

Human Failure Due to Stress

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Abstract

Stress has been considered a major negative impact on employees worldwide. The present century is known as the stress era since human life is full of stress and strain. Workers know how their anxiety and stress levels impact their capacity for productivity. The main reason for stress presence is the complexity of the human personal, social, and ecological environment, and simultaneously interactions of humans with its surrounding. In terms of psychological sciences, stress is a feeling of mental tension. Low levels of stress are more desirable, and even healthy, and facilitate human performance. However, high levels of stress result in social, psychological, biological problems, and serious harm to people. This project shows innumerable studies in this field investigated the role of different related factors of stress and aimed to aggregate various dimensions of theoretical issues and influences of stress in human everyday life especially in work. Also, this project introduces multiple devices for stress measurement and how they are conducted to employees in order to measure their stress levels. A conducted survey done with 30 engineers working at NPCC, the results have shown different levels of stress on conducted employees. However, the present study was an effort to make a theoretical unity of different measurement devices. According to the obtained results and data, stress can't be investigated and observed via a single study, therefore, incorporation is much needed by psychologists to analyze and develop future frameworks for minimizing and controlling work-related stress.

Keywords

Stress, Strain, Heart rate variability (HRV), Galvanic skin response (GSR), and Perceived Stress Scale (PSS).

Introduction

People may experience work-related stress as a reaction to pressures and demands incompatible with their skills and knowledge. Although stress can arise under various work conditions, it is frequently exacerbated when staff members feel they have little support from managers and coworkers and little influence over work procedures (Ahn et al. 2021). Stress and pressure are frequently confused, which is sometimes used to justify poor management techniques. Because of the requirements of the modern work environment, pressure on the job cannot be avoided. Depending on the resources available and the individual's traits, the pressure deemed acceptable by the individual may even keep employees awake, able to work, engaged, and able to learn. On the other hand, stress results when that pressure becomes excessive or uncontrollable. Employee health and company performance can both be critically impacted by stress.

A job enhances a person's health and outlook in numerous ways. Unfortunately, many people experience such high-stress levels at work that it surpasses any potential advantages and even endangers their health. Job stress results when the job demands do not meet a worker's abilities, resources, or needs. According to the National Institute for Occupational Safety and Health in the United States, stress at work can also result in ill health and even harm (Akkoç et al. 2021). Many employees report feeling stressed at work, negatively affecting their performance and health. Stress levels differ between occupations and demographic groupings. Stress is more likely to affect some workers than others. According to studies, those in lower-skilled jobs, women, and younger workers are most at risk of developing complications from workplace stress.

Circumstances that are unpredictable or uncontrollable, uncertain, ambiguous, or foreign, or that involve conflict, loss, or performance expectations are prone to induce stress. Recurring problems like family obligations, job insecurity, lengthy commutes, and time-sensitive events like the pressure of exams or work deadlines can bring stress. Personal traits like these facilitate coping with stress and expectations at work. Time management, assertiveness, and problem-solving are a few examples. Moreover, favorable workplace conditions and social support contribute to people's happiness. Investments in

work infrastructure, training, effective management and employment practices, and work organization can improve these resources (Ahn et al. 2021). Employers have traditionally blamed the stress victim rather than its cause when there is stress at work. It is becoming more widely acknowledged that businesses are obligated under the law to prevent employees from getting sick. Preventing stress is also in their long-term economic best interests because it is likely to lower client happiness, increase the rate of accidents, increase sick leave and early retirement, increase stress among employees who are still working, and reduce work performance.

Why Is It Important

There are two categories of workplace stressors: physical and mental. Physical stressors include noise, inadequate lighting, an uncomfortable workspace, and ergonomic issues like poor working posture. The most common sources of stress are probably psychosocial stressors. High job demands, rigid work schedules, lousy job supervision, poor work design and structure, bullying and harassment, and job insecurity are a few of these. Stress at work has negative consequences on employee and company performance. The stress impacts at work are visible in employees' behavior, mental health, and physical health (Albort et al. 2020). These impacts start as distress from stressors and develop into a continuum. High blood pressure and anxiety that result from distress raise the risk of coronary heart disease, substance misuse, and anxiety disorders. It is well known that stress increases the risk of cardiovascular disease. According to studies, stress at work increases the chance of developing cardiovascular disorders like obesity, high blood pressure, and high cholesterol. Moreover, it contributes to harmful cardiovascular events, including heart attack and stroke.

A growing body of research has shown that stress at work raises the risk of developing diabetes. Other physical health issues connected to professional stress are immune system illnesses, musculoskeletal conditions like chronic back pain, and gastrointestinal conditions such as irritable bowel syndrome. Employees' mental health is also negatively impacted by the workplace, with an increased risk of anxiety, burnout, depression, and substance use disorders (Lawet al. 2020). Employees under stress at work are more prone to indulge in harmful habits, including smoking, drugs, abusing alcohol and eating poorly. Workplace stress has these associated health impacts, which decrease employee productivity, raise absenteeism and presenters increase the number of days missed from work for medical appointments, and raise healthcare expenses for businesses. Moreover, workplace stress is associated with a greater incidence of accidents, injuries, and turnover, all of which raise administrative costs. Therefore, addressing the causes of work-related stress will save lives and improve employee productivity.

Problem Statement

In high risk industries where systems are built to world class engineering standards with built in engineering control to ensure safe and effective operations, human factors and errors remain the weak link. In the past, human factors and errors have contributed to serious incidents and operational issues.

Considering human failures related to workplace stress, how can the risk of human failures be eliminated to ensure a safe operating system in high risk industries?

Objectives

Stress due to work, also known as work-related stress, is a common problem that affects many people in the workplace. It is a type of stress that is caused by excessive work demands, long working hours, a high-pressure work environment, and a lack of control over one's job. Work-related stress can have a negative impact on an individual's physical and mental health, as well as their overall well-being. Therefore, the main objective of this study is to focus on the impact of employees' internal dialogue on the appraisal of stressors and how to manage stress and relaxation strategies. In addition, the following approach will be followed to meet the project objectives:

Develop a framework to eliminate the risk of human failure due to workplace stress on safety performance.

- Recommend the best features that are used to test and evaluate stress in the workplace.
- Provide data to prove the effectiveness of the approach.

2. Literature Review

Hormones Related to Happiness and Sadness that We Can Measure

The body uses hormones as chemical messengers. After being released by glands into the bloodstream, they act on many organs and tissues to regulate everything from how the body works to how one feels. The joyful and occasionally euphoric feelings that some hormones create have earned them the moniker feel-good hormones for that particular group of hormones. Also, they are thought of as neurotransmitters, meaning they convey information across the chasms between nerve cells. The four feel-good hormones are oxytocin, dopamine, serotonin, and endorphins.

Dopamine

Dopamine plays a vital role in the brain's reward system by assisting us in experiencing pleasure. Sex, shopping, and the aroma of baking cookies can cause a rush or release of dopamine. The dopamine-producing neurotransmitter also plays a role in reinforcing. The powerful sense of reward that comes with substances like heroin or cocaine can be addictive, which is dopamine's darker side. The dopamine hormone is involved in learning, concentration, heart rate, pain processing, and kidney function. It is also essential for movement, blood vessel functions, sleep, and mood management (Law et al. 2020). Neurons produce dopamine in the area near the base of the brain in two steps.

Initially, tyrosine is transformed into L-dopa, a different amino acid. Next, as enzymes convert L-dopa into dopamine, another transformation occurs. A lack of dopamine brings on rigid movements, a defining feature of Parkinson's disease. Although studies show that a dopamine deficiency also contributes to sadness, serotonin depletion is more frequently associated with depression. Those with depression frequently experience a loss of drive and focus. Tyrosine is the building block for the neurotransmitter dopamine. Thus, increasing this amino acid dietary intake may help one's brain produce more of it. There is proof that a tyrosine-rich diet can help with memory and mental function.

Serotonin

The center of the brainstem produces the serotonin hormone, which controls different brain functions, including digestion, memory, addiction, fear, and stress response. Depression and low serotonin levels are related. Serotonin levels in the brain are raised by the two types of antidepressants most frequently prescribed, selective serotonin reuptake inhibitors (SSRIs) and serotonin and norepinephrine reuptake inhibitors (SNRIs). Serotonin levels can be raised naturally, without the need for drugs. Exercise is one natural approach to raising serotonin levels (Cummings et al. 2021). Tryptophan, an amino acid that the brain uses to create serotonin, is released more by exercising, such as riding a bike or lifting weights. This increase in serotonin and other endorphins and neurotransmitters is why many people experience the runner's high after a strenuous workout. Another alternative to raising serotonin levels naturally is exposure to the sun or intense light designed to mimic it. One of the leading therapies for the seasonal affective disorder (SAD), the wintertime depression that a decline in serotonin levels can bring on, is light therapy.

Endorphin

In reaction to pain or stress, the hypothalamus and pituitary gland release endorphins, a class of peptide hormones that both reduce pain and produce a general sense of well-being.

They are called endogenous because our bodies create them. They imitate the effects of the opioid painkiller known as morphine. There are about 20 different kinds of endorphins. The one linked to the runner's high, beta-endorphin, is the most researched. In addition, endorphin hormones come from laughter, falling in love, having sex, or eating a wonderful meal.

Oxytocin

The brain produces the hormone oxytocin, which the pituitary gland then releases into the bloodstream. It is known as the love hormone because one of its primary purposes is to promote childbirth. The uterine muscles are stimulated to contract by oxytocin, and prostaglandin synthesis is also stimulated, leading to increased uterine contractions.

Oxytocin is occasionally administered to laboring women to quicken the process. Oxytocin promotes maternal bonding and aids milk movement from the breast ducts to the nipple after birth. Therefore, lacking the above hormones can result in sadness and potential depression.

Adrenalin

Adrenalin hormone is regarded as a stress hormone that causes sadness. Adrenal glands produce the hormone adrenaline to aid in preparation for challenging or dangerous circumstances. The rapid release of adrenaline into the blood is known as an adrenaline rush. It prepares the body for a fight-or-flight reaction. Pheochromocytoma can result in elevated blood pressure if the adrenal glands create too much adrenaline or norepinephrine. It is a tumor

that a surgeon can remove. Thus, high blood pressure is not an automatic indication of a tumor. A healthcare practitioner might perform blood tests and imaging to assess an individual's stress level.

Cortisol

It is also a stress hormone that causes sadness. The adrenal glands, endocrine glands on top of the kidneys, create and release the steroid hormone cortisol. The body's response to stress is one of the many components cortisol influences. Many people refer to cortisol as the "stress hormone." In addition to controlling the body's stress response, it has numerous other significant effects and functions. It is also crucial to remember that various types of stress might occur biologically.

Causes and Symptoms

Causes

Work-related stress results from job demand, poor work relationships, lack of control, work-life balance, job insecurity, and organizational culture. Some organizations demand too much from their workers, thus exposing them to mental strain that results in pressure. Assessing the job characteristics and the employee's ability to deliver within the stipulated timeline and available facilitation is essential. In addition, employees often need more control over their performance obligations. Such situations expose them to anxiety and mental health issues.

Sometimes, poor relationships between employees and their employers lead to work-related stress. Poor relationship promotes job insecurity and lack of recognition (Law et al. 2020). There are also cases where employees need help to balance their work life with their personal life. Some jobs are demanding and eat into family time, thus exposing workers to insecurities and strain. For example, women often experience a lack of work-life balance as they have to attend to their family, including domestic chores. Thus, long working hours and weekend work commitments are some factors resulting in a lack of work-life balance. In some cases, the organizational culture discourages employees from work performance. Some organizational cultures discriminate based on gender and ethnic background.

According to a report issued by the UK's Health and Safety Executive (HSE) in 2019. As Figure 1 shows the main causes of work-related stress based on the UK's HSE. 620,000 workers were suffering from stress due to workload. 200,000 workers are marked for lack of support, and 180,000 workers have stress due to violence, threats, or bullying. However, stress due to lack of control was recorded to be the lowest rate. (Cassidy 2022)

The workplace is a significant source of stress-inducing demands, pressures, and structural and social resources. Workplace factors linked to stress and health concerns can be divided into two categories: those that have to do with the work itself and those that have to do with the social and organizational setting of the workplace. Some inherent employment hazards are long work hours, time management pressure, work overload, complex duties, a poor work environment, a lack of breaks, and job facilitation. Stress can be brought on by unclear tasks, competing roles, limits, and having to take care of others. Under the promotion, a lack of training, and work insecurity are all stressful. Therefore, the potential for career advancement is a crucial stress reliever (Elomaa et al. 2021). Two more stressors or stress reducers are connections at work and organizational culture. Stress is increased by managers who are negative, demanding, unsupportive, or bullying, but stress is decreased by a healthy social component to the workplace and effective teamwork.

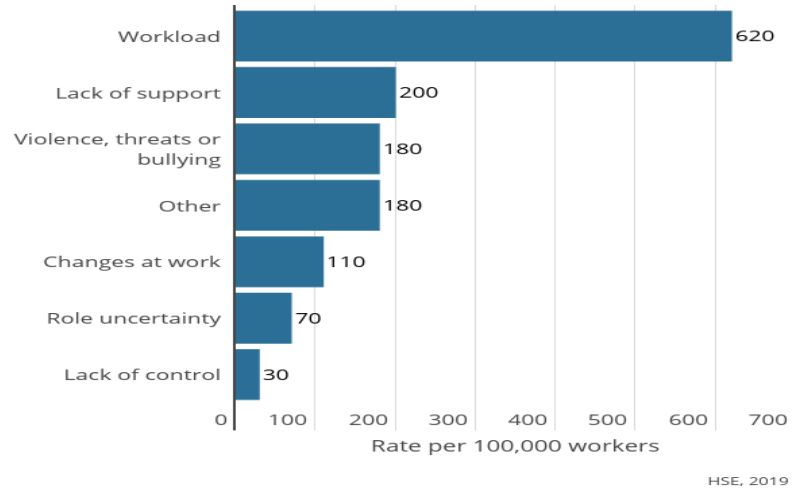


Figure 1. Causes of work-related stress based on UK HSE

Stress is brought on by an organizational culture that rewards presenters or unpaid overtime. On the other hand, a culture that involves employees in decision-making keeps them updated on organization events and offers top-notch amenities, and recreational opportunities lessens stress. Organizational change is a significant source of stress, mainly when consultation needs to be improved. Mergers, relocations, restructuring or downsizing, individual contracts, and organizational redundancies are a few examples of such developments. According to one school of thinking, individual differences in traits like personality and coping mechanisms play the most significant role in determining whether or not given job conditions would lead to stress; in other words, what is problematic for one person may not be a problem for another (Law et al. 2020). Even though individual variances are essential, empiricalevidence supports the claim that most people find particular working situations stressful.

Symptoms

Although it is straightforward to identify the sources of stress in life, it can take more work to pin down their impacts. Knowing what stress is allows us to identify how it might harm an employee's physical and mental health. Hormones that heighten senses, quicken the heartbeat, slow breathing, and tighten muscles are released while the nervous system is alert. The description generally uses the fight reaction (Ornek, Esin, 2020). As a result of its biological programming, people have little to no control over it. This response is continuously triggered when stressful conditions are ongoing or unresolved, wearing down many biological systems. Eventually, the immune system becomes compromised, and tiredness sets in. Infection or injury risk is raised as a result. These symptoms are simple to spot, but because chronic illnesses take years to develop and have a wide range of potential causes, their impacts on stress are less visible. Stress contributes significantly to several widespread but severe health issues. According to the CDC (Centers for Disease Control and Prevention), healthcare expenses are over 50% greater for employees who report high-stress levels.

The following statistics show the most common health effects caused by workplace stress for US workers.

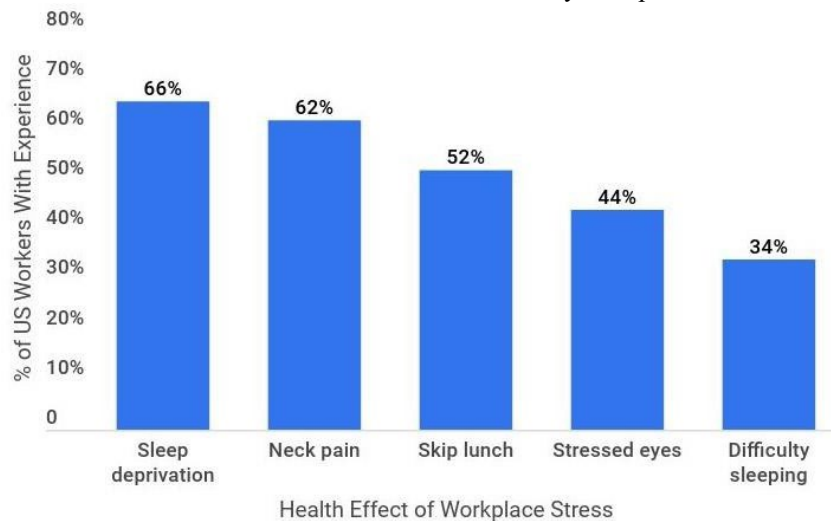


Figure 2. Most common health effects caused by workplace stress

66% of US employees report sleep deprivation, while 34% have sleeping difficulty. Regarding neck pain due to stress 62% of US employees are diagnosed with neck pain and 44% have stressed eyes. However, 52% of employees tend to skip their lunch due to work-related stress (40+ worrisome workplace 2023).

Work-related stress can manifest through emotional and mental side effects, including loss of work morale, anxiety, depression, and confidence in job performance. Employees can also experience a lack of job motivation and potential mood swings. These emotional symptoms lead to decreased job productivity and low job satisfaction among employees. There are also physical symptoms of work-related stress, including indigestion, drastic weight gain, weight loss, headaches, or chest pains. Thus, employees can experience significant health issues due to stress from work. According to the CDC, there are long-term health effects from work-related stress. It can cause cardiovascular diseases and exceptionally highly demanding jobs. In addition, employees can experience musculoskeletal disorders and psychological disorders due to work-related stress. Employees who work under pressure are at high risk of workplace injuries as they are likely to overlook safety measures. It is also likely for

stressed employees to attempt suicide, and experience ulcers, immune function, and even cancer. Therefore, it is essential to support the welfare of employees and protect them from potential harm.

Effect on Performance

Workers are less likely to experience work-related stress if the demands and pressures of their jobs are appropriate for their knowledge and abilities. The body's reaction to actual or perceived threats is stress (Cahill et al. 2021). Most of our problems nowadays cannot be resolved using the fight-or-flight reaction. We must work through our issues and come up with wise solutions. Stress is a result of how individuals respond to their circumstances. Individual responses to these situations vary. It is normal to experience some stress, and it can even improve our life. It frequently gives us the drive and inspiration to tackle daily obstacles at home and work. One's ability to rise to a challenge and achieve the objectives, including deadlines, sales or production targets, or acquiring new clients, depends on the stress response.

Employees consider burnout as their top concern regarding work-related stress. The revelation raises questions about managing stress and increasing work productivity. Employees that experience chronic stress, often known as burnout, lose interest in their jobs. Those who are checked out at work from burnout cannot maintain standard productivity levels. Burnout worsens the turnover rate by increasing absenteeism and other negative behaviors. Due to stress, employees who experience burnout are less engaged, productive, and satisfied with their jobs (Schwepker et al. 2021). Burnout brought on by prolonged stress is one of the leading causes of employees leaving their jobs. Moreover, severe depression increases the chance of burnout in workers, which significantly negatively influences their quality of life and employment. Stress at work can spiral out of control. Stress frequently causes more serious mental health issues that lower team members' productivity levels. Moreover, stress can lead to higher rates of anxiety and depression, which can impact an employee's professional and personal life. American Psychological Association spread survey results conducted in 2021 based on work and well-being after the COVID-19 pandemic. Nearly three in five employees (59%) have experienced negative impacts of work-related stress, including a lack of interest, motivation, or energy (26%), difficulty focusing (21%), and a lack of effort at work (19%). The overall statistic is shown in Figure 3 (Work and Well-being 2021).

Impact of Work-Related Stress on the Immune System

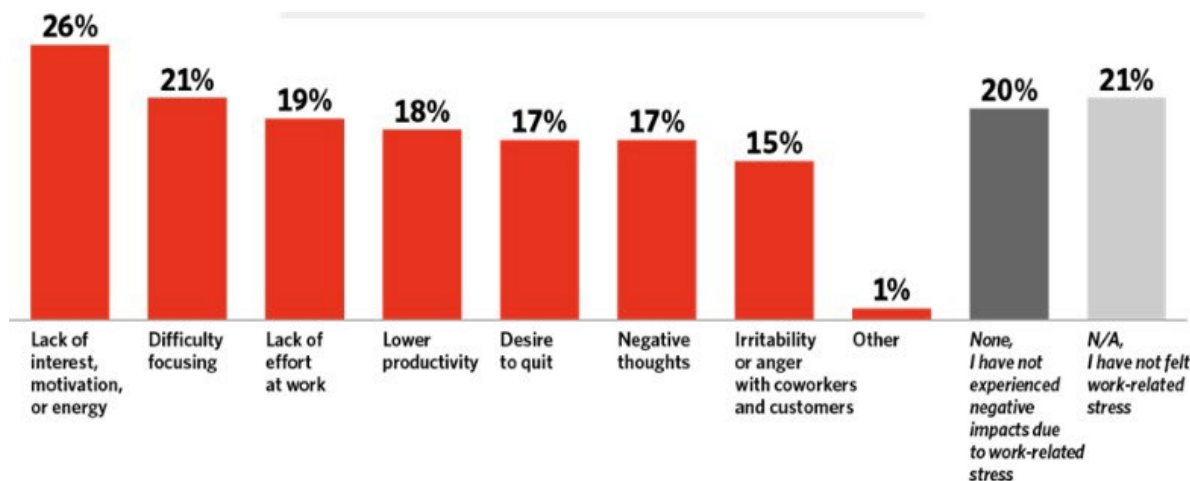


Figure 3. 59% experienced negative impacts of work-related stress

Our immune system responds to invaders of our bodies like a police force to prevent illness. The white blood cells that make up our immune system fight off bacteria, viruses, and cancerous cells in the body. Stress is a result of numerous causes. But regardless of the source, stress causes your body to produce the hormone cortisol. By reducing the number of lymphocytes in the circulation and obstructing everyday white blood cell communication, cortisol can reduce the ability of your immune system to fend against invaders. Stress-related disorders typically have complicated, multi-layered causes, including biological, psychological, and social components, making their recovery challenging. The body's autonomic nerve systems start to accept elevated stress levels as usual when they

persist for a long time in our bodies. Long after the stressful event has passed, it continues to create high quantities of stress hormones, severely weakening the immune system. Individuals in this mood frequently exhibit irritability, anger, anxiety, panic attacks, and racing thoughts.

Returning to one's regular, peaceful, and balanced condition might involve mindfulness exercises like yoga and meditation that teach a person to be aware of their breath, mind, and body sensations. Some people will need the assistance of a mental health specialist. When under stress, people may turn to harmful coping mechanisms, including smoking, drinking, and occasionally using drugs. Moreover, these activities weaken the immune system and may result in headaches, flu-like infections, cardiovascular disease, diabetes, asthma, stomach ulcers, and other disorders. Colds and coughs that recur frequently are indicators of a weakened immune system. When your immunity deteriorates, a recurring cycle is set up that makes overcoming your propensity for illness challenging. A weakened immunological response to disease is one of the most severe health impacts that can result from this, along with effects on appetite and sleep.

Overall, stress triggers the body's fight-or-flight response. Chronic stress causes negative health impacts on human mood, immune and digestive systems, and cardiovascular health. Figure 4 shows the impacts of stress on the human body when the stress response keeps firing, day after day, it might put human health at serious risk. These symptoms included: depression, insomnia, heart attack, headache, etc. (Pietrangelo 2023).

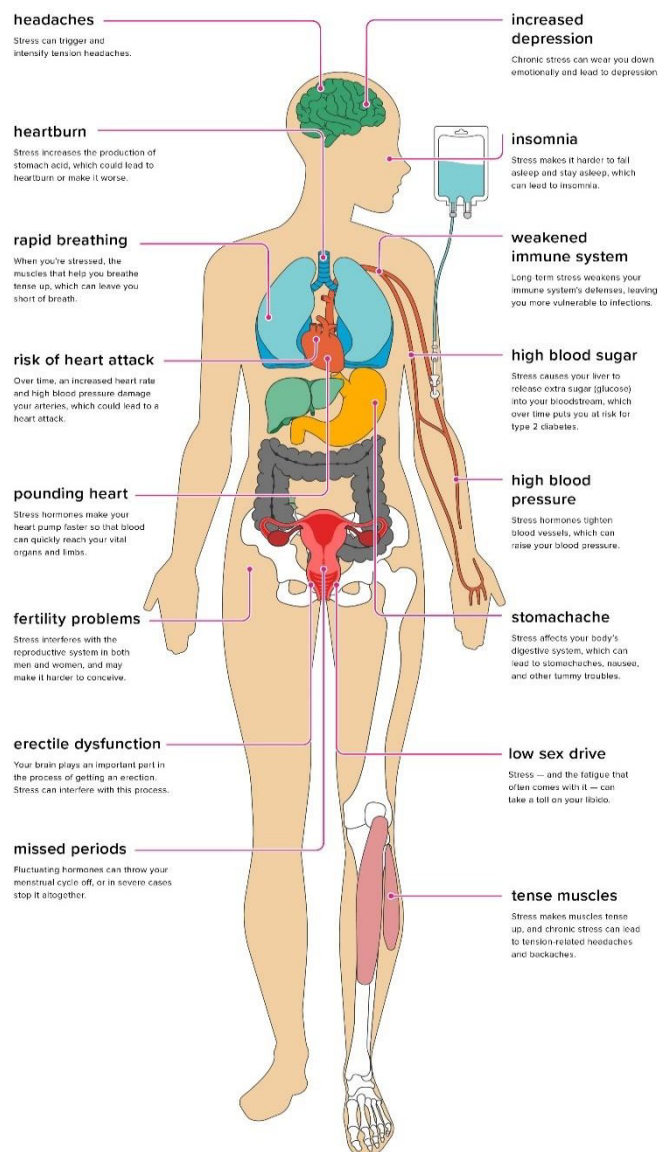


Figure 4. The effects of work-related stress on the human body

Relationship between Work-Related Stress and Human Error, Memory, Decision Making

Repetition and human mistakes are positively and significantly correlated among employees in the manufacturing sector. In performing the same movements repeatedly for an extended amount of time, repetition can make workers feel fatigued and, indirectly, lead them to lose their concentration. It will ultimately result in many human mistakes (Nwaogu and Chan 2021). Hand duties performed at work frequently might result in injuries, poor performance, and more significant compensation expenditures. Employees under pressure from the production manager to complete their tasks more quickly to achieve better production outputs are likely to commit mistakes. In addition, there is a significant and positive link between stress and human error among manufacturing workers. Due to work stress, industrial workers may become distracted from the company's primary goals and lose their composure. It has been demonstrated that stress significantly impacts employees' productivity and quality of work.

Stress impacts the development of an individual's memory. It is more challenging to learn when under stress because people find it more challenging to form short-term memories and convert them into long-term memories. Stress can have an impact on the kinds of memories we create. When one is under stress, it can affect how one sees things and how effectively one can recall those views later. As a result, an individual may need help recalling an event's specifics when stressed. Even after they are created, memories can evolve. Every time one accesses a memory, they add to it based on how they are currently experiencing it, much like when an individual takes something from a shelf and puts it back, leaving fingerprints from their previous handling. A small quantity of stress is a motivator, but too much of it can be more of a hindrance than a help. Such is the case of interpersonal interactions, memories, and activities that promote health. Stress can impair memory function by preventing an individual from forming and retrieving memories.

Regarding issues of making decisions, there are two ways that cognition and emotion are related. Cognitive processes, notably executive function mental control, emotion regulation, attention, and memory, influence the perception of stress and the individual response. After experiencing stress and strain due to the first transaction, executive functioning skills further influence the response to the subsequent arousal (Nwaogu and Chan 2021). Thus, decision-making results from an individual's capacity to control their emotions. Individuals under emotional pressure lack self-control and are likely to make irrational decisions. Emotions control them, are often make wrong decisions. Their scope of judgment is compromised due to emotional distress. Therefore, workers should avoid making decisions under stress and anxiety conditions.

Tests that Can Measure Stress

Several tests can measure individual stress levels, including the heart rate variability (HRV), perceived stress scale (PSS), stress assessment and research toolkit (StART), brief job stress questionnaire (BJSQ), workplace stress scale (WSS), trial social stress test (TSST). One of the most recognized methods for measuring stress levels is the Perceived Stress Scale (PSS), which measures an individual's perception of stress. It assesses the degree to which an individual considers their situations as stressful. Thus, the questions are designed to evaluate how uncontrollable, unpredictable, or overloaded an individual's life is based on stress levels. The PSS questions target one's feelings and thoughts in the last month. They come in general nature and are easily understood by the participant. Thus, the test is free of bias and any form of discrimination.

Stress can also be measured using heart rate variability (HRV). Analysis of heart rate variability (HRV) is a popular technique for measuring stress. It entails keeping track of the difference in time between successive heartbeats. In other words, it examines how the interval between heartbeats changes rather than just how quickly one's heart is pumping. An individual's sympathetic nervous system, which controls their fight-or-flight response, is a part of the ANS. The parasympathetic nervous system, which assumes control when one is calm, is also involved in the study. The ANS is out of balance when one is frequently in fight-or-flight mode. The participant may notice this imbalance in the HRV. When an individual is in a fight-or-flight state, HRV is lower, and when calm, it is higher. High HRV is linked to enhanced cardiovascular health and Trusted Source stress resilience. A medical expert can use an ECG to assess the HRV.

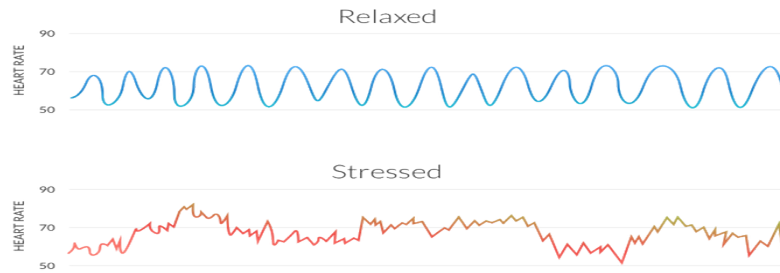


Figure 5. Heart Rate Variability (HRV) difference between relaxed and stressed

Figure 5 presents the difference between relaxed and stressed measurements of HRV. By this measurement, we are able to examine how efficient the human heart is in reacting to different scenarios. Higher HRV scores mean that the heart is more capable of reacting to negative reactions. However, lower HRV scores mean that the heart is less adaptable and reacts to life experiences slowly. Moreover, HRV can be trained. HRV training is a new protocol created by sport psychology to help athletes regulate and maintain their heart rate, and breathing during extreme competitive stress. Recently, HRV is implemented in various aspects such as; job interviews, and test-taking. Researchers have found practicing HRV training at least once a day over three months resulted in improvements in HRV scores which will improve human performance (Marini 2019).

The Stress Assessment and Research Toolkit (StART) measures the stress levels and guides the participant to identify the possibility of stress experience in the past month. It involves self-report measures to identify the potential causes of stress. In addition, StART also adopts physiological indicators like electrothermal activity and heart rate to measure stress (Restrepo and Lemos 2021). Another tool is the Brief Job Stress Questionnaire (BJSQ) which relies on self-report to assess potential workplace stress. The questions targeted in BJSQ include job control, job demands, job satisfaction, and social support. Thus, it tackles the psychological aspects of job control, job demand, and buffering factors like social support from management or colleagues. Finally, the Trier Social Stress Test (TSST) is based on laboratory assessment where individuals deliver a speech and other mental arithmetic activities. The indicators include blood pressure, heart rate, and control levels.

3. Methods

Survey

This study examines recollections and fabricated experiences. Participants will be asked to recall significant workplace memories on the following pages. They will be asked to imagine significant occurrences that could occur in their future professional experiences or have happened in their previous positions but did not. Thus, the recollections or imagined events the participants write about should occur at a particular time and location and last up to a whole day or 24 hours. It is essential to describe each memory or imagined occurrence briefly. They should give each recollection or imagined occurrence a brief title and respond to many questions after finishing writing about it. The research will involve a group of 30 engineers working in a Construction Company located in Abu Dhabi. The participants will respond on a scale of 1-5, never, seldom, sometimes, often, and always.

1. Are you clear about what is expected of you at work?
2. Do you decide when to take a break?
3. Are their colleagues always demanding things from you that are hard to combine?
4. How convenient do you go about getting your job done?
5. Are you subjected to personal harassment in any form of unkind words or behavior?
6. Have you experienced unachievable deadlines?
7. In case work gets difficult, will your colleagues help?
8. Do you get supportive feedback about your work?
9. Do you work intensively?
10. Do you have a say in your work speed?
11. Do you have a clear understanding of your duties and responsibilities?
12. Have you ever neglected your work because you have so much to do?
13. Do you understand the goals and objectives of your department?

14. Are there friction and anger between your colleagues?
15. Do you have a say on how to do your work?
16. Do you take sufficient breaks?
17. Do you understand the significance of your work to the overall aim of the organization?
18. Are you pressured to work long hours?
19. Do you decide what to do at work?
20. Do you have to work very fast?

4. Data Collection

The survey questions were informed by the Health and Safety Executive (HSE) guidelines. The statistical analysis below presents the survey outcome for the questionnaire presented to 30 engineers. 60% of the respondents reported that they are always aware of their work expectations. Likewise, 30% reported sometimes needing to be made aware of their work expectations. However, 2% and 8% of the respondents claimed to need to learn about their job

requirements on most occasions. The study also revealed that only some employees decide when to take a break from job obligations. The nature of the workload dictates the operations of the employees. About 80% of engineers reported taking breaks when relieved of their duties and, in most cases, having to work extra hours when needed. It was also reported that the work environment needed the desired collaboration as most engineers focus on delivering their tasks.

4. Results and Discussion

4.1 Numerical Results

The stress tests were conducted by monitoring the body temperatures, heart rates, oxygen saturation levels, and the GSR sensor tests. For instance, the body temperatures were recorded as low, medium, high, or very high, and a correlation was built with the heart rates. High body temperatures were relative to the heart's relaxation, anxiety, and calmness. Therefore, the heart rate tests were conducted using the prototype oxygen saturation sensor. A relationship between Work-Related Stress, Human Error, human failure Memory, and Decision Making was built to explore the dangers of work-related stress. The table below shows the relationship between health status and stress levels for 10 engineers.

Table 1, Results for stress levels in relation to the participant's health status

	Health Status					Stress Levels		
	Heart rate (bpm)	Body temperature (°C)	Oxygen Saturation (%)	Health Status	Information	GSR (S)	Health Status	Fuzzy Output
1.	92.70	34.8	97	Unhealthy	Experiencing a mild symptoms of hypothermia	2.33	Anxiety	0.60
2.	82.83	37.20	95	Healthy	-	2.56	Calm	0.35
3.	67.37	35.28	95	Healthy	-	2.27	Calm	0.31
4.	59.88	37.10	95	Healthy	-	1.98	Calm	0.33
5.	79.92	35.85	96	Healthy	-	2.19	Calm	0.37
6.	76.83	39.45	96	Unhealthy	Pyrexia	2.04	Calm	0.35
7.	90.12	35.24	97	Unhealthy	Acute Hypothermia	5.99	Anxiety	0.63
8.	81.19	36.99	94	Not Healthy	Hypoxia	2.17	Calm	0.35
9.	84.94	36.18	98	Healthy	-	0.83	Calm	0.34
10.	106.72	38.16	97	Not Healthy	Tachycardia	5.99	Stressed	0.91

4.2 Graphical Results

The design of the stress measurement device includes mainly a sensor fusion device to measure stress levels. It involves data collection from several sensors to generate accurate and comprehensive information. The fusion sensor technique provides information from sensor readings from different methods, including voting, neural networks, fuzzy logic, and discrete Bayesian. The fusion sensor device measures physical and mental health through vital signs and stress levels. It works with a mobile application to improve health monitoring. The measured parameters include body temperature, oxygen saturation (SpO₂), and heart rate. With a fuzzy logic algorithm, the device combines and processes the readings for the body temperature, galvanic skin response (GSR), and heart rate to measure the stress level. The device is operated using a microcontroller that leads to the determination of the stress levels.

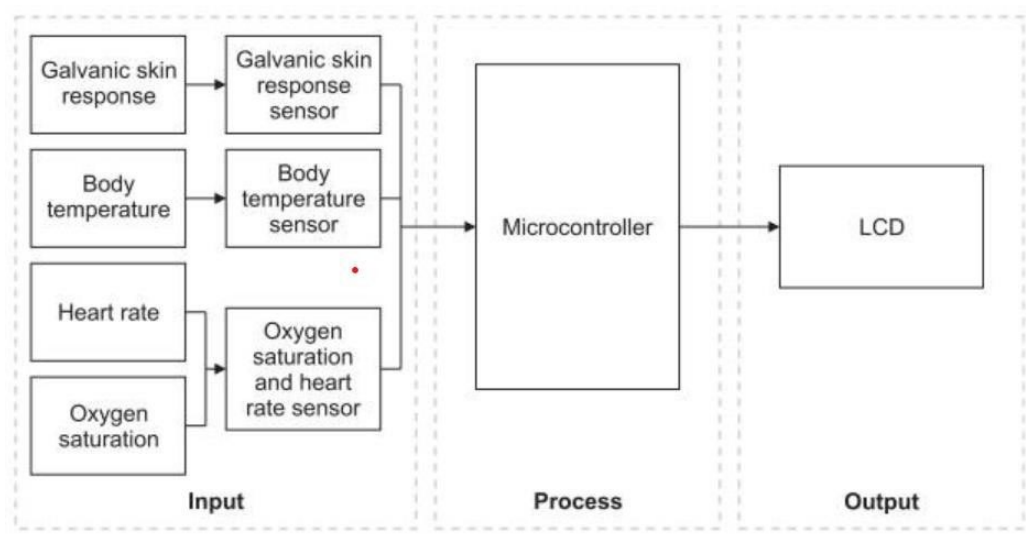


Figure 6. Sensor Fusion Method for measuring stress levels

The software for the microcontroller and the software for the application comprises the two sections of this device's software. With a fuzzy logic approach, the microcontroller's software allows the device to properly read, process, and combine sensor data to calculate the stress level. The microcontroller also uses the Internet to deliver the findings of data processing to cloud databases. The sensor reading process using the sensor fusion method is carried out sequentially by deciding the priority of launching each component into the program. It is done to prevent readings from colliding with different sensors.

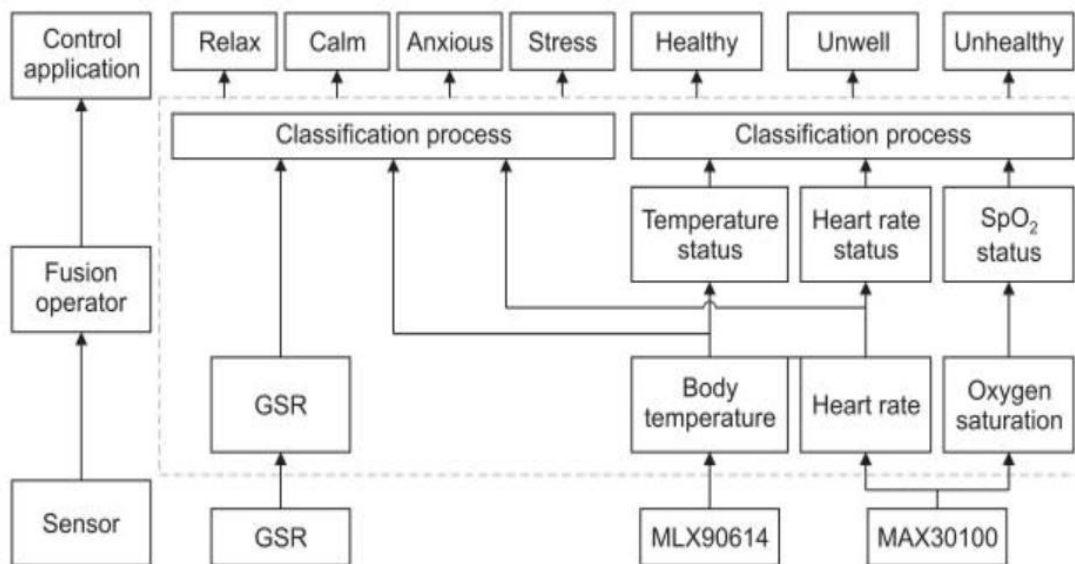


Figure 7. The Galvanic Skin Response.

The device's installation requires body temperature, heart rate, and oxygen saturation limitations. Young people are thought to have a typical body temperature range of 36°C and 37.5°C (96.8°F to 99.5°F). Regarding body temperature, pyrexia, and hypothermia are the two basic variations. Pyrexia or hyperpyrexia is the term used to describe a body temperature higher than usual. Pyrexia sets in when the body temperature reaches between 38°C and 40°C (104°F). Hyperpyrexia is the medical term for a very high temperature, such as 41°C (105.8°F). Hypothermia is a body temperature below normal, less than 35°C (95°F).

Table 2. Different classifications of stress levels (GSR- galvanic skin response, H&T- body temperature)

Condition	GRS (μ S)	Heart rate (bpm)	H & T ($^{\circ}$ C)
Relax	<2	60-70	36-37
Calm	2-4	70-90	35-36
Anxious	4-6	90-100	33-35
Stress	>6	>100	<33

The average heart rate ranges from 60 to 100 beats per minute. Those with a heart rate of less than 60 bpm have bradycardia, whereas those with a heart rate of more than 100 bpm are said to have tachycardia. The participant's apical pulse should be checked if they exhibit bradycardia or tachycardia. Age, gender, physical activity, fever, drugs, dehydration, stress, and pathology are all factors that might impact heart rate. The arterial oxygen saturation of a healthy individual with normal lungs and inhaling air at sea level ranges from 95% to 100%. The patient needs prompt treatment if the oxygen saturation is 94% or lower because hypoxia is present. A clinical emergency may be indicated if the saturation is less than 90%.

Stress Management Framework

Implementing workplace stress management and wellness programs can minimize the impact of stress since stress can't vanish completely. A framework has been developed to manage workplace stress including mechanisms and activities. A test will be conducted on the employee who experiences stress, and based on the stress level he/she will fit into the right category. Since stress level differs from one employee to another a framework shows different classifications of stress levels such as; relaxed, calm, anxious, and stressed. Extreme stress level presents the highest stress reading of GRS >6 that employee is recorded. In this case, the employee will have a special case and a fast response from the responsible team to manage his stress (the recommended ways are shown in Table 3)

The framework is basically a science-based activity that allows employees to manage stress better and find a healthier life balance.

The main part is to assess the employee's behavior during his availability in the workplace. The reason behind this is that the employee might have a bad habit which increases the stress level. The better way is to guide the employee on the right track.

There are many steps to avoid or reduce stress such as;

In general:

- Get adequate sleep (stop drinking caffeine dose after 5:00 PM)
- Stay hydrated and enjoy a balanced diet
- Exercise three times per week and get away from the desk At work
- Prioritize your tasks
- Break large tasks into smaller ones
- Maintain a clean and tidy environment (if you are suffering from the dust please contact the right person to remove the dust)
- Allocate time for your break and take your lunch away from your desk
- Change your positions, move around by walking or standing
- Ask for assistance
- Do calming and breathing exercises

The framework is developed based on our experience and knowledge. However, further improvement is required with psychologists, since they are the best professionals who know how to deal with mental health, and what are the factors that contribute to their anxiety. Moreover, psychologists help patients to manage their anxiety through

therapy, also some employees have stress from their lives which has a significant contribution to the work and their performance. Therefore; hiring a psychologist in a company or collaborating with a mental health center would be a great idea since the employee can share his private feelings with them. Through conducted multiple sessions of the therapies the employee can understand how his thoughts contribute to stress symptoms, and how to identify the triggers that develop the stress.

Any employee classified with a high level of stress must be seen by a psychologist. Table 3 shows the developed framework to manage stress within the organization. The recommendations can be altered based on the employee's stress level.

Table 3. Stress Management Framework

Define the level of stress	Ways to reduce stress	Duration	Vital Signal Required (before & after)	Reading from the vital signal is acceptable	Reading from the vital signal is not acceptable
Stress	<ul style="list-style-type: none"> - Force the employee to take annual leave - Enroll the employee into stress management program - Assess employee behavior 	Weeks to months	<ul style="list-style-type: none"> - GSR - Body temperature - Heart rate (HRV) - Blood pressure 	- Observe employee behavior	- Elevate employee cases to psychologist for further improvement.
Anxious	<ul style="list-style-type: none"> - Meditation exercise - Enroll the employee into stress management program 	Week-month		- Check employee's satisfaction	<ul style="list-style-type: none"> - Annual leave - Assess employee's behavior
Calm	<ul style="list-style-type: none"> - Spa Voucher - Earlier leave from workplace (minimize working hours) - Entertainment card for employee's family (force employee to spend quality time with his family) 	Day-week		- Check employee's satisfaction	- Enroll the employee into a stress management program to avoid increasing stress levels
Relax	<ul style="list-style-type: none"> - Allocate employees to the company's activities - Free cinema ticket 	days		- Check employee's satisfaction	- Free membership access to the gym for three months and can be extended.

4.3 Proposed Improvements

The accuracy and reliability of the stress measurement results could be improved through the adoption of the Perceived Stress Scale (PSS), the Stress Assessment and Research Toolkit (StAR), the Brief Job Stress Questionnaire (BJSQ), the Triad Social Stress Test (TSST), and the Workplace Stress Scale (WSS). These tools

present significant characteristics that support their application in measuring stress levels and burnout among employees. Their perceived adaptability is as follows;

The Perceived Stress Scale (PSS)

The Perceived Stress Scale (PSS) is a famous self-report questionnaire that measures how stressful people consider their lives to be. It has been proven to be a relevant and accurate tool for measuring stress since it asks questions regarding feelings of control, coping, and stress. The PSS comprises ten questions that gauge a person's emotions and perceptions of stressful circumstances in their life. The purpose of the questions is to gauge how chaotic, out of control and overburdened the respondent believes their life to be. The PSS is a valid and reliable indicator of perceived stress in various demographics, including clinical populations, working people, and college students. Its applications include studies on how stress affects various health outcomes, such as heart disease, anxiety, depression, and health-related behaviors. The PSS presents significant advantages, like its ease of administration and scoring. The scale is easy to use and takes only a few minutes to complete. Additionally, it is a commonly used and acknowledged indicator of felt stress, making comparisons across studies possible.

The Stress Assessment and Research Toolkit (StAR)

StAR can produce reports and dashboards, visually representing participants' stress levels and related data. It can help establish focused interventions and support methods and recognize trends and patterns in stress levels. StAR also offers a variety of tools and resources to help people and organizations control and lower their stress levels. Some options include self-help books, relaxation techniques, and suggestions for leading a healthy lifestyle. StAR's adaptability and flexibility are among its advantages. The platform can be altered to suit the requirements of various organizations and demographic groups. It can be applied in various venues, including businesses, healthcare facilities, and educational institutions. Based on comments and study results, StAR is constantly updated and enhanced. StAR is an effective technique for determining and tracking stress levels in people and organizations.

Through its variety of tools and services, people and organizations may manage and lower their stress levels, which can improve their mental and physical health.

The Brief Job Stress Questionnaire (BJSQ)

The BJSQ is made up of 57 questions that evaluate a variety of stressors associated with the workplace, such as workload, interpersonal problems, and a lack of control over one's work. The questionnaire evaluates a person's physical and mental reactions to work stress, including exhaustion, irritation, and anxiety. Most respondents can finish the BJSQ in less than 20 minutes because it is made to be completed in a brief time. The survey has been utilized in research in different professions and businesses and is available in numerous languages. The BJSQ presents a significant strength through its evaluation ability of occupational stressors and employee reaction to job stress. The questionnaire offers thorough details regarding the causes of work-related stress and the person's physical and psychological reactions to stress, pointing to areas benefiting from intervention and assistance. The BJSQ's emphasis on job stress as a multi-dimensional construct is one of its main strengths. In order to provide a more comprehensive view of the origins of work-related stress, the questionnaire measures a variety of job-related stressors, such as workload, interpersonal problems, and a lack of control over work.

The Triad Social Stress Test (TSST)

Three parts, or "triads," make up the TSST and are intended to make the individual feel stressed. The first triad addresses a public speaking program where the individual must speak about a predefined subject before an audience. The second triad presents a mental arithmetic activity where the individual must complete challenging calculations quickly. The third triad entails a social evaluative feedback assignment where a trained evaluator provides the participant with unfavorable criticism regarding their performance in the previous triads. The TSST presents a standardized and carefully monitored process, which enables accurate and repeatable measurement of individual stress responses. The TSST has been used in various studies on stress, including how it affects social interaction, cognitive function, and health outcomes. Thus, it can provide more reliable and accurate study results for measuring the relationship between stress levels, employee accuracy, and decision-making efforts.

The Workplace Stress Scale (WSS)

The WSS comprises 18 questions that evaluate a variety of stresses associated with the workplace, such as workload, interpersonal problems, and job security. The questionnaire evaluates a person's physical and mental reactions to work stress, including exhaustion, irritation, and anxiety. Most respondents can finish the WSS in less than 10 minutes because it is made to be done briefly. The survey has been utilized in research across various

professions and businesses and is available in numerous languages. The WSS is a simple procedure and presents easy-to-use tools. It presents a short and straightforward questionnaire for participants and researchers to assess and analyze the study results. The WSS also thoroughly evaluates the individual's stress levels and work-related stressors. Thus, it helps identify areas that require intervention. The WSS's emphasis on occupational stress as a multidimensional phenomenon is one of its main strengths. In order to provide a more comprehensive understanding of the origins of stress in the workplace, the questionnaire examines a variety of stressors, such as workload, interpersonal problems, and job security.

5. Conclusion

Stress at work has a complicated relationship with human error, memory loss, and decision-making. It can have a detrimental influence on a person's capacity to carry out activities and make judgments. High amounts of stress can affect cognitive abilities such as memory, attention, and decision-making, which increase the likelihood of mistakes and errors. When someone is under stress, they could be more prone to neglect crucial information, make mistakes, or forget vital data, resulting in mistakes and failures. Stress from the workplace also affects one's ability to make decisions. When under stress, a person could be more inclined to act quickly or rely on inaccurate information than to take the time to properly weigh all of their options and decide what to do. Human memory impairment can also have an impact on judgment. A person may be more prone to make the same mistakes in the future if they have previously failed or made blunders, especially if they are stressed out or under pressure to achieve. Overall, work-related stress, human error, memory loss, and poor decision-making are all connected and can significantly influence productivity and job performance. It is crucial for people and organizations to be aware of how stress may affect these variables and to take actions to control stress levels and reduce the likelihood of mistakes and failures.

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Biography

Amal Almarzooqi is currently enrolled in the Master of Engineering in Health, Safety and Environment Engineering program (MEng in HSE Engineering) at Khalifa University as well. Amal has a very wide and rich knowledge of HSE and ergonomics and human factors, she has been chosen to present and publish a paper in AHFE2022 that will be held in New York in July 2022, the paper title is Toxic Work Environment, and it has been accepted and submitted. She has a lot of volunteering community hours in the civil engineering college at the university. She is a civil engineer who graduated from Khalifa University with applied science and engineering in January 2020. Khalifa University has become the first and only university in the UAE to be placed among the top 200 universities in the world. She participated in the solar decathlon 2020 for a sustainable critical house and greenhouse construction that was displayed at EXPO 2020 in Dubai, and this was the graduation project for her bachelor's degree. She published a paper about (Indoor Air quality in Abu Dhabi 2018) and it was a collaboration with the Abu Dhabi environment agency. The civil engineering background that she has includes the following fields: Geotechnical & Foundation Engineering, Concrete & Material & steel, Engineering Management, Project control & construction management, Structural engineering, Wastewater engineering, Air pollution and environmental engineering, and Geology science.

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Saed Talib Amer is a Faculty member at Khalifa University. His research focuses on computer-integrated manufacturing and robot-controlled nondestructive testing. Dr. Amer also worked on sustainability metrics research and systematic measures to enforce engineering sustainability education. His previous work included seat comfort analyses for Boeing aircraft and robotics solutions for Unexploded Ordnance (UXO) remediation. Finally, Dr. Amer worked on simulation solutions for hybrid renewable energy research. Dr. Amer earned his Doctor of Philosophy in Computer and Information Systems Engineering with a concentration in Computer Integrated Manufacturing Systems in August 2012 from Tennessee State University, USA.