



(RESEARCH ARTICLE)



Examining the effect of maintenance work on employees' physical and mental health, as well as their overall well-being, in industrial settings

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Abstract

This study examines the impact of maintenance work on the physical, mental health, and overall well-being (PMHOW) of employees in some industry types in South Eastern Nigeria. The research aims to enhance occupational health standards and support interventions for industrial maintenance workers. It identifies the stressors that maintenance workers face (physical work demands, high-pressure work environment, shift work and irregular work hours, lack of recognition and support, exposure to hazardous conditions, job complexity and technical challenges, and; monotony and repetitive tasks), these stressors affect employees' health and well-being through musculoskeletal disorders, mental fatigue, increased risk of accidents, stress, anxiety, and burnout to mention but a few, it proposes strategies for mitigating them which include ergonomic practices, realistic workloads, supportive work culture, adequate staffing etc. Employee Satisfaction Survey was conducted across targeted industries. Based on survey results, employees' perceptions of variances in work characteristics reveal a mix of stable and fluctuating trends. This information helped identify which work characteristics were consistently experienced and which ones vary significantly among employees. Euclidean Distance assessment carried out also aided in identifying areas of intervention by focusing on specific groups of related work characteristics to enhance the work environment and promote better health outcomes. To enhance the mental and physical well-being of maintenance workers, organizations should implement comprehensive strategies that are tailored to the unique stressors and challenges of their work. This approach will not only boost job satisfaction but also contribute to a more efficient and healthier workforce.

Keywords: Employee satisfaction survey; Physical and mental health; Maintenance work characteristics; Employee satisfaction score; Organizational factor analysis; Euclidean similarity assessment.

1. Introduction

Industrial operations depend heavily on maintenance work [1], which makes sure that the machinery and systems that are vital to productivity continue to operate safely and reliably. However, maintenance workers' PMHW can be adversely affected by the physically demanding nature of their jobs, which is marked by high-pressure environments, shift work and irregular hours, exposure to hazardous conditions, job complexity and technical challenges [2]. When compared to workers in other occupations, industrial maintenance personnel frequently have particular difficulties [3]. Chronic fatigue and musculoskeletal issues might result from the physical demands of the job, and stress levels can be raised by the high-pressure atmosphere and the need for quick problem-solving. To further exacerbate the psychological and physical stress, inconsistent shift patterns also disrupt sleep and social life [4]. There is an increased chance of injury to the body and emotional trauma when working with and exposed to a hazardous environment. Biological or physiological stress refers to the demands placed on the physical body, experienced stress, on the other hand, describes how those demands are seen and made meaning of. A mix of both concepts can be used to understand stress. Stress at work specifically refers to how people react to situations, demands, and pressures at work that are not

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appropriate for their skill level or understanding [5]. Although maintenance workers are essential to the industrial sector, little is known about the specific stressors they face and how those stressors affect their PMHOW.

Through the following objectives: to determine the specific stressors that maintenance workers encounter and how these stressors impact their PMHOW; to determine organizational strategies in industrial stressors management; to determine the coping strategies that maintenance workers use to manage work-related stress and preserve mental health; to assess the influence of work characteristics on the mental health of maintenance workers, and to carry out similarity assessment of work characteristics, this extensive study aims to investigate the complex effects of maintenance work on workers' PMHOW in industrial environment and proffer mitigation strategies, it will also identify connections and similarities among various work characteristics, offering valuable insights for workplace assessments and improvement by industrial organizations. The results are intended to guide the development of better workplace procedures and guidelines to reduce health issues and enhance the overall well-being of workers in five specific industries: oil and gas, construction, manufacturing, and energy in South Eastern Nigeria.

By examining the relationship between maintenance work, physical work and demands, high-pressure work environment, lack of recognition and support, exposure to a hazardous environment, job complexity and technical challenges, shift work and irregular hours, and; employee PMHOW outcomes, this literature presents a thorough summary of the body of research on the subject. The physical demands of maintenance tasks frequently include lifting, bending, and working in confined spaces. These physical demands have been linked to musculoskeletal disorders (MSDs), chronic pain, and weariness, for example, [6] showed that job strain among high physical demand groups is not well captured by psychosocial variables. The employee's perception of work pressure and the manager's application of it are not as strongly correlated as was predicted by [7], this two variables appear on different albeit, marginally correlated factors, suggesting that there is variability in the application of work pressure and, consequently, variability in the employee's responses to it. [8] and [9] conducted a review that suggests, enhancing the psychosocial work environment may help reduce Stress-Related Disorders (SRDs). While public recognition encourages commitment and positive perceptions, personal recognition increases dedication, job satisfaction, and loyalty [10]. [11] argues that supervisors' ability to identify emotions affects how successful their appreciative behaviour is. A study by [12] found that "the most important to least important variables of motivation and job satisfaction" are related, it further adduced that the key elements to be taken into account when trying to motivate staff members are "job training," "good salary," and "recognition from colleagues." The everyday health management of industrial workers should place greater emphasis on the occupational health monitoring of those with occupational exposure to coal dust, asbestos dust, benzene, and noise [13]. [14] Noted that workers may experience short-term health risks such as headaches and skin burns, while long-term health consequences include respiratory illnesses, musculoskeletal disorders, leukemia, hypoxia, hypertension, and cardiovascular disease. The complexity and technical challenges inherent in maintenance work can be both a source of stress and a factor contributing to job satisfaction. According to [15], job complexity may be defined as the physical and mental demands placed upon an employee. Job complexity (the extent to which a job is multifaceted) increases customer orientation, and customer orientation increases employee creativity. Companies should think about rearranging workplace wellness perks to help employees and their families more effectively and go beyond the office [16]. Non-standard working hours (by shifts) affect the occupational health of employees since they raise the risk of burnout, anxiety, and depression [17]. [18] Further added that people who felt their shift schedule had a significant negative influence on their personal lives or were unhappy with it, were more likely to experience burnout and discomfort from shift employment.

According to the reviewed literature, performing maintenance in industrial settings presents serious risks to one's bodily and emotional well-being. Maintenance personnel are exposed to a variety of health concerns due to their job intricacy, physical demands, high-pressure workplaces, shift work, lack of recognition, and exposure to hazardous conditions. A multifaceted approach is needed to address these problems, one that includes ergonomic solutions, encouraging workplace policies, sufficient training, and recognition initiatives.

2. Materials and Methods

The study assessment procedure involved identifying the specific challenges and stressors that maintenance workers encounter, and examining how these factors affect their overall well-being and mental health. Furthermore, it investigates organizational strategies in industrial stressor management, and the various coping mechanisms employed by maintenance employees to effectively manage work-related stress and promote good mental health. Additionally, based on employee survey outcomes, the study uses Euclidean distance to examine relationships and commonalities between diverse work characteristics, providing significant perspectives for workplace evaluations and remediation.

2.1. Specific challenges and stressors faced by maintenance workers and how it affects their PMHW

The term "stressors" refers to a category of psychosocial events and conditions that are believed to induce strain and ultimately affect both physical and mental well-being of an individual [19]. Both the work environment and the nature of the work itself have a significant impact on health, safety and work. A considerable portion of the overall population's health issues can be attributed to their occupation [20]. Maintenance workers face significant challenges that impact their well-being and mental health. They operate in high-pressure environments where they must quickly respond to equipment malfunctions. This leads to elevated stress levels as they strive to minimize downtime and maintain production. The physical demands of their work such as manual labor and repetitive tasks can cause physical strain, muscle fatigue, and a higher risk of musculoskeletal injuries. These factors contribute to mental stress. Additionally, irregular work schedules disrupt their routines and sleep patterns, increasing stress and fatigue. Exposure to hazardous substances, environment, and dangerous equipment creates anxiety and fear, further affecting their mental well-being. Furthermore, a lack of recognition and support can lead to feelings of isolation, disengagement, and low morale. The complexity of maintenance tasks, which require specialized skills can also be mentally taxing and cause frustration and job dissatisfaction.

To address these issues, proactive measures should be taken. This includes providing training and support for maintenance workers, promoting work-life balance, implementing safety guidelines, fostering appreciation, and offering mental health resources. Employers should prioritize safety and offer support programs and recognize the contributions of their employees. Creating a positive work culture is also crucial. Regular health assessments, ergonomic improvements and open communication can further help mitigate the negative impacts on maintenance workers' well-being.

2.2. Organizational strategies in industrial stressors management

Managing stress in an industrial setting requires a comprehensive approach that involves identifying sources of stress, implementing mitigation strategies, and promoting overall employee well-being [21]. Key stressors in this context include excessive workloads, poor work environments, unclear job expectations, work-life balance issues, interpersonal conflicts, and job insecurity. To manage these stressors at the organizational level, it is important to ensure realistic workloads, improve workplace safety and conditions, clarify roles and responsibilities, promote flexible working hours, and enhance interpersonal relationships through conflict resolution and team-building activities. Job security can be strengthened through transparent communication and providing opportunities for career growth. At the individual level, stress management can be addressed through workshops on mindfulness and time management, employee assistance programs, offering confidential counseling, health and wellness programs, promoting physical activity and healthy eating. Creating a supportive environment involves training managers to recognize and address stress, fostering open communication, and implementing recognition and reward programs. Regular monitoring and evaluation through surveys and assessments are crucial for identifying stress levels and sources, allowing for continuous improvement of stress management strategies. Ultimately, both management and employees must be committed to reducing stress levels in order to improve well-being and productivity in industrial settings.

2.3. Coping mechanisms employed by maintenance employees to manage work-related stress and maintain mental well-being

Maintenance employees face unique challenges that can lead to work-related stress, such as physical demands, long hours, and pressure to meet deadlines. Engaging in coping strategies can help minimize the negative impact of job insecurity on employee well-being [22]. To manage this stress and maintain mental well-being, they employ various coping mechanisms. Engaging in physical exercise, such as jogging, weightlifting, or yoga, helps reduce stress and anxiety by releasing endorphins. Effective time management is crucial, allowing them to prioritize tasks and manage time efficiently, reducing stress and providing a sense of control. Relying on colleagues and friends for workload sharing, emotional support, and camaraderie also mitigates stress. Mental distancing techniques such as taking breaks, practicing mindfulness, and engaging in relaxation exercises like deep breathing help clear the mind. Breaking down high-priority tasks into smaller, manageable chunks further enhances control and reduces stress. Prioritizing self-care activities, including sufficient sleep, a healthy diet, and engaging in hobbies outside of work supports stress management. Seeking help from supervisors, HR professionals, or mental health professionals is another strategy for addressing specific work-related stressors. Teamwork, involving sharing knowledge, expertise, and providing support, effectively manages stress. Regular feedback from supervisors or peers fosters recognition, value, and motivation. Both organizational culture and work environment have a simultaneous impact on job performance [23], finding meaning and purpose in their work helps many maintenance employees cope with stress.

Table 1 presents the factors that can affect the health and well-being of maintenance workers. It also highlights the impact of these factors on their physical and mental health, along with the strategies to mitigate them.

2.4. Instruments and factors utilized to evaluate impact of work characteristics on maintenance workers' well-being

2.4.1. Workload, job demands, support systems, and workplace culture

The negative impacts of workload and job demands can be exacerbated by a lack of sufficient support systems. Maintenance workers often find themselves without recognition or reward for their contributions as well as lacking supportive supervisors and colleagues who can offer guidance and emotional support. Moreover, the absence of a positive work culture that prioritizes employee well-being and health can result in feelings of isolation, disengagement, and low morale, according to [24], support from the organization for balancing work and family life is more important than support from a generic supervisor. A positive work culture that values employee well-being and health can be fostered by implementing open communication channels, recognizing and rewarding contributions, supporting employees' personal and professional growth, prioritizing employee well-being and mental health, and cultivating a sense of community and belonging among employees.

2.4.2. Maintenance worker survey

The survey questionnaire is aimed to assess the impact of work characteristics on the health and well-being of maintenance workers. [25] demonstrated that a 10-item well-being questionnaire can have strong psychometric properties and predictive validity. This questionnaire includes important elements such as job characteristics, individual differences in personality and coping mechanisms, appraisals, and outcomes. These elements must encompass both positive and negative aspects. In the present study, the appraisals specifically examined the interactions between the organization and the employee. Participant information, including name, age, gender, years of experience, and industry type was collected. The questionnaire consisted of five industry types, Oil and Gas (O&G), Construction (CST), Manufacturing (MNU), and Energy (EN)). The stressors included physical Work Demands (PWD), High-Pressure Work Environments (HPWE), Shift Work and Irregular Work Hours (SWIWH), Lack of Recognition and Support (LRS), Exposure to Hazardous Conditions (EHC), Job Complexity and Technical Challenges (JCTC), Monotony and Repetitive Tasks (MRT). Forty participants, ten from each industry type were asked how the various stressors affected their physical, mental health and well-being. The responses were scored on a Likert scale from 1 to 5, with 1 representing "not affected" (strongly disagree), 2 representing "less affected" (disagree), 3 representing "moderately affected" (neutral), 4 representing "affected" (agree), and 5 representing "highly affected" (strongly agree).

Table 2 contains data on workers from various industries, including O&G, EN, MNU, and CST. Each worker has been assigned a unique ID and their information includes age, gender, years of experience, industry type, and work-related factors such as PWD, HPWE, SWIWH, LRS, EHC, JCTC and MRT.

2.4.3. Sum of scores and mean score

The sum of scores (S_s) is a calculation method used to aggregate individual responses from employees to determine their overall satisfaction or engagement. It is calculated by adding up the individual scores (I_s) from each employee, and the resulting total is often referred to as the "sum of scores". For example, if an organization surveys N employees and asks them to rate their job satisfaction on a scale of 1-5, the sum of scores would be calculated by adding up the individual scores. This method provides a total score that represents the overall satisfaction or engagement of employees. Mathematically,

$$S_s = \frac{1}{N} \sum_{i=1}^N S_i \dots\dots\dots (1)$$

On the other hand, the mean score is an alternative method for calculating the average satisfaction or engagement of employees. It is obtained by dividing the total sum of scores by the number of employees. In the example mentioned earlier, the mean score would be determined by dividing the sum of scores (S_s) by the number of employees (N). This calculation would yield a mean score of (M_s), which represents the average level of satisfaction or engagement among employees. The mean score is expressed as,

$$M_s = \frac{S_s}{N} \dots\dots\dots (2)$$

2.4.4. Employee satisfaction score

The Employee Satisfaction Score (ESS) is an important metric used to determine overall employee satisfaction in an organization. It is calculated by surveying employees and asking them to rate their satisfaction with various aspects of their job, such as job duties, work environment, communication, leadership, compensation, growth opportunities, and work-life balance. The ESS is determined by averaging the responses to these questions, with a higher score indicating greater employee satisfaction. Tracking ESS offers several benefits to organizations, satisfied employees are typically more engaged and motivated, leading to increased productivity and performance. Additionally, a high ESS can contribute to lower turnover rates, as dissatisfied employees are less likely to leave. By understanding the factors driving employee satisfaction, organizations can make informed decisions to improve employee well-being and retention. A strong ESS also helps attract top talent and enhances the organization's reputation. To effectively track ESS, organizations use methods like online surveys, Net Promoter Score (NPS), and employee feedback systems. However, challenges such as low response rates, biased data, and limited sample sizes may arise. Organizations can overcome these challenges by using anonymous surveys to increase response rates, utilizing data analytics to identify trends, and ensuring an adequate sample size for representative data. Ultimately, tracking ESS is crucial for organizational management, providing valuable insights for enhancing employee experience, reducing turnover, and strengthening the employer brand. Therefore, organizations should prioritize ESS tracking and continually strive for improvement.

In this scenario, based on a Likert scale of 1-5, where 1 represents "not affected" (strongly disagree) and 5 represents "highly affected" (strongly agree), which happens to be the benchmark. ESS is expressed as the maximum Likert values in agreement with the asked question minus the mean score, A lower score means less dissatisfaction (higher satisfaction), while a higher score means more dissatisfaction (lower satisfaction). Mathematically,

$$ESS = 5 - M_s \dots\dots\dots (3)$$

Each of these calculations has its own strengths and weaknesses. The sum of scores provides a total score that represents the overall satisfaction or engagement of employees. On the other hand, the mean score provides an average score that represents the typical level of satisfaction or engagement among employees. By understanding these different methods, organizations can make informed decisions about how to improve employee satisfaction and engagement.

Table 3 and Figure 1 display the results of a survey assessing various work characteristics evaluated using three key metrics. S_s , which represents the total score for each work characteristic, with a maximum possible score of 40. The M_s is the average score for each characteristic, calculated by dividing the sum of scores by 40. ESS measures employee satisfaction with each work characteristic, with higher scores indicating greater satisfaction.

2.4.5. Similarity assessment (Euclidean distance)

There is no single type of measurement (distance or similarity) that is universally superior to others [26]. This is because different measures possess specific properties, some of which may be advantageous for certain applications but not for others. The Euclidean Distance (ED) is a widely used metric in various real-world applications. There are two methods for assessing similarity: calculating the ED and using clustering techniques to identify characteristic groupings. To determine the similarity of work characteristics, we can either calculate the ED or employ clustering techniques to analyze their scores. Calculating the ED between the work characteristics using both their sum of scores and mean scores aids in understanding the relationships and similarities among different work characteristics which can be beneficial for workplace assessments and interventions. It will enable the identification of how characteristicsThe ED matrix for the work characteristics, based on both the sum of scores and mean scores is expressed as:

$$ED = \sqrt{(S_{s_1} - S_{s_2})^2 + (M_{s_1} - M_{s_1})^2} \dots\dots\dots (4)$$

To create the complete distance matrix, Python can be used to populate the distances for every possible combination of work characteristics using ED. Firstly, survey data is collected and quantification of each work characteristic for all employees is carried out. Then, the distance between each pair of work characteristics is computed, ensuring that calculation for every possible pair is not overlooked. The calculated distances are then used to populate the distance matrix. Each cell (i, j) in the matrix represents the distance between the i-th and j-th work characteristics. This systematic approach ensures a thorough analysis of the entire dataset and guarantees that the matrix is fully completed and verified. The final matrix provides a comprehensive overview of the relationships between different work characteristics, which facilitates further analysis and interpretation.

Table 4 presents the similarity assessment, which involves measuring the similarity between work characteristics through the comparison of their sum of scores and mean scores.

3. Results and Discussion

3.1. Organizational factor and analysis

Table 1 Organizational factor analysis of work characteristics

Factor	Impact on physical health	Impact on mental health	Mitigation strategies
PWD	Musculoskeletal disorders, chronic pain, and fatigue.	Stress and mental fatigue.	Ergonomic practices, taking regular breaks, and receiving proper training.
HPWE	Physical exhaustion, and increased risk of accidents.	Anxiety, stress, and burnout.	Realistic workloads, supportive work culture, and adequate staffing.
SWIWH	Sleep disorders, cardiovascular issues, and fatigue.	Anxiety, depression, and social isolation.	Consistent shift schedules, sufficient rest periods, good sleep and hygiene.
LRS	Lack of self-care and reduced commitment to safety practices.	Low morale, job dissatisfaction, depression, and anxiety.	Regular feedback, recognition of achievements, and career development opportunities.
EHC	Acute injuries, chronic illnesses, respiratory issues, and hearing loss.	Chronic stress, anxiety, and post-traumatic stress disorder (PTSD).	Safety guidelines, personal protective equipment (PPE), and regular safety training.
JTC	Mental fatigue and physical strain,	Anxiety, stress, and frustration.	Comprehensive training, continuous professional development, and technical support.
MRT	Physical injuries, repetitive strain injuries (RSIs).	Frustration, boredom, and mental fatigue.	Task variety, job rotation, and skill development.

The nature of maintenance work in industrial environments can have a significant impact on the physical and mental health of employees, these workers face various stressors that if not properly managed can result in chronic health issues and a decrease in their overall quality of life. Managerial support is crucial for maintaining the mental health of maintenance workers, to achieve this, it is important to provide training on employee mental health, encourage supervisors to prioritize employee well-being, and reward supervisors who demonstrate empathetic leadership. Employers in industrial settings must take a proactive role in addressing these challenges, this can be done by implementing comprehensive health and safety programs, fostering a supportive work culture, and ensuring that workers have access to necessary resources and support systems. By adopting a holistic approach that includes ergonomic practices, support for shift workers, strict safety routines, comprehensive training, recognition and support, and measures to reduce the impacts of stressors, employers can create a healthier and more supportive work environment. Ultimately, leading to enhanced well-being and productivity of maintenance workers.

3.2. Maintenance employees' survey result

Table 2 Result of interview of 40 maintenance personnel of different industry type

Worker ID	Age	Gender	Years experience of	Industry type	PWD	HPWE	SWIWH	LRS	EHC	JTC	MRT
1.	38	M	10	O&G	2	4	4	3	5	2	3
2.	30	M	5	O&G	4	4	3	2	4	5	5
3.	49	F	15	O&G	5	3	3	4	4	3	4
4.	28	M	7	O&G	3	3	2	3	3	3	3
5.	41	M	13	O&G	4	3	4	3	3	3	3

6.	38	M	10	O&G	3	2	4	3	2	4	5
7	32	F	8	O&G	5	4	3	2	2	4	4
8.	33	M	5	O&G	3	3	3	4	4	3	3
9.	27	M	5	O&G	3	4	5	3	4	4	5
10.	44	M	11	O&G	4	4	2	3	3	3	3
11.	27	M	5	EN	3	4	4	3	4	4	3
12.	33	F	6	EN	4	3	3	4	5	3	2
13.	41	F	11	EN	4	3	3	3	3	2	4
14.	43	M	9	EN	3	2	3	3	4	3	3
15.	51	M	16	EN	3	3	4	4	3	3	3
16.	26	M	4	EN	4	3	3	3	3	4	5
17.	27	M	5	EN	2	3	4	2	3	3	3
18.	37	M	7	EN	4	3	3	3	2	3	2
19.	43	F	8	EN	3	5	3	5	4	5	4
20.	26	M	4	EN	2	2	2	4	4	2	4
21.	25	M	3	MNU	2	4	5	3	4	4	5
22.	32	M	7	MNU	5	3	4	3	5	4	3
23.	29	F	4	MNU	4	3	3	5	3	4	3
24.	30	M	7	MNU	3	5	3	2	3	2	4
25.	26	M	4	MNU	4	4	4	4	4	3	3
26.	44	M	14	MNU	5	5	5	3	2	4	2
27.	31	M	5	MNU	4	3	4	5	5	5	4
28.	36	M	8	MNU	3	3	3	4	3	3	2
29.	25	F	3	MNU	3	4	3	3	3	3	4
30.	36	F	7	MNU	5	4	4	3	4	4	3
31.	46	M	18	CST	3	4	3	3	2	4	2
32.	39	M	10	CST	3	3	3	2	3	5	2
33.	40	M	15	CST	4	5	5	4	4	4	3
34.	25	M	8	CST	5	3	4	4	4	4	4
35.	31	M	7	CST	4	2	2	4	3	4	4
36.	48	M	18	CST	3	5	3	3	3	3	3
37.	35	M	10	CST	4	2	3	5	4	2	5
38.	37	M	10	CST	3	3	4	2	4	4	2
39	25	F	4	CST	4	4	4	3	2	3	3
40.	28	M	6	CST	3	5	3	4	3	3	3

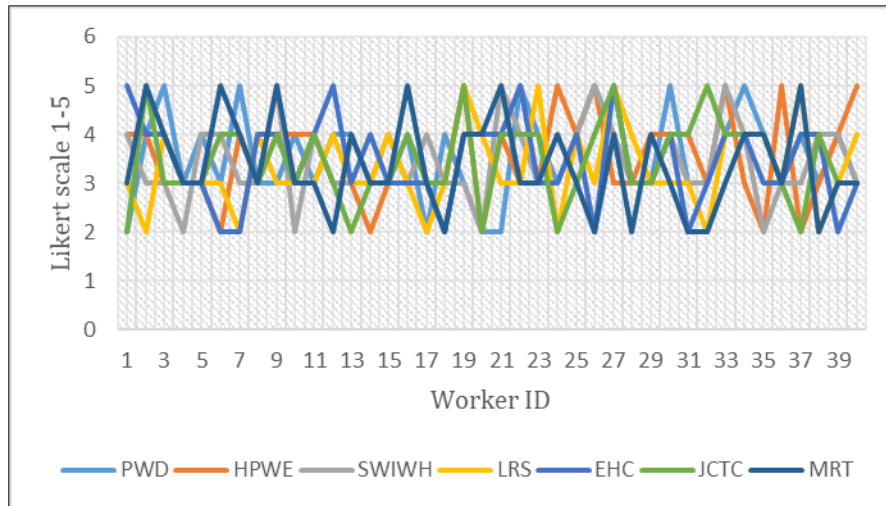


Figure 1 Maintenance employee survey response trend

Figure 1 illustrates variability and trends of the survey data in employee responses across different work characteristics. PWD fluctuates between values of 2 and 5, indicating varying levels of perception or experience among participants. HPWE exhibits a mix of moderate stability and peak values, reflecting some consistent responses with notable instances of higher intensity. SWIWH is relatively stable, mainly oscillating between 3 and 4, suggesting a more uniform employee experience. LRS scores mostly in the middle range of 3s and 4s, implying a moderate level of respect and support. EHC often reaches the maximum value of 5, indicating high occurrences or strong perceptions. JCTC shows considerable variation with several high values, highlighting fluctuating levels of job challenge and task complexity. MRT reveals both stability and peaks, suggesting a mix of consistent and extreme experiences regarding management responsiveness and transparency. The variations in work characteristics as perceived by employees, revealed a combination of both stable and fluctuating trends. This survey is useful in identifying the work characteristics that are consistently experienced and those that vary significantly among employees. Organizations that aim to address specific areas of employee satisfaction and workplace improvement can greatly benefit from understanding these trends.

3.3. Sum of scores, mean score, and employee satisfaction score

Table 3 Calculation results of sum of scores, mean score and employee satisfaction score

Work characteristics	Sum of scores (S_s) $\frac{1}{40} \sum_{i=1}^{40} S_i$	Mean score (M_s) $\frac{S_s}{40}$	Employee satisfaction score (ESS) $5 - M_s$
PWD	137	3.425	1.175
HPWE	136	3.400	1.600
SWIWH	137	3.425	1.175
LRS	122	3.050	1.950
EHC	120	3.000	2.000
JCTC	136	3.400	1.600
MRT	142	3.550	1.450
Average		3.180	

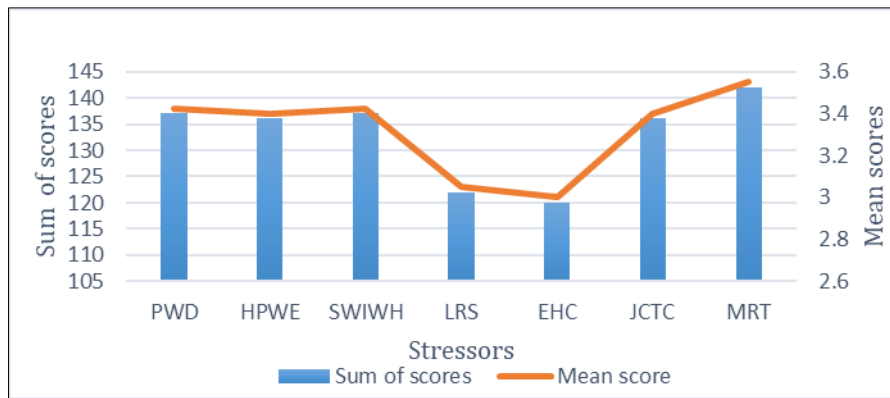


Figure 2 Sum and mean score chart

3.3.1. Sum of scores

The S_s reveals that the work characteristics predominantly have high scores, indicating that the job is demanding and challenging in various aspects. The highest score, 142, is attributed to MRT, suggesting that the job involves a significant amount of repetitive tasks with little variation or challenge, this can lead to boredom and dissatisfaction. The scores for PWD, HPWE, and SWIWH are all very high, ranging from 136 to 137. This indicates that the job is physically demanding, stressful, and has irregular work hours, which can impact employees' physical and mental well-being. JCTC also scored high, with a score of 136, indicating that the job requires technical expertise and problem-solving skills. On the other hand, the score for LRS is relatively lower, at 122. This suggests that employees may not have received adequate recognition and support, which can lead to dissatisfaction and low morale. EHC scored the lowest, with a score of 120, indicating that while employees may be exposed to hazardous conditions, it is not as significant as the other demands. The analysis suggests that the job is characterized by a mix of challenges, requiring employees to manage multiple stressors.

3.3.2. Mean score

The mean score for physical work demand is 3.425, which suggests a moderate level of PWD, mean score for a HPWE is 3.400, indicating a moderate level of pressure at work. Similarly, the mean score for managing SWIWH is 3.425, indicating a moderate level of difficulty. On the other hand, the mean score for LRS is 3.050, indicating a relatively low level of support from the organization or colleagues. The mean score for EHC is 3.00, indicating a relatively low level of exposure. Furthermore, the mean score for JCTC is 3.400, indicating a moderate level of work complexity. The mean score for MRT is 3.55, indicating a relatively high level of repetitive tasks. The average mean score stood at 3.180, indicating a moderate level of stress and challenges in the workplace.

3.3.3. Employee satisfactory score

PWD has a rating of 1.575, indicating a moderate level of dissatisfaction, which is similar to SWIWH. HPWE also has a rating of 1.600, suggesting moderate dissatisfaction. JCTC shares a similar rating of 1.600 with HPWE, indicating similar challenges. MRT, on the other hand, has a lower rating of 1.450, suggesting, it contributes less to dissatisfaction. However, the most critical issues are EHC, rated at 2.000, and LRS, rated at 1.950, which are the main sources of dissatisfaction. By addressing work pressure and technical challenges through improved strategies and resources, the observed dissatisfaction rate could be lowered or mitigated leading to a conducive work environment that enhances employee health and wellbeing.

Figure 1 illustrates a clear discrepancy in the heights of the bars on the chart. The tallest bar represents MRT at 142, which is significantly higher than the others. This suggests that employees are experiencing boredom, frustration, and dissatisfaction, indicating a lack of engagement in their work. In contrast, both PWD and SWIWH are at 137, indicating challenges related to physical strain and irregular scheduling. Despite these concerns, the towering height of the MRT bar highlights the urgent need for employers to promptly address this issue. EHC, shown by a shorter bar at 120, also requires attention. The stark visual contrast in the bar heights emphasizes the most critical issues faced by employees, urging employers to prioritize addressing MRT in order to enhance overall work environment satisfaction.

3.4. Similarity assessment using Euclidean Distance

Table 4 Similarity assessment

Work characteristics $\sqrt{(Ss_1 - Ss_2)^2 + (Ms_1 - Ms_1)^2}$	PWD	HPWE	SWIWH	LRS	EHC	JCTC	MRT
PWD	0.00	1.00	0.00	15.00	17.00	1.00	5.00
HPWE	1.00	0.00	1.00	14.00	16.00	0.00	6.00
SWIWH	0.00	1.00	0.00	15.00	17.00	1.00	5.00
LRS	15.00	14.00	15.00	0.00	2.00	14.00	20.00
EHC	17.00	16.00	17.00	2.00	0.00	16.00	22.00
JCTC	1.00	0.00	1.00	14.00	16.00	0.00	6/00
MRT	5.00	6.00	5.00	20.00	22.00	6.00	0.00

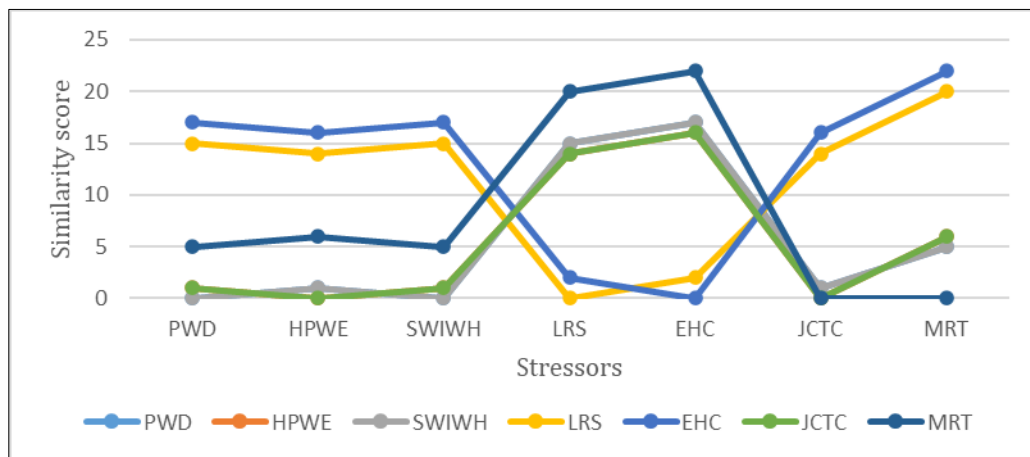


Figure 3 Maintenance employee survey response trend

Figure 3 shows that PWD, HPWE, SWIWH, and JCTC are highly similar and form a closely related cluster with distances ranging from 0 to 1. LRS and EHC are highly similar to each other with a distance of 2 but they differ significantly from the other characteristics with distances ranging from 14 to 17. MRT, on the other hand, shows moderate similarity to PWD, SWIWH, HPWE, and JCTC, with distances of 5 or 6 but it is distinctly separate from LRS and EHC with high distances of 20 and 22, respectively. This assessment can guide workplace interventions by specifically targeting groups of related characteristics to improve the overall work environment and health outcomes. It's important to note that different types of work characteristics and conditions do not directly correlate or interchange with each other. Instead, they have their distinct impacts on workers' well-being and should be evaluated independently when assessing the overall quality of work life. Therefore, this assessment can help identify areas for improvement by focusing on specific groups of related characteristics in order to enhance the work environment and promote better health outcomes.

4. Conclusion

This study aimed to comprehensively explore the complex impacts of maintenance work on the physical, mental health and overall well-being of workers in industrial settings. It also aimed to propose strategies to mitigate these impacts and identify relationships and similarities among different work characteristics. The study further, provides valuable insights for workplace assessments and interventions by industrial organizations. Key findings of the study indicate that,

Maintenance workers face numerous stressors, which include PWD, HPWE, SWIWH, LRS, EHC JCTC, and MRT, these stressors can lead to musculoskeletal disorders, chronic pain, mental fatigue, physical exhaustion, increased accident,

risk, stress, anxiety, and burnout, etc. To improve their health and well-being, it is crucial to implement ergonomics practices, provide regular breaks, offer proper training, manage realistic workloads, foster a supportive work culture, and ensure adequate staffing, etc.

The perception of employees regarding work characteristics reveals a mix of both stable and fluctuating trends. This information is valuable in identifying work characteristics that are consistently experienced and those that vary significantly among employees. Organizations seeking to address specific areas of employee satisfaction and improve the workplace can greatly benefit from an understanding of these trends.

The stark visual contrast in S_s values emphasizes the most critical issues faced by employees (MRT =142, PWD and SWIWH =137, HPWE and JCTC =136, LRS =122, and EHC =120). This revelations urges employers to prioritize addressing stressors with higher S_s i.e., MRT, to enhance overall work environment satisfaction.

The study highlights that various work demands have unique impacts on the well-being of workers and should be assessed and addressed separately or in groups. The goal of this targeted approach is to improve the work environment and promote better health outcomes for employees.

To enhance the PMHOW of maintenance workers, organizations must implement comprehensive strategies that are specifically designed to address the distinctive stressors and challenges associated with maintenance work. By doing so, not only will job satisfaction be improved, but it will also contribute to a more efficient and healthier workforce.

Compliance with ethical standards

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