example, tailored training programmes for manual workers have been shown to reduce reports of work-related musculoskeletal back injuries⁶⁴. There have also been promising results for home exercise interventions and job-specific training interventions at work⁶⁵. Interventions which improve understanding of the connections between psychosocial factors which influence psychological wellbeing in both work and non-work contexts also tend to be more successful⁶⁶.

Explaining the lack of understanding of 'what works'

Given the huge number of interventions around psychological wellbeing and the raft of studies in the literature, it is surprising that there is not more clarity around 'what works'. Part of the problem is that not all occupational groups have been studied, and where they have been, they have not always been studied in the same way⁶⁷. It is difficult to establish what a clear outcome measure is for psychological wellbeing at work. Both absenteeism and presenteeism (where employees remain in work whilst their performance is impaired) are very difficult to define or evaluate properly⁶⁸. There are also large geographical gaps in the literature⁶⁹. Many studies use a cross-sectional design, collecting data through surveys and questionnaires and offering only limited understanding of one given point in time⁷⁰. This does not capture longer term trends, such as incremental improvements in psychological wellbeing or developmental shifts in behaviours⁷¹. There is a clear need for more longitudinal studies where researchers are able to look at interventions around and alongside other organizational changes. This should encompass a focus across the longer term, in order to better understand the range of actual outcomes that interventions produce and improve comprehension of which strategies provide the most positive impact overall⁷².

More systematic approaches to improving worker health and well-being via organizational, management and work design changes include prominent interventions such as the German health circles approach; Work Positive from Ireland; and Prevenlab from Spain⁷³. What these

60 Bjerkan, 2010; McVeigh et al., 2016; Gibson Smith et al., 2018

61 Murphy, 2018; Watson et al., 2018

62 Fenton et al., 2014

63 Bolier et al., 2013; Donaldson et al., 2019

64 European Agency for Safety and Health at Work, 2007

65 Ludewig & Borstad, 2003

66 Bolier, 2013; Donaldson et al., 2019

67 Michie & Williams, 2003; Hilton & Whiteford, 2010

68 Jensen et al., 2017; Maestas et al., 2020

69 Lu et al., 2013; Shimazu et al., 2016; Shan, 2017

70 Abbe et al., 2011; Pinion et al., 2018; Feng et al., 2020

71 Bolier, 2013

72 Donaldson et al., 2019

73 Nielsen et al., 2010

approaches share is the tailoring of interventions to the specific psychosocial factors involved in an organizational setting⁷⁴. They also share an emphasis on employee participation, which is accomplished by involving employees throughout the whole process from design to implementation. Participation of this kind ensures appropriate levels of ‘buy in’ across the organization. Whilst such approaches have provided some positive outcomes, these can also be blunted by broader structural changes within organizations (such as management changes which favour different approaches). **In order to reap maximum benefits, interventions need to be made integral to the core structure of a business practice rather than treated as either something ‘nice to have’ or as in place simply to fulfil legal obligations (as is the case with 63% of surveyed organizations with the EU-27)**⁷⁵.

Another critical success factor is the clarity with which interventions are framed. There is evidence that practices aimed at increasing employees’ psychological wellbeing can conflict with, and even contradict, those aimed at improving organizational performance⁷⁶. This is particularly the case where employees perceive wellbeing interventions to be primarily motivated by other interests, such as cost savings. For example, flexible working practices have long been regarded by industry leaders and policy makers as offering ‘mutual benefit’ to workers and enterprise. Whilst flexible working patterns can be seen to increase worker control and choice (resulting in positive effects on health outcomes), in instances where flexibility is seen by employees as being driven by ‘bottom-line’ organizational interests (such as a shift toward fixed-term contracts, involuntary zero-hour or part-time employment), this has resulted in unequivocally negative mental and physical health effects⁷⁷.

In summary, despite the tendency to focus on physiological factors in relation to safety, there is ample evidence that psychosocial factors have a significant impact on both safety culture and safety climate. Modelling this impact needs to take into account the specific combinations of structural and psychosocial factors found within a sector and understand how these are interpreted and responded to by employees. Workplace interventions which use this kind of information to design tailored, holistic approaches which are genuinely participative and clearly framed tend to be more successful.

74 Nielsen et al., 2017

75 Milczarek & Xabier, 2012

76 Loon et al., 2018

77 Joyce et al., 2009; Kattenbach et al., 2010; Uglanova & Dettmers, 2018

Psychological Wellbeing in Different Sectors

The five critical infrastructure sectors covered in this report – maritime, construction, engineering, food and digital – share a number of structural features around how work is organized. In general, the work can be physically demanding, either due to the physical labour involved or the long working hours and shift patterns⁷⁸. In some sectors this is coupled with high levels of qualitative underload (i.e. repetitive ‘boring’ work). It is well-established that this combination of working conditions can lead to high levels of stress which can be transferred outside of the work itself⁷⁹. These sectors also have high levels of peripatetic work, where employees either have to travel significant distances in order to work or are required to spend long periods of time away from home. This adds considerably to overall stress levels of the worker.

However, our primary concern in this report will be the combination of these physical structural features with the specific psychosocial factors which are found within each sector. As the model in figure 2 indicated, psychological wellbeing is predominantly impacted through the specific experiences and feelings that are generated as a consequence of perceived inequalities within the workplace. Understanding the specific combinations of structural and psychosocial factors within each sector is therefore critical to evaluating the relationship between psychological wellbeing and safety. It should also be noted that variability across roles within each sector can be mapped by taking this combination of structural and psychosocial factors into account. For example, administrative workers within the construction sector may not experience precisely the same structural demands, but the presence of behavioural norms around ‘masculine culture’ may result in similar psychosocial impacts (e.g. a sense of ‘lack of control’ because of behavioural rather than organizational factors)⁸⁰. Similarly, land-based workers in the maritime industry may not be subject to the same long shift patterns, but they can also suffer from similar problems with workforce cohesion that arise from the way work is organized within the sector.

Suicide and occupation: Socioeconomic factors now a dominant feature

A study in 2012 considered the notion that occupational suicide rates are often linked to easy occupational access to a method of suicide. Suicide rates across all occupations in the UK were compared, along with how they have changed over the past 30 years, giving due consideration for socioeconomic factors effecting each group. It was found that several occupations with the highest suicide rates (per 100 000 population) during 1979–1980 and 1982–1983, including veterinarians (ranked first), pharmacists (fourth), dentists (sixth), doctors (tenth) and farmers (thirteenth), all have easy occupational access to a method of suicide. By 2001–2005, there had been large significant reductions in suicide rates for each of these occupations, so much so, that none ranked in the top 30 occupations. Occupations with significant increases over time in suicide rates were found to be all manual occupations whereas occupations with suicide rates that decreased were mainly professional or non-manual. It was concluded that socio-economic forces now seem to be a major determinant of high occupational suicide rates in Britain. This reinforces earlier findings in similar studies across the world⁸¹ which suggest that access to methods is not a strong indicator of suicide by itself, but is instead one element within a complex interaction between job factors (e.g. work stress) and other risk factors such as age and presence of an existing mental health condition.

78 Pease & Raether, 2003; Townsend et al., 2012

79 Powell et al., 2018

80 Hetherington et al., 2006

81 Boxer et al., 1995; Skegg et al., 2010

Maritime and Energy Sectors

There are impacts to the psychological wellbeing of seafarers and other maritime workers across the globe. Commonly reported psychological issues include anxiety, depression, sleep deprivation and increasing experiences of isolation⁸². Mental health issues are considerably more common in contexts of peripatetic work (i.e. work at sea). For example, studies of merchant seafarers have shown that fatigue and perceived lack of support whilst working at sea lead to adverse effects to mental and emotional wellbeing⁸³. Although the nature of work amongst navy seafarers is not directly comparable to merchant seafaring, a large-scale study found that sailors for the British Royal Navy showed differences between sea and land-based working, with risk factors such as perceived poor leadership styles, low morale and a lack of cohesion amongst the workforce coming to the fore whilst working at sea⁸⁴. The material working conditions of life at sea can also negatively impact psychological wellbeing. Many of these factors will have significant consequences on overall health and wellbeing, not least due to the safety critical nature of much of the work undertaken and the level of health required when working 'remote from care'.

Those who work at sea may experience a number of psychosocial factors connected with their working conditions⁸⁵. This includes stressors such as constant exposure to dangerous/high risk situations; excessive or insufficient work responsibilities (monotony, or lack of stimulation and perspective development); fatigue, burnout, and biological disturbances from shift work; being confined in small spaces with the same group over long periods of time; separation anxiety (from friends and family); feelings of isolation⁸⁶. Long shift work can result in sleep deprivation, whilst having confined, mobile spaces to conduct work increases the potential for safety incidents⁸⁷.

In general, poor working and living conditions are correlated with an increased likelihood of injury and/or mortality at work, with seafarers being particularly vulnerable to issues of work-related stress and isolation⁸⁸. The literature indicates that organizational support for maritime workers can sometimes be limited⁸⁹ and maritime managers face the challenge of balancing commercial interests with the welfare of individual seafarers in a competitive market with tight margins⁹⁰.

It should be noted, however, that there is evidence of good initiatives in relation to psychological wellbeing throughout the sector⁹¹. There are also numerous recommendations which have been developed within the industry. These include reduction of work overloads via simplified procedures and increased crewing levels sufficiently able to cover duties required; improved focus on scheduling and task demands; better monitoring of fatigue levels; overall review for periods of maximum continuous service at sea; and improved security of employment, with due emphasis on

82 Andruskiene et al., 2016; Mellbye & Carter, 2017
83 Doyle et al., 2016; Hystad, Nielsen & Eid, 2017
84 Whybrow et al., 2016
85 Lu et al., 2016
86 Jeżewska et al., 2006
87 Chambers & Main, 2015; Mette et al, 2018; Borovink, 2011
88 Oldenburg et al., 2010; Rosanov, 2020
89 Xiao et al, 2017; McVeigh et al., 2019
90 De la Campa Portela & Gil Pérez, 2016
91 Rozanov, 2020

the provision of means to secure and sustain a full career at sea. It has also been suggested that awareness among those working at sea (from junior to senior level) should be raised with regards to the importance of psychosocial factors and that ways to discuss and resolve problems be considered a priority whilst on board⁹².

Improvements to reduce human factors as a cause of accidents in maritime

In recent decades, much focus has been placed on technological improvements which may aid in the reduction of accidents and incidents within the maritime industry. This includes concerns with overall structure of vessels, onboard systems and other improvements designed to increase efficiency and productivity within the sector. However, despite these advances, the overall occurrence of accidents remains high. Decision makers within the sector place emphasis on the human aspect; the 'system of persons' and their human needs and expectations when managing the working pressures imposed upon them under difficult circumstances out at sea. The efficient planning of the living and working conditions for those on board must take into account a number of psychosocial characteristics of the crew members. These can include issues around the uncertain supply of experienced officers and seamen; difficulties associated with the formation of excessively reduced crews; cohesion issues sometimes associated with multicultural crews (such as language difficulties which may impact awareness of duties, and lack of training). Solutions to such issues require appropriate levels of long-term investment in the human system⁹³.

Within the energy sector, it has been found that structural factors such as increased labour intensity and poor working environments impact upon psychological wellbeing⁹⁴. This can interact with other factors. For example, in China young workers have been found to experience high levels of depression, feelings of isolation and other psychological problems at greater levels than their older, more experienced colleagues⁹⁵. The low mental health of miners in China is now more widely recognised, with efforts to improve the psychological wellbeing of mine workers becoming a 'core' aspect in the future of safety management. The implementation of behaviour-based safety management is one method which has proven effective in positively impacting the mental health of mine workers. However, this method of safety management has also provided different effects in the overall improvement of psychological indicators of miners. More research is required in order to better understand any potential long term effects⁹⁶. Interventions which are aimed at providing organizational support have also been found to be effective within and across different countries. For instance, good leadership, which fosters a sense of shared identity within the workforce, has been seen to foster a positive working environment and promote good health and wellbeing⁹⁷, with emphasis on the importance of community and social relations, whilst also combatting issues of isolation, depression and other psychological issues⁹⁸.

92 Carter, 2005; Pawar et al., 2012; Bal et al., 2015

93 De la Campa Portela & Gil Pérez, 2016

94 Amponsah-Tawiah et al., 2014

95 Sun, 2016

96 Yu & Li, 2019

97 Steffens et al, 2018

98 McPhedran & De Leo, 2014; James et al., 2019

Construction Sector

Significant structural issues have been found to dominate the construction industry, including long working hours, job insecurity and high levels of workplace stress⁹⁹. The widespread prevalence of subcontracting and short-term contracts has also proven problematic, resulting in increased uncertainty and anxiety amongst the workforce along with other psychosocial factors¹⁰⁰. The severity and prevalence of negative impacts on mental and emotional wellbeing within the construction industry has been repeatedly underlined¹⁰¹. Common issues such as substance abuse and workplace bullying have been found to remain prevalent¹⁰². Interventions which have aimed to directly improve working conditions and security of work have demonstrated some clear contributions to better health outcomes¹⁰³. Nonetheless, too many organizations appear to focus on the physical safety of the workforce at the expense of psychological wellbeing¹⁰⁴, with practices such as alternative work schedules currently offering promising solutions in this area¹⁰⁵.

The importance of gender

The issue of gender appears to be common across the majority of work sectors explored in this report. In the engineering context, for example, women are observed to suffer significantly more than men in terms of workplace stress and other psychological issues¹⁰⁶. The construction industry remains largely male-dominated; with the issue of masculinity in this context linked to issues of psychological wellbeing¹⁰⁷. Women workers, for example, were observed to work double their contracted hours in order to be in-line with male counterparts. All of which raises important implications for a healthy work/life balance¹⁰⁸. There are also some extreme cases where the disparity of gender is highlighted within global and cultural contexts. In Zambia for instance, female fish traders buy fish from fishermen, process the fish and travel long distances to sell these products in markets. These women are sometimes forced to engage in transactional sex processes whilst transporting goods to and from fish camps. These 'fish for sex' negotiations leave the women particularly vulnerable to HIV infection not to mention ongoing psychological trauma from these experiences. Transportation negotiations with fisherman and the subordinate social and economic social position of women in such fishing communities within sub-Saharan Africa are important drivers of HIV risk amongst female fish traders¹⁰⁹.

An in-depth comparison of female and male construction professionals has shown that poor mental health includes issues of stress, panic attacks, insomnia and fatigue, anxiety and strains on family life¹¹⁰. Whilst female workers appear to be affected more adversely in comparison to men, females are also observed to play up to the male stereotypes said to dominate the industry – often working more than the double the time of their contracted hours, which raises important

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- 99 Park et al, 2016; Barnay, 2016; Bowers et al, 2018
100 Carmichael et al., 2016; Kleiner et al, 2015; Bala et al., 2016
101 Oswald et al., 2019
102 Lim et al., 2017; Pidd et al., 2017
103 Barnay, 2016
104 Carmichael et al., 2016
105 Oswald et al., 2019
106 Urnikye & Kaminskis, 2011
107 Carmichael et al, 2016
108 Lim et al, 2017
109 Béné & Merten, 2008
110 Powell et al, 2018

implications for a healthy work-life balance¹¹¹. Studies from Australia have also shown that women in the construction industry appear to be more anxious than men and are observed to experience high levels of discrimination, workplace bullying and sexual harassment. Surprisingly however, there is currently little evidence for gender difference in depression on current measurements, and the main stressors experienced by female workers are the same as for male workers¹¹². Gender then demonstrably adds an additional range of psychosocial factors within this industry¹¹³.

One of the most successful intervention programmes around psychological wellbeing in the construction sector is the MATES initiative operating in Australia¹¹⁴. The programme aims to raise awareness of suicide as a preventable problem, build stronger and resilient workers, provide help and support, and collaborate with researchers to present best practice approaches around mental health to the industry. Core interventions include training and assistance which aim at breaking down taboos and providing guidance on having conversations with each other about suicide and ill mental health. There is also an external support network who support workplace volunteers to create onsite support networks, prevent suicide and establish mentally healthy worksites. A blueprint published in 2018 also sets the Australian Building and Construction industry at the forefront of mental health protection internationally through its efforts to provide mental health and suicide prevention literacy¹¹⁵.

Engineering Sector

The primary structural factor which emerges from the large body of evidence on the engineering sector is that of the time pressures, including both the pace of work and its overall timing¹¹⁶. The most commonly reported effects on psychological wellbeing include problems with concentration, emotional stress, anxiety and depression¹¹⁷. The relationship between job strain and increased risk of cardiovascular problems has also been demonstrated in this sector¹¹⁸. Work experiences in the engineering context have also been linked to ergonomic issues in modern offices, demonstrating a need to redesign offices to prevent adverse psychological outcomes for workers¹¹⁹. At a broader psychosocial level, it has been reported that psychological distress in the workplace is related to a sense of contribution to society¹²⁰. Workplace bullying has also been correlated with psychological wellbeing in this sector¹²¹. There is a significant body of evidence that shows that workplace bullying is associated with organizational factors, suggesting that in this case the way engineering work is structured facilitates this psychosocial impact¹²².

111 Lim et al, 2017; Powell et al, 2018

112 Sunindijo & Kamardeen, 2017

113 Kotera et al., 2019

114 MATES, 2020

115 Australian Construction Industry, MATES, Beyond Blue, & University of Melbourne, 2018

116 Kuutila et al., 2020

117 Frutiger et al., 2019

118 Habibi et al., 2015

119 Bridger & Brasher, 2011

120 Ozaki et al., 2012

121 Rosario-Hernandez et al., 2018

122 Feijo et al., 2019

Research in this area indicates that there are gender differences in the experiences of work stress and other psychological issues, with women tending to suffer more than men in terms of workplace stress¹²³. Workers without higher education also appear to be particularly vulnerable to these experiences of work – which may be due to increased pressure¹²⁴. Particular solutions to some of the issues highlighted above include alternative work arrangements and support. For example, a study with Canadian workers found that higher levels of job control, social support and security were associated with improved psychological health¹²⁵. Again, this suggests that it is the feelings provoked by workplace activities rather than the physical nature of the work itself that has the greater effect on psychological wellbeing.

Food Sector

The food sector includes a diverse range of occupations and working conditions. Farming, for example, has been extensively studied in relation to stress and mental health outcomes; notably quantitative research which covers stress, suicide and depression. However, whilst it was found that some geographical regions had a substantial body of literature, there remain some significant knowledge deficits; including the prevalence of mental health outcomes, how they are impacted by risk and protective factors, and which intervention strategies were likely to be most impactful¹²⁶.

In the food processing parts of the sector, there is clear evidence of widespread ergonomic issues, primarily around adopting long standing positions over a significant amount of time¹²⁷. The physical impact this has upon health can also result in diminished psychological wellbeing. One psychosocial factor which is very particular to this sector is that of the impact of ‘dehumanising’ work, such as that involved in animal butchery labour. Workers in US slaughterhouses have been observed to experience a higher prevalence of psychological distress relative to the wider US population in other roles¹²⁸. Work in these roles involves cutting and chopping non-human animals in order to prepare and process food. There is a tendency to enter this workforce on vocational programmes at a comparatively young age (e.g. 15 years old). This can be particularly damaging in emotional and mental health contexts¹²⁹; with the normalisation of such violence within an employment context also raising clear and important ethical implications for individuals at the level of the organization and society.

Digital Sector

Commonly reported mental health issues within the digital sector include work-related stress, depressive symptoms and some evidence of alcohol abuse¹³⁰. As with other sectors discussed in the report, the use of short-term contracts results in concerns around uncertain working hours and inconsistencies in income¹³¹. Contract workers particularly experience increased levels of work-life

123 Urnikye & Kaminskas, 2011
124 Ritchie, 2018
125 Fan et al., 2019
126 Hagen et al., 2019
127 Mohd Fazi et al., 2017
128 Leibler et al., 2017
129 Blaznik, 2018
130 Darshan et al, 2013; Dinghra et al, 2013
131 Sayah & Suess, 2013

conflict, which contributes to poor psychological wellbeing¹³². There is also some evidence to suggest that there are gender differences in the experience of digital related work. For example, research into call centre work shows gender difference in terms of emotional competence and quality of life¹³³. However, the evidence is mixed across global regions as to whether female or male workers demonstrate higher emotional competences, which may reflect broader cultural patterns in the norms around displays of emotionality at work¹³⁴.

There are some specific structural features which characterise work in the digital sector that impact on psychological wellbeing. For example, IT project management has been shown to involve considerable levels of stress resulting from dual pressures including those of organizational demands and those relative to managing the needs of multiple stakeholders¹³⁵. The so-called 'dark side' of information technology has also demonstrated issues resultant from control by technology itself and management, with difficulties in switching off from work, poor work/life balance, issues surrounding job security and the continuous need to adapt to new working practices¹³⁶. This raises the need for specific kinds of organizational support and intervention, including managerial-level support (e.g. processes of cooperation), and the facilitation of autonomy and flexibility in job roles¹³⁷. The kinds of support which have been recommended within the literature involve building relationships between employers and employees where transparency around digital connectivity and surveillance can be maintained. The use of 'private spaces' or times where employees can communicate without being surveilled can alleviate the stresses of constant connectivity¹³⁸. This can be extended to entirely 'email free' days within the working week¹³⁹.

In summary, the five sectors discussed in this report are characterised by hard physical work in terms of structural factors and difficult emotional work with respect to psychosocial factors. There are some specific common features. For example, the prevalence of masculine cultures come with associated behavioural norms that facilitate workplace bullying and discrimination¹⁴⁰. The use of specific kinds of contractual arrangements (i.e. fixed term, rolling short-term and zero-hour contracts) can also create high levels of uncertainty across the sectors¹⁴¹. This results in specific combinations of structural and psychosocial factors that may be shared across otherwise distinct forms of work, producing similar impacts on psychological wellbeing (for instance, substance abuse and presenteeism as a result of long working hours on insecure contracts)¹⁴².

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- 132 Gisler et al, 2018
133 Kamboj et al., 2015
134 Smith Major et al, 2002; Hill et al., 2010; Henke et al., 2016
135 Smith et al., 2011
136 Tarafdar et al., 2015
137 Ganensan & Jegatheeswari, 2017; St Hilaire et al., 2018
138 Akhtar & Moore, 2016
139 <https://plandigitaluk.com/no-email-day/>
140 Stergiou-Kita et al., 2015
141 European Agency for Safety and Health, 2002
142 Lim et al, 2017; Pidd et al, 2017

The Impact of Developing Technologies of the 4th Industrial Revolution on Safety in the Workplace

The 4th Industrial Revolution (also known as 4IR) is a term coined by Klaus Schwab to describe a post digital revolution world¹⁴³. It is characterised by a range of new technologies which blur the boundaries between physical, digital and biological worlds, with developments said to be impacting 'all of human existence as we know it'; from shaping social norms to national and global policy making¹⁴⁴. The most common impact on psychological wellbeing associated with 4IR is the 'hyper-acceleration' of work processes¹⁴⁵. This takes the form of a constant time pressure and intensification of the levels of work. This arises, in part, because new technologies can multiply the amount of connections a given employee has with others within and outside their organization, along with a tendency to see technological changes as requiring wholesale changes in organizational structure¹⁴⁶. The use of new smart technologies at work is often accompanied by time pressure, work interruptions, multitasking and the erosion of boundaries between work and life (since work can be more easily 'taken home')¹⁴⁷. There is evidence to suggest that the acceleration of work in this way results in stress, anxiety, burnout, and work-family conflicts¹⁴⁸. The mechanisation of work has long been associated with feeling of alienation and dehumanisation, but evidence suggests that emerging digital technologies compound this by creating a sense that employees are 'always on' and unable to ever really properly disconnect from work¹⁴⁹. At a broader level, there is evidence to suggest that as robots and advanced machines increasingly replace humans in accomplishing manual tasks in the age of 4IR, workers experience mentally challenging jobs and, as a result, report more cognitive health complaints¹⁵⁰. Research suggests that workers in the service sector (i.e. retail, real estate, finance, insurance, scientific, and technical services) who feel that their jobs might be replaced by smart technology are more likely to report cynicism and depression¹⁵¹.

The use of new technologies to quantify and determine workers' productivity and performance (i.e. data-driven systems of management) has become a defining aspect of the 4IR¹⁵². The implementation of electronic monitoring and surveillance however can lead to the eradication of trust in organizations¹⁵³. Heightened levels of anxiety, fear and insecurity tend to arise within work environments guided by performance metrics, data analytics, and ubiquitous surveillance devices¹⁵⁴. Central to these concerns are the new technologies' spill over effect into workers' private lives and the increasing role of data in determining life-chances and choices¹⁵⁵. It is important to consider how the trend towards continuous monitoring of performance and data-based rating features of new technologies – e.g. ratings given to individuals by customers – can impact on the psychological wellbeing of workers, particularly those operating within the gig economy¹⁵⁶.

143 Xu et al., 2018

144 Zervoudi, 2020; Philbeck & Davis, 2019

145 Sandoval-Reyes et al., 2019

146 Sonnentag & Bayer, 2005; Golden & Wiens-Tuers, 2008; Sandoval-Reyes et al., 2019

147 Evenstad, 2018

148 Müller-Thur et al., 2018

149 Sandoval-Reyes et al., 2019

150 Coldwell, 2019; Stenfors et al., 2013; Wixted et al., 2018

151 Brougham & Haar, 2018

152 Ball et al., 2016

153 Holland et al., 2015

154 Moore & Piwek, 2017

155 Min et al., 2019

156 Garben, 2017

The gig economy

The gig economy is a term associated with work in the so called 'new economy' and the shifting conditions of business, often characterised by short-term contracting and freelance, where precarious forms of work become the norm. This is driven in part by the emergence of 'platform labour' facilitated by technologies of the 4IR, such as digitisation, remote and flexible working, self-employment through digital platforms etc. Here both physiological and psychological risks and safety are transferred as more a matter for the individual worker to manage, since much of the work is positioned as taking place outside of the organizations which commission it. Workers unions and action groups however, continue to advocate the need for tighter regulations within these increasingly normalised modes of production, and for governments across the world to better enforce what is seen as a continued 'stripping back' of worker's rights¹⁵⁷.

By performing work-related activities (often outside of normal hours and any kind of typical working schedule) via ICT devices and smartphones in particular, workers stay psychologically occupied with work and, subsequently, job stressors remain present. Empirical studies show that workers who stay online during off-job hours and answer work-related messages with their smartphones or ICT devices cannot detach themselves from work psychologically as the time spent on work takes time away to recover from job stressors, which ultimately deteriorates their psychological wellbeing¹⁵⁸. To address this, some organizational policies may be applied – such as encouraging employees not to contact colleagues during off-job hours, and if doing so, mentioning in their communications that a response is not expected until the next workday. At the individual level, measures such as putting smartphones away or leaving them behind at the workplace might be required. More generally, it is thought that those who have access to mechanisms, such as organizational support and friendship opportunities, are better suited to cope with technology-led insecurity and fear¹⁵⁹. Nonetheless, there are a number of clear dangers to workers' health which have arisen from a culture that allows individuals to be 'always connected' to their work. An urgent priority therefore is to ensure that such risks are better understood and promptly addressed.

Digital technologies can also have a positive effect on psychological wellbeing. Automated screening techniques have been developed for psychological difficulties such as stress, anxiety, and depression¹⁶⁰. For example, GPS data collected from mobile phone can act as a powerful predictor for affective problems including depression and social anxiety¹⁶¹. Changes in mental states can be discerned through the algorithmic detection of voice intonations, computer mouse and keyboard use-patterns¹⁶². The use of machine learning technologies in this way can improve the accuracy and precision of existing screening techniques¹⁶³. There is also evidence for the effectiveness of digital psychological interventions at work, provided through internet, mobile technology, or software. These have been shown to have a moderate positive effect on psychological wellbeing (i.e. stress, depression, and psychological distress), with interventions

157 Vallas & Schor, 2020

158 Golden & Wiens-Tuers, 2008; Sonnentag & Bayer, 2005

159 Goetz & Boehm, 2020

160 Lee et al., 2019; Farzanfar & Finkelstein, 2012

161 Chow et al., 2017; Hellhammer et al., 2016

162 Hibbeln et al., 2017; Malhi et al., 2017; Solanki & Shukla, 2014; Hagiwara et al., 2017

163 Sau & Bhakta, 2019

delivered over a shorter time frame (6 to 7 weeks) and using elements of persuasive technology (i.e. self-monitoring and tailoring) having the greatest engagement and adherence¹⁶⁴. Intervention through wearable technologies also demonstrates some moderate positive results. For example, a study of a large technology company found a modest reduction in reports of stress and distress from a four-week intervention based on wrist band monitors in comparison to a control group¹⁶⁵. As is the case with other kinds of interventions around psychological wellbeing, building trust between stakeholders as to the purpose of the intervention is critical. Collaborations between app developers, health behavioural change professionals, experts on psychological wellbeing, and end-users have the potential to improve the effectiveness of these kinds of digital interventions¹⁶⁶.

New technologies = new problems

Technology is sometimes viewed as having a 'double edged identity' within the contemporary workspace¹⁶⁷. Recent studies exploring the psychosocial impacts of technological change in contemporary workplaces for example, have suggested that new technology together with digitisation has created a number of new problems for workers. Notably, there are changes in control methods leading to new pressures; with the 'agile' workplace also allowing for a global division of labour, together with outsourcing of routine work. Additionally, there have been increased pressures in factory and manufacturing, where labour practices are often regulated externally. A number of ethical concerns have also been raised within the realm of electronic performance monitoring (EPM). EPM can be defined as including email monitoring, phone tapping, tracking computer content and usage times, video monitoring and GPS tracking. The longest history of EPM was found in service/ call centre work¹⁶⁸, where various types of surveillance have facilitated lean working practices. Emotion tracking is also considered a standard activity in contact centres throughout India¹⁶⁹. Here the data produced from new technologies may be used as productivity indicators which can show the employees' location; email usage; website browsing; printer usage; telephone activity; even tone of voice and physical movement during conversation. Such practices are said to have become increasingly normalised throughout the world. This presents a number of ethical concerns not least in the way in which it may be used to micromanage employees and invade privacy. Along with being morally dubious, at the very least, such practices have been seen to lower job satisfaction, increase stress levels, reduce trust, and therefore negatively impact the social aspects of the working environment. All of which may lead to the creation of poor psychosocial conditions.

Teleworking is a key area in which the impact of the 4IR on psychological wellbeing has become readily apparent. Before the COVID-19 pandemic, only about one in five workers reported frequent teleworking (also referred to as telecommuting, remote work, e-work, virtual work, distance work, distributed work, home-based work), and only about one in ten reported full-time working at a site other than the central office¹⁷⁰. Since the emergence of the pandemic, however, teleworking has become the predominant work mode across the globe and generated significant interest from organizational practitioners and decision-makers alike.

164 Carolan et al., 2017

165 Smith et al., 2020

166 de Korte et al., 2018

167 Akhtar & Moore, 2016

168 Taylor et al., 2002

169 Van Jaarsveld & Poster, 2013

170 Reaney, 2012

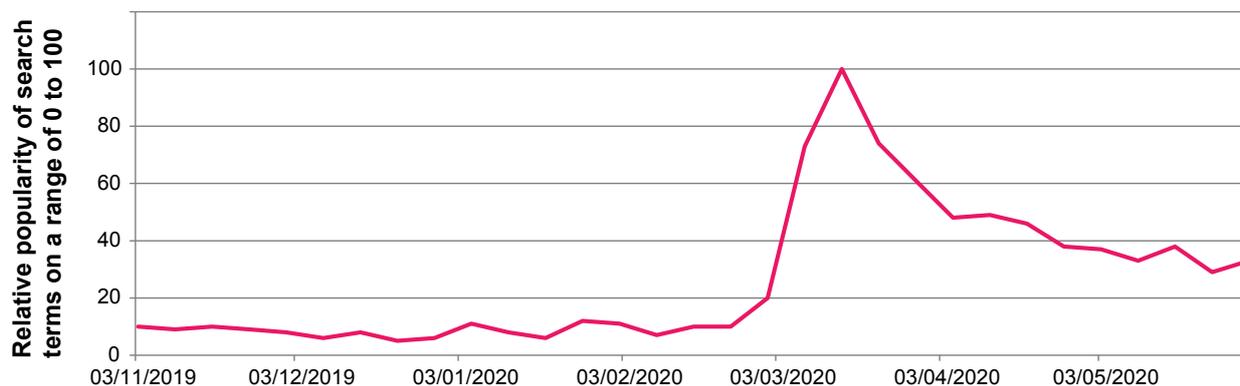


Figure 3: Evolution of searches for the term “teleworking” on Google, worldwide. (Source Google Trends).

Studies of teleworking have considered a range of factors that are relevant to safety and psychological wellbeing, including performance, career progression, withdrawal behaviour, job satisfaction¹⁷¹. The results have been mostly inconclusive. We cannot definitively say whether teleworking is universally good or bad for employees¹⁷². There are numerous well-designed, well-implemented studies that show teleworkers experience significantly more mental health symptoms as a consequence of stress when compared with office workers¹⁷³. And there are equal amounts of high-quality studies which have found the opposite to be the case¹⁷⁴. Similarly, there are mixed results in studies of the impact of teleworking on work-family balance, with some studies pointing to the negative effects on psychological wellbeing of a blurring of boundaries between work and family life and others pointing to the advantages of flexibility¹⁷⁵. The problem here arises because the specific nature of the work being performed is rarely considered, and the very particular combination of psychosocial factors in which the work is being conducted are also understudied – for example, caring responsibilities, the size and nature of any family, the extent to which teleworking reduces the opportunities the workplace provides for social engagement etc¹⁷⁶.

In summary, the 4th Industrial Revolution has direct and indirect impacts on psychological wellbeing. The changing nature of some forms of work presents some direct challenges, particularly through the accelerated pace of work and the constant connectivity of the employees to the workplace. But equally important is the changing emotional relationship to work that is created through a blurring of the boundaries between work and home and the sense of being continuously monitored. This is particularly acute in telework or home-working, as has been demonstrated during the recent COVID-19 pandemic. Interventions to support psychological wellbeing will need to primarily work on organizational levels of support, addressing in particular the sense of insecurity and absent peer support that some technological changes can bring about.

171 Allen et al., 2015; Gajendran & Harison, 2007

172 Gajendran & Harison, 2007

173 Mann et al., 2000; Mann & Holdsworth, 2003; Weinert et al., 2014

174 Gajendran & Harison, 2007; Hill et al., 2010; Maruyama & Tietzse, 2012

175 Smith Major et al, 2002; Ayyagari et al., 2011; Ellison, 1999; Felstead & Henseke, 2017; Golden et al., 2006; Hornung & Glasser, 2009

176 Ward & Shabha, 2001; Hill et al., 2010

The Impact of COVID-19 on the Return to Work

Communities who have undergone quarantine and isolation are likely to suffer severe impacts to their mental health¹⁷⁷. These can include reported negative psychological effects such as symptoms of post-traumatic stress, anxiety, 'confusion, and anger' brought about by stressors such as prolonged quarantine, fears around infection, lack of resources, contradictory information, financial loss and boredom¹⁷⁸. This suggests that many workers may be returning to work with greatly diminished psychological wellbeing. Indeed, a significant number of workers across the five sectors discussed in this report will have been either furloughed or asked to work from home during the COVID-19 pandemic. There is some emerging evidence which indicates what the impact will be on psychological wellbeing of this change to working conditions.

The emerging literature suggests that lack of information or conflicting 'health messaging' increases insecurity and heightens anxiety¹⁷⁹. It is then vital that the arrangements put into place to manage infection control within the workplace are clearly explained with a communication strategy that avoids inconsistencies or contradictions, uses plain language and ensures that the reasons for measures are clearly communicated¹⁸⁰. This includes format and delivery modes, alongside risk communication in order to address how this may vary and maximise effect for diverse groups. Evidence which has emerged from China and Thailand suggests the main priority areas for addressing the wellbeing of the workforce during the pandemic include meeting basic daily needs; enhancing communications for delivery of current, reliable, and reassuring messages; and developing robust psychosocial and mental health support options¹⁸¹.

Some workers across the five sectors may have acted as 'frontline' or 'key workers'. The evidence here suggests the likelihood of developing symptoms consistent with post-traumatic stress disorder, depression, and of substance use disorders¹⁸². This may present as a 'deadly combination' of untreated/undertreated signs of depression which should be managed through timely screening, triaging and referring of workers to appropriate services. Key workers can often be reluctant to take up formal support, making it imperative that support is provided proactively¹⁸³. Psychological support has been found to be effective here¹⁸⁴. Organizations should also seek to safeguard the morale and mental health of workers through measures such as shorter working hours, regular rest periods, and rotating shifts for those working in high-risk areas¹⁸⁵. As with other interventions discussed in this report, it is vital that workers feel confidence in the motivation underlying the intervention so that they can access support without fear of being blamed.

Understanding between experts and governments is vital to the formulation of effective strategy both for the public and in terms of conduct across enterprise. This is particularly true for industries which are expected to continue to provide key services during pandemics. All communication must be informative, clear and concise with measures fully outlined, and the impact of 'misinformation' minimised. Mental health should be considered a key concern for the entire population (with due

177 Hossain et al., 2020
178 Brooks et al., 2020
179 Holmes et al., 2020; Brooks et al., 2020
180 Holmes et al., 2020
181 Li et al., 2020 ; Yao et al., 2020
182 Gold, 2020
183 Kinman et al., 2020
184 Cao et al., 2020
185 Ho et al., 2020

focus on vulnerable groups and those working on the frontline). This is crucial to achieve the best possible outcomes and to provide a solid platform to allow recovery from the pandemic. Psychological wellbeing is not only central to maintaining morale, it is intertwined with physical health (notably maintaining a healthy immune system). Workers must feel valued, and as part of this must know that their own safety is of a high priority. Organizations should prioritise mental health support and employ strategies which can minimise psychological risk during the pandemic and following any resolution to the crisis. This is paramount for those on the front line; especially those tasked with the success of healthcare and service delivery.

Remote working during COVID-19

A study of employees remote working in the IT and E-Commerce sector during the COVID-19 pandemic, indicated that communication, organization climate, organization policies, job satisfaction and psychological factors all significantly influenced psychological wellbeing during this period¹⁸⁶. Amongst the issues found were:

- Overworking
- Lack of human interaction and loneliness
- Balancing multiple shifts and covering different working zones
- Bad health habits (lack of exercise etc)
- Isolation and lack of support (a particular issue for workers who are less tech savvy)

In addition, a misconception was found within the company culture that felt employees were 'not reaching their full potential', and may 'work only to the targeted tasks which are considered important', whilst the rest of the time they were thought to 'relax'. Though the quantification of a service and intangible benefit is complex, the authors stress that managers must find a way to overcome this misconception and better recognise what is taking place during a pandemic and how this will impact the workforce on a human level.

Concluding Remarks and Recommendations

The best available data illustrates that concerns regarding psychological wellbeing constitute one of the primary health concerns of this century, with some predicting that if current trends continue, mental health will become the leading cause of mortality and morbidity worldwide by the end of the next decade. As such, the human and economic cost caused by the ongoing neglect of mental health worldwide should already be considered both damning and alarming; this is at a time when, prior to a global pandemic, both were already considered to be highly underestimated. It is therefore vital that policy makers, industry leaders, and those with influence better recognise and prioritise mental health as the global crisis many organizations already deem it to be.

This rapid evidence assessment has drawn together the evidence base around five sectors which are responsible for the 'critical infrastructure' of modern life and where safety issues are paramount – maritime/energy, construction, engineering, food and digital. Across all these sectors, it is clear that whilst there is a substantial body of work in relation to psychological wellbeing, the physical aspect of safety still tends to remain the primary concern. However, understanding the relationship between structural aspects of work and the psychosocial factors that they give rise to appears to be key to designing and implementing successful interventions. Holistic interventions that are tailored to the specific relationships between structural and psychosocial factors have overwhelmingly been demonstrated to be the most effective strategies. On that basis, we offer the following recommendations:

- Psychological wellbeing needs to be treated as equally important as physiological health in reviewing and evaluating safety practices in occupational settings. This is a fundamental principle for securing improvements in safety practices;
- Better systems for recording data around psychological wellbeing need to be developed, which are both sensitive to the stigma around declaring mental health conditions, and able to distinguish between transient fluctuations in mood and longer terms impacts;
- Mental health should not be treated as an 'individual' matter, but is instead grounded in how employees experience the ways in which work is organized. Addressing mental health in the workplace needs to begin with analysing the structural factors in occupational settings which give rise to perceived inequalities. Non-diagnostic approaches to mental health, such as the Power Threat Meaning Framework (PTMF) are valuable tools for this kind of analysis;
- The model we have provided in this rapid evidence assessment can be used to map the ways in which employees interpret and respond to perceived inequalities in the workplace. For example, it could be used as a framework to support a dialogue between managers, employees and other stakeholders that seeks to identify what aspects of the workplace generate threats to wellbeing, and the ways in which employees respond to these threats in ways relevant to safety practices;
- Whilst structural factors have a clear influence on psychological wellbeing, it is psychosocial factors which give rise to the emotions that are central to mental health. It is the specific combination of structural and psychosocial factors which determines the impacts on employees, and which need to be mapped with respect to any given sector. There are a wide range of resources which might inform this mapping, including the PRIMA-EF framework developed by the Institute for Work, Health and Organizations¹⁸⁷;

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- There are numerous examples of good practice in relation to psychological wellbeing across the five sectors considered in this report. What they have in common is taking a holistic and sustained approach that becomes embedded within the long-term strategies of the organizations concerned and which facilitates participation across levels. Interventions that deliver long-term benefits need to be designed at this scale and aim for a corresponding level of buy-in across all stakeholder groups within the organization;
 - The 4th Industrial Revolution will result in significant changes to the way that work is organized across sectors involved in critical infrastructure. The current evidence suggests that it is not possible to make global evaluations of how trends such as teleworking impact on psychological wellbeing. In line with the recommendations above, it is knowledge of the specific psychosocial factors in play within a given organizational setting that will be crucial to understanding how the 4IR shapes safety-relevant behaviours;
 - As employees in the five sectors considered in this report begin to adjust to the new ways of working that have emerged during the COVID-19 pandemic, the key psychosocial factors that impact on the psychological wellbeing of employees are a perception of clarity in the information provided and a feeling of being valued by employers. Managing successful transitions during and after the pandemic will require organizations to address both issues systematically.

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Appendix: Procedure Used for Rapid Evidence Assessment

Search Procedure: To address the questions posed in the original brief, a series of initial gateways, databases and search terms were identified. It had been decided that for this task searches should primarily focus on academic literature, with some grey literature which may come from unions, safety councils and other such organizations. Utilising a search engine (Google Scholar), free text search terms were used to scan for useful literature and provide the starting point.

The search then proceeded through repetitive refining of search terms, logging the procedure at each step. Concept tables were created (for example, table 1 relates to a search for mental health globally by occupation; table 2 for searches relating to internal sub questions 2.1-2.4 and table 3 for internal sub-questions 2.5 – 2.7).

Critical Appraisal: Subsequent critical appraisal of evidence utilised the following weightings.

Design	Level
Systematic review or meta-analysis	A
Randomised control studies	B
Cross-sectional studies (quantitative)	C+
Cross-sectional studies (qualitative)	C-
Case studies, theoretical papers	D
Blog or media publications	E

Due to language restrictions priority was given to English language peer reviewed articles.

Table 1

Search term concept table - Scale of mental health globally by occupation			
Concept 1	Concept 2	Concept 3	Concept 4 (Wild Card)
Global mental health	Absenteeism	Maritime and energy	None used
Global mental wellbeing	Perception of risk of mental health	Engineering	
Depression		Construction	
Anxiety			
		Food	
Suicide		Digital cyber	
Workplace well being			
Occupational stress			

Table 2

Concept 1	Concept 2	Concept 3 (Wildcard)	Bridging terms
Mental health/ill health	Safety in the workplace	Psychosocial factors	Impact on/of
Psychological/Mental wellbeing/well-being/wellness	Occupational health	Stressors/stress factors	Correlation
Depression	Worker safety	WRS (work related stress)	Causation
Anxiety	Accidents at work		Association
Stress	Occupational safety and health (OSH)		Consequence
Mental strain	Safety risks		Relationship/in relation to
Job fatigue	Safety conditions/ climate		
Stressors	Occupational accidents		

Table 3

Concept 1	Concept 2	Bridging terms
Mental well being	Risky behaviour	Impact on/of
Psychological well being	Safety behavior	Association
Wellness	Safety attitude	Relationship/in relation to
Stressors	Perceived risk	
Well being in occupational safety and health (OSH)	Risk perceptions	
Psychosocial factors	Attitudes towards health and safety risks	
Stressors/stress factors	Risks to worker safety	
Work related stress		

Limitations: Whilst most papers were considered, some restrictions did apply; for example, this included limitations regarding only English language material. Exceptions were made where sources were considered seminal works or highlighted by the network of international collaborators as a significant text. Decisions were made to restrict searches to English language text for pragmatic purposes; additionally for reasons pertaining to the possibilities of making meaningful comparisons between texts. A number of further considerations were taken into account prior to and during this search. This included those associated with REA as a methodology, such as: not regarded as fully comprehensive or generally deemed as reliable as a full systematic review; flexible method with non-specific guidance (can equate to questions of reliability, and risk of accusations of bias); and not considered suitable for very broad topics. Additional restrictions were applied during this search. For example, where search terms were found to be producing a high yield, the decision was taken to exclude older articles (those over 20 years old) in preference of up-to-date studies; this may also have prohibited some studies of significance. However during synthesis (particularly when analysing the content of systematic reviews and other REA's of relevance) some snowball sampling was also applied, which helped to reduce such concerns. Nonetheless, it is accepted that, as with all research of this nature, it is not guaranteed that 'nothing will be missed' and the results should be considered accordingly.

Further Considerations: The preliminary stages of the REA yielded a high number of results (with some search terms producing above a million hits) which meant much time was spent on processing and ensuring we were able to capture as much relevant data as possible. For instance the rapid search undertaken for section 2 (the impact of wellbeing on occupational health and safety) drew on combination searches from the concept tables (see tables 2 & 3) and yielded high volume hit returns (ranging from a few thousand to 1,000,000+). From these searches, only 260 sources were found which met the study criteria; with a further 108 pieces of literature considered for further interest. It should be noted that, due to the high number of hit returns, the decision was taken to discount studies over 20 years old in order to concentrate on more recent findings. However, those identified during initial searches, along with any further pieces (through snowball sampling or via direct recommendation from research team colleagues for example) were also captured.

As such, the periods covered by the material ranged from 1969 to 2020. Of these studies, 132 were published within the last 10 years. The literature covered a wide range of sectors and occupations. This included maritime (n=46); emergency services (n=9); agriculture, food production and the food service industry (n=15); construction and engineering (n=27); armed forces (n=5); aviation and aerospace (n=6); health (n=34); energy (n=18); ICT and digital/design services (n=5); retail (n=3); transport (including public transportation and logistics [n=8]); office and supply (n=5); along with a considerable number of studies focusing on 'general' working populations (74). The vast majority of the literature was concerned with negative elements; for example worker fatigue, stress and burnout, depression, anxiety and other psychosocial issues in relation to the working environment and occupational health and safety. This search also targeted material concentrating on interventions and strategies for improving psychological well-being and mental health (n=39); this ranged from stress management and recommendations for improving better work-life balances, to exploring optimisation of sleep and exposure to daylight. There were also approaches which considered the impact of arts and meditation, the natural environment and other recommendations for the promotion of health and wellbeing in the workplace.

The vast majority of studies favoured cross sectional design methodology (134), in contrast to 72 studies offering in depth findings from systematic reviews, and/or meta-data analysis. Comparatively, this rapid search revealed only a small amount of data emerging from randomised control studies (23), with theoretical pieces and small sample case studies making up the rest.

The search for evidence concerning different types of work and psychological wellbeing was equally successful in producing a high number of hits from the search terms it utilised. This phase of the research aimed to capture all materials relevant to the mental health and psychological well-being of workers within and beyond specific industries (i.e. maritime, energy, food, construction, and engineering). Primary search terms included: [Occupation Type] AND "mental health". The [occupation type] search term was replaced with the following variations through the searches: "Maritime"; "Maritime and Energy"; ("Maritime" OR "Fisheries" OR "offshore" OR "energy sector"); ("Energy Sector" OR "Energy Industry" OR "Energy Worker(s)" OR "Energy employee(s)"); ("IT industry" OR "IT sector" OR "IT employee(s)" OR "IT worker(s)"); "Engineering"; "Construction"; ("Food industry" OR "Food Worker(s)" OR "Food Employees" OR "Food Processing"). Additional refinement terms included: AND ("well-being" OR "wellbeing"); "safety"; "strain"; "work strain"; "stress"; [scholarly journal sources only].

Search 2.0, 'occupation type and risk management' aimed to capture all materials relevant to the mental health and psychological well-being of workers in the specified industries (i.e. maritime, energy, food, construction, and engineering), with a particular interest on reducing mental health risk. Typically, within this search, the primary search was followed up with 'wellbeing' or/and "mental health" and many risk management studies are focused on areas outside the scope of this study. Primary Search Term: [Occupation Type] AND "risk management" AND/OR "risk reduction". The [occupation type] search term was replaced with the following variations through the searches: ("Maritime" OR "Fisheries" OR "offshore" OR "energy sector"); ("Energy Sector" OR "Energy Industry" OR "Energy Worker(s)" OR "Energy employee(s)"); ("IT industry" OR "IT sector" OR "IT employee(s)" OR "IT worker(s)"); "Engineering"; "Construction"; ("Food industry" OR "Food Worker(s)" OR "Food Employee(s)" OR "Food Processing"). Additional refinement terms included: AND ("well-being" OR "wellbeing"); "health"; "strain"; "safety"; ("depression" OR "anxiety") "work(-ing) condition(s)"; [Scholarly Journal Sources only].

An additional search (3.0) included Occupation Type and Wellbeing. This search aimed to capture all materials relevant to the mental health and psychological well-being of workers in the specified industries

(i.e. maritime, energy, food, construction, and engineering) and outside of those industries, with a specific focus on occupational grouping related to mental health outcomes. This search was conducted independently of search 1.0 and 2.0 so did not include duplicate data including the results from these searches. The results were as follows.

1.0 [Occupation Type] AND "mental health"						
	SCOPUS	Wiley Online	JSTOR	Library OneSearch Pro	Web of Science	ProQuest
1.1 "Maritime" AND "mental health"						
Primary search	44	402	518	4882	30	12151
After refinement	-	181	203	197	-	206
Included in matrix	22	3	4	15 (2)	2	6
1.1.2 ("Energy industry" OR "Energy sector" OR "Energy worker" OR "Energy workers" OR "Energy employee" OR "Energy employees") AND "mental health"						
Primary search	3	80	127	2224	4	60
After refinement	-	-	-	26	-	32
Included in matrix	1	1	0	0	0	2 (1)
1.1.3 "Fisheries" AND "mental health" (partially complete; can be removed)						
Primary search	20					
After refinement	9					
Included in matrix	-					
1.2 ("IT industry" OR "IT sector" OR "IT employee" OR "IT worker") AND "mental health"						
Primary search	7	118	39	9	4	2370
After refinement	-	-	-	-	-	74
Included in matrix	5	3 (1)	2	4	2	5
1.3 "Engineering" AND "mental health"						
Primary search	649	182*	3249	90584	150	14173
After refinement	71	118	145	49	-	14
Included in matrix	7 (5)	0	0	8 (5)	6 (1)	3 (3)
1.4 "Construction" AND "mental health"						
Primary search	1178	10898	11100	135740	976	213992
After refinement	114	15	68	15	107	52
Included in matrix	16 (2)	0	6 (4)	3 (3)	2	5 (2)
1.5 ("Food industry" OR "Food sector" OR "Food workers" OR "Food processing") AND "mental health"						
Primary search	63	479	414	4244	9	9834
After refinement	-	165	103	44	-	36
Included in matrix	3	0	2	3 (1)	1	4 (1)
Total reviewed: 3713						
Total captured in matrix: 146 (31)						

Note: the bracketed units indicate the number of results that are relevant to other contexts. These results may or may not be specific to the occupational type criteria of this review but, if not, can be generalised to the specified groups (e.g. contract workers, blue collar vs. white collar workers). - indicates searches where no further refinement was necessary. * Indicates some change to primary search terms.

2.0 [Occupation Type] AND "risk reduction"						
	SCOPUS	Wiley Online	JSTOR	Library OneSearch Pro	Web of Science	ProQuest
2.1 ("Maritime" OR "fisheries" OR "offshore" OR "energy industry" OR "energy sector") AND "risk management" AND/OR "risk reduction"						
Primary search	304	4360	2733	52775	464	154099
After refinement	49	24	59	106	4	52
Included in matrix	2	0	0	5 (3)	0	3 (1)
2.2 "IT industry" OR "IT sector" OR "IT employee(s)" OR "IT worker(s)" AND ("risk management AND/OR "risk reduction") AND ("wellbeing" OR "wellbeing") AND "mental health"						
Primary search	362	301	124	43	23	12883
After refinement	0	52	28	1	0	95
Included in matrix	0	0	1	0	0	9
2.3 "Engineering" AND ("risk management AND/OR "risk reduction")						
Primary search	9614	17895	13716	141220	1650	64553
After refinement	18	34	35	45	6	45
Included in matrix	2 (2)	1 (1)	0	2 (1)	1 (1)	3
2.4 "Construction" AND ("risk management AND/OR "risk reduction")						
Primary search	4457	15502	7578	136693	2192	354443
After refinement	36	35	14	16	14	64
Included in matrix	4	0	0	0	1	4 (3)
2.5 "Food industry" OR "Food sector" OR "Food Worker(s)" OR "Food employee(s)" OR "Food Processing" AND "risk management" OR "risk reduction"						
Primary search	548	1829	592	12031	10	32938
After refinement	9	18	117	40	3	78
Included in matrix	0	0	0	1	0	0
Total reviewed: 1097						
Total captured in matrix: 39 (12)						

Note: the bracketed units indicate the number of results that are relevant to other contexts. These results may or may not be specific to the occupational type criteria of this review but, if not, can be generalised to the specified groups (e.g. contract workers, blue collar vs. white collar workers). - indicates searches where no further refinement was necessary. * Indicates some change to primary search terms.

3.0 "Occupation Type" AND "mental health"						
	SCOPUS	Wiley Online	JSTOR	Library OneSearch Pro	Web of Science	ProQuest
Primary search	310	77	28	365	11	256
After refinement	34	-	-	61	-	70
Included in matrix	17	15	10	28	5	12
Total reviewed: 281						
Total captured in matrix: 87						

The final search conducted was for evidence concerning the impact of the 4th Industrial Revolution on psychological wellbeing and safety practices. Some of the evidence here was already discovered in the earlier searches. There was also a significant amount of grey literature. The initial search scanned three databases i) Scopus; ii) Science Direct; iii) PubMed (including MedLine) to find evidence on the relationship between: (1) 4th Industrial Revolution and mental health; (2) 4th Industrial Revolution and physical health; (3) remote work and mental health.

(1) was conducted by using the following combination of terms: (4.1) (“mental health” OR “mental wellbeing” OR “depression” OR “anxiety”) AND (“technology” OR “technologies” OR “4th Industrial Revolution” OR “4IR” OR “industry 4.0” OR “algorithm” OR “algorithms” OR “machine learning” OR “big data” OR “artificial intelligence”) AND (“workplace” OR “corporation” OR “enterprise” OR “company”). Please see Matrix 1.

(2) was conducted by using the following combination of terms: (4.2) (“health and safety” OR “safety and health” OR “OHS”) AND (“technology” OR “technologies” OR “industrial revolution” OR “4IR” OR “industry 4.0” OR “algorithm” OR “algorithms” OR “machine learning” OR “big data” OR “artificial intelligence”) AND (“workplace” OR “corporation” OR “enterprise” OR “company”). Please see Matrix 2.

(3) was conducted by using the following combination of terms: 4.3 (“mental health” OR “depression” OR “anxiety” OR “mental wellbeing” OR “psychological”) AND (“work from home” OR “working from home” OR “teleworking” OR “telework”) OR (“telecommute” OR “telecommuting” OR “remote work” OR “mobile work”). Please see Matrix 3.

For (1) and (2) articles before 2010 were excluded, but date parameters were left open in (3).

All three searches together generated 259 results in total.



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