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Artikel Penelitian

Workload Assessment of Construction Workers Using the Job Strain Index (JSI) Method at Revitalization of Hospital X

Ari Rahman*, Rivario Azriel Kirana, Fatimah Dinan Qonitan, Eri Aryani

Department of Environmental Engineering, Universitas Pertamina, South Jakarta, Indonesia

*Correspondence e-mail: ari.rahman@universitaspertamina.ac.id

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ABSTRACT

Workers engaged in high-intensity physical and mental activities are susceptible to increased workloads that may lead to work-related health issues. In the revitalization project at Hospital X, several workers reported discomfort across multiple body areas. An initial assessment utilizing the Nordic Body Map (NBM) questionnaire identified the predominant complaints in the right hand, back, and waist, with scores of 72, 70, and 69, respectively. These complaints primarily result from exposure to repetitive and prolonged physical tasks during the project. This study aims to investigate musculoskeletal complaints through the NBM questionnaire and evaluate physical workload using the Job Strain Index (JSI) method among construction workers engaged in various activities, including piping, ducting, plumbing sprinkle, electrical work, and AC insulation. The JSI analysis revealed that ducting work exhibited the highest strain index score of 20.25, followed by AC insulation at 18, and plumbing sprinkle at 10.12, categorizing all three as hazardous risk activities (probably dangerous). In alignment with the risk control hierarchy, recommended mitigation strategies include the implementation of engineering controls, such as providing work aids to alleviate physical loads and applying ergonomic principles. Additionally, administrative controls are proposed, including the regulation of working hours, scheduling of breaks, and conducting safety patrols. To further enhance worker protection, it is critical to supply adequate personal protective equipment (PPE) that meets both quality and quantity standards, including safety helmets, masks, and gloves tailored to the specific demands of each task.

Keywords: Hierarchy of risk control, Job strain index (JSI), Musculoskeletal, Nordic body map (NBM), Physical workload

ABSTRAK

Pekerja yang melakukan aktivitas fisik dan mental dengan intensitas tinggi memiliki risiko peningkatan beban kerja yang berpotensi menimbulkan gangguan kesehatan akibat kerja. Pada proyek revitalisasi Rumah Sakit X, sejumlah pekerja melaporkan keluhan ketidaknyamanan pada beberapa bagian tubuh. Hasil penilaian awal menggunakan kuesioner *Nordic Body Map* (NBM) menunjukkan keluhan utama pada tangan kanan, punggung, dan pinggang dengan skor masing-masing sebesar 72, 70, dan 69. Keluhan tersebut terutama dipengaruhi oleh paparan aktivitas fisik yang bersifat berulang dan berlangsung dalam durasi yang panjang selama proyek berlangsung. Penelitian ini bertujuan untuk mengidentifikasi keluhan muskuloskeletal menggunakan kuesioner NBM serta menganalisis beban kerja fisik melalui metode *Job Strain Index* (JSI) pada pekerja konstruksi yang terlibat dalam berbagai jenis pekerjaan, yaitu *piping*, *ducting*, *plumbing sprinkle*, *electrical*, dan *AC insulation*. Hasil analisis JSI menunjukkan bahwa pekerjaan *ducting* memiliki *strain index* skor tertinggi sebesar 20,25, diikuti oleh pekerjaan *AC insulation* sebesar 18 dan *plumbing sprinkle* sebesar 10,12. Ketiga jenis pekerjaan tersebut termasuk dalam kategori risiko berbahaya (*probably dangerous*). Berdasarkan hierarki pengendalian risiko, upaya mitigasi yang direkomendasikan meliputi penerapan pengendalian teknik (*engineering control*) berupa penyediaan alat bantu kerja untuk menurunkan beban fisik dan mendukung penerapan prinsip ergonomi. Selain itu, pengendalian administratif (*administrative control*) seperti pengaturan jam kerja, penjadwalan waktu istirahat, dan pelaksanaan patroli keselamatan juga perlu diterapkan. Upaya perlindungan tambahan dilakukan melalui penyediaan alat pelindung diri (APD) yang memadai, baik dari segi jumlah maupun kualitas, meliputi helm keselamatan, masker, dan sarung tangan yang sesuai dengan karakteristik pekerjaan.

Kata Kunci: Beban kerja fisik, Hierarki pengendalian risiko, *Job strain index* (JSI), *Muskuloskeletal*, *Nordic body map* (NBM)

1. INTRODUCTION

Human activities encompass both mental and physical work. Excessive physical and mental work may result in a workload (Pratiwi, Saputra, & Manangkot, 2020). Conducting work beyond one's capacity can lead to fatigue among workers. Incorrect posture or work positions are identified as contributors to worker fatigue (Ardian, 2018). The Regulation of the Ministry of Manpower of the Republic of Indonesia Number 5 of 2018 on Occupational Safety and Health (OSH) comprehensively covers activities aimed at ensuring and safeguarding the safety and health of workers through preventive measures against work accidents and work-related diseases (Kementerian Ketenagakerjaan Republik Indonesia, 2018). Workplace hazards include improper posture and excessive workloads, which can elevate the risks of work-related injuries and fatigue. Awkward work posture denotes a position where body parts deviate from their natural alignment (Evandariantio & Dwiyantri, 2017). Factors contributing to improper work posture encompass job requirements, inadequate tools matching one's abilities, and limitations of the worker. Variances in work posture can yield varying degrees of strength. Undertaking strenuous work and incorrect work posture may result in undue physical strain, posing a potential risk of musculoskeletal complaints (Muis, Jufrizen, & Fahmi, 2018). According to the Occupational Health and Safety Council of Ontario (OHSCO) in 2007, musculoskeletal complaints encompass a range of conditions affecting muscles, nerves, and tendons. Repeated work activities have the potential to cause tissue damage, leading to muscle discomfort and pain. To mitigate musculoskeletal complaints and alleviate the physical burden on workers, ongoing evaluations are crucial to prevent the recurrence of such issues (OHSAS, 2007).

In 2022, Hospital X embarked on a construction project involving finishing work in ducting, insulation, pipe installation, electronic installation, and plumbing. Through observation and interviews with the workers, it was discovered that many of them complained of upper-body discomfort. This finding was corroborated by the NBM questionnaire results, which served as preliminary research. The NBM questionnaire results revealed that the back, waist, and right hand were the areas workers complained about the most, with scores of 70, 69, and 72 (grey highlight). Analysis of the interview results and the NBM questionnaire indicated that the upper extremities were the body parts most frequently mentioned in complaints. Concerns about these complaints potentially disrupting work productivity prompted the necessity for a comprehensive analysis of the upper body members of the workforce to mitigate the risk of musculoskeletal disorders. The results of the physical burden analysis of the workers will inform the implementation of OSH ergonomics in the workplace by the Indonesian Minister of Manpower Regulation No. 5 of 2018 regarding OSH (Kementerian Ketenagakerjaan Republik Indonesia, 2018).

A preliminary assessment utilizing the Nordic Body Map (NBM) questionnaire has indicated that musculoskeletal complaints are predominantly concentrated in the upper extremities and trunk. The right hand recorded the highest complaint score of 72, followed by the back at 70, the waist at 69, the upper neck at 66, and both the right shoulder and left hand, each scoring 65. The elevated score for the right hand is primarily attributed to a significant number of workers reporting discomfort. Specifically, 34 individuals classified their discomfort as "slightly hurt," 12 categorized it as "hurt," and 4 reported it as "very hurt." Notably, the right hand is the only body region where reports of discomfort reached the "very hurt" level, indicating a greater degree of distress compared to other body areas. This situation highlights the necessity for targeted interventions to address these complaints and enhance workplace ergonomics.

Complaints were notably present in the trunk region, with recorded scores of 70 for the back and 69 for the waist. Specifically, 40 workers indicated experiencing "slight hurt" discomfort in their backs, while 9 workers reported being "hurt." In relation to the waist, 34 individuals described their discomfort as "slight hurt" and 12 indicated they were "hurt." These findings reveal that a significant proportion of employees are experiencing discomfort in bodily areas typically associated with prolonged standing, bending, lifting, or repetitive manual tasks. Additionally, elevated complaint scores were observed in the upper neck (66), right shoulder (65), left shoulder (61), and left hand (65). This suggests that the physical demands of the work involve repetitive upper-limb movements and non-neutral postures, contributing to worker discomfort.

In contrast, the complaint scores related to lower-extremity body parts were relatively low. Specifically, the knees, calves, ankles, and feet exhibited scores ranging from 44 to 51. The lowest scores were recorded for the right ankle (44), left foot (44), left ankle (45), and right foot (46). These findings indicate that the physical demands of the work are predominantly placed on the upper body rather than the lower extremities. Overall, the predominance of complaints observed in the hands, shoulders, neck, back, and waist suggests a potential risk for work-related musculoskeletal disorders (WMSDs). The concentration of complaints within these body regions implies that workers may be subjected to repetitive motions, forceful exertions, and awkward postures. This situation emphasizes the necessity for a comprehensive ergonomic assessment to identify contributing risk factors and to devise appropriate intervention strategies.

The JSI method aims to evaluate the physical workload of workers regarding the risk of musculoskeletal disorders in the Distal Upper Extremity (DUE), which includes the elbow, forearm, wrist, and hand (Permana, Simanjuntak, & Yusuf, 2018). Since many workers are involved in upper-body-related work during the project, the JSI method is considered appropriate for this study. The JSI method also has the advantage of being specific in assessing the

physical workload of workers and providing reasonably accurate results in assessing work processes (Ardian, 2018). The results obtained are expected to serve as a reference for analyzing the extent of the physical workload received by the workers, providing recommendations for reducing the potential injury risks for construction workers.

2.METHOD

The initial data collection method in this research involves distributing NBM questionnaires to workers to assess the areas of their bodies where they report experiencing pain. The next step is to evaluate their working activities using the JSI method. This method examines six variables: intensity of exertion (IE), duration of exertion (DE), effort per minute (EM), hand/wrist posture (HWP), speed of work (SW), and duration per day (DD) (Adhitama & Pratiwi, 2020). After collecting data on workers' body complaints through the NBM questionnaire and assessing their physical workload with the JSI method, the subsequent action is to formulate the recommendations for improvement following the hierarchy of control

1.Job Strain Index (JSI)

The Job Strain Index method aims to gauge the physical workload of workers and assess the job's susceptibility to musculoskeletal disorders in the Distal Upper Extremity (DUE), covering the forearm, elbow, hand, and wrist (Moore & Garg, 1995). Subsequently, values for the six variables are determined, as outlined in Table 1.

Table 1. Parameter for Each Variable

Rating Value	Intensity of Exertion (IE)	Duration of Exertion (DE)	Effort/Minute (EM)	Hand/Wrist Posture (HWP)	Speed of Work (SW)	Duration per Day (DD)
1	Light (1)	<10% (0.5)	<4 (0.5)	Excellent (1)	Very Slow (1)	<1 (0.25)
2	Moderate Heavy (3)	10 - 30% (1)	4-8 (1)	Good (1)	Slow (1)	1 - 2 (0.5)
3	Heavy (6)	30 – 50% (1.5)	9 – 14 (1.5)	Fairly Good (1.5)	Slow Moderate (1)	2 – 4 (0.75)
4	Very Heavy (9)	50 - 80% (2)	15 – 19 (2)	Poor (2)	Fast (1.5)	4 – 8 (1)
5	Heavy Approaching Maximum (13)	80 - 100% (3)	>19 (3)	Very Poor (3)	Very Fast (2)	>8 (1.5)

Source: (Moore & Garg, 1995)

The Strain Index score (SI score) was determined through analysis of each category. The following calculation formula in equation (1) can be utilized. This formula will provide essential insights that can be categorized and interpreted effectively (Moore & Garg, 1995).

$$SI = IE \times DE \times EM \times HWP \times SW \times DD \quad (1)$$

Where:

- SI : Strain Index
 IE : Intensity of Exertion
 DE : Duration of Exertion per Cycle
 EM : Efforts per Minute
 HWP : Hand/Wrist Posture
 SW : Speed of Work
 DD : Duration per Day

The required variable data includes the following assessment categories:

- Intensity of Exertion (IE) represents the effort required to perform a task once. It is obtained by measuring the worker's pulse with an oximeter while working and during rest time. This intensity exertion classification is determined by the percentage of Cardiovascular Load (%CVL) and the observable signs of exertion. The *Light* category indicates a %CVL of under 10% and is defined by effort that is not outwardly visible (invisible effort).

The *Moderate Heavy* category covers a %CVL from 10% to 29%, where the exertion becomes visibly apparent (visible effort). In the *Heavy* category, which has a %CVL between 30% and 49%, the effort is evident, even though facial expressions remain unchanged (clear effort; unchanged facial expression). The *Very Heavy* category signifies a high level of intensity with a %CVL of 50% to 79%, characterized by significant effort and noticeable changes in facial expression (substantial effort; changed facial expression). Lastly, the *Heavy Approaching Maximum* category illustrates an extreme state with a %CVL higher than 80%, where individuals engage their shoulders or back to produce power (using shoulders or back to generate power). CVL is an approach to assessing physical exertion by contrasting the maximum heart rate with the working heart rate, as outlined (Andriyanto & Bariyah, 2012). The IE value was determined from the calculated %CVL and its corresponding IE multiplier, using the following equation (Moore & Garg, 1995):

$$\%CVL = \frac{DN_k - DN_i}{DN_m - DN_i} \times 100\% \quad (2)$$

Where

- %CVL : Percentage Cardiovascular Load (%)
- DN_k : Working Heart Rate (beats per minute, bpm)
- DN_i : Resting Heart Rate (beats per minute, bpm)
- DN_m : Maximum Heart Rate (beats per minute, bpm)

- b. The Duration of Exertion (DE) can be calculated by measuring all activities with their respective durations during the observation period, then dividing the measured activity duration by the total observation time and multiplying the result by 100 (Andriyanto & Bariyah, 2012).
- c. Effort per Minute (EM) is measured by counting the number of activities that occur during the observation period, dividing the total number of activities by the duration of the observation period, and measuring it in minutes (Andriyanto & Bariyah, 2012).
- d. Hand/Wrist Posture (HWP) estimates the hand or wrist position relative to the neutral position. The assessment of wrist posture is based on the range of motion angles in three dimensions—wrist extension, wrist flexion, and ulnar deviation—as well as the associated level of effort. The *Excellent* category indicates a very neutral position, with small movement angles: 0°–10° for extension, 0°–5° for flexion, and 0°–10° for ulnar deviation. The *Good* category reflects an almost neutral position, with extension angles of 11°–25°, flexion of 6°–15°, and ulnar deviation of 11°–15°. The *Fairly Good* category represents a non-neutral position, with extension ranging from 26° to 40°, flexion from 16° to 30°, and ulnar deviation from 16° to 20°. The *Poor* category involves greater ranges of motion and more significant deviation, with extension ranging from 41° to 55°, flexion from 31° to 50°, and ulnar deviation from 21° to 25°. Finally, the *Very Poor* category indicates extreme conditions, characterized by extension greater than 60°, flexion greater than 50°, and ulnar deviation greater than 25°, reflecting a posture that deviates considerably from neutral and requires considerable effort (Moore & Garg, 1995).
- e. Speed of Work (SW) is an estimation of how quickly the workers perform their work. This classification outlines performance evaluation based on the percentage of achievement of the standard, along with the corresponding level of effort. The *Very Slow* category indicates performance below 80% of the standard, associated with a very relaxed state (very relaxed). The *Slow* category includes performance levels between 81% and 95%, defined by an effort level that remains relaxed (relaxed). Following that, the *Slow Moderate* category signifies performance from 96% to 110%, recognized as a standard speed of work. The *Fast* category denotes higher performance levels between 111% and 125%, indicative of a hurried working environment (hurried). Lastly, the *Very Fast* category demonstrates performance surpassing 125%, paired with high effort and a speed that is challenging to maintain (hurried and hard to keep up with) (Moore & Garg, 1995). Performance rating is calculated using the Westinghouse method, which involves assessing four factors considered fairness and unfairness in work: skill, effort, working conditions, and consistency (Kusuma & Firdaus, 2019).
- f. Duration per Day (DD) is defined as one of the six key variables within the JSI methodology. This variable denotes the cumulative amount of time expended by a worker in performing a specific work. The assessment of DD is quantified according to the total duration of task performance within a standard daily work period (Ihsan, 2019).
- g. The strain index scores (SI score) provide insight into the nature of jobs associated with distal upper extremity disorders, according to the Job Strain Index classification, a JSI value below 3 is considered probably safe, values between 3 and 7 indicate a moderate risk, whereas scores equal to or greater than 7 are classified as probably hazardous, urging individuals to exercise heightened awareness and caution in these roles (Moore & Garg, 1995).

3.RESULTS AND DISCUSSION

3.1. Direct Observation in the Workstation

This research analyzed five working activities from the construction project of Hospital X. The tasks performed include piping, ducting, plumbing, electrical, and AC insulation, all of which involve 44 workers. The description of various work can be seen in Table 2 and Figure 1.

Table 2. Identification of Workstation

Working Activity	Location	Number of Workers
Piping	4 th Floor Zone C	8
Ducting	4 th and 8 th Floor	9
Plumbing Sprinkle	B ^{2nd} Floor Zone A	12
Electrical	4 th Floor Zone A	5
AC Insulation	4 th Floor Zone B	10

The following describes the work carried out in the construction of Hospital X.



Figure 1: Various Construction Work for Hospital X

(a) Piping, (b) Ducting, (c) Plumbing Sprinkle, (d) Electrical, and (e) AC Insulation

3.2. Results of the Job Strain Index (JSI) Assessment

The result of the JSI assessment, which measures six variables: Intensity of exertion (IE), duration of exertion (DE), effort per minute (EM), hand/wrist posture (HWP), speed of work (SW), and duration per day (DD), is as follows:

a.Intensity of Exertion (IE)

Intensity of exertion is obtained by measuring the heart rate of the workers (Ilario, 2019). The following are the heart rate data of the workers at each workstation. The heart rate data of the workers is presented in Table 3.

Table 3. Heart Rate Data of Workers

Working Activity	DN _i (bpm)	DN _k (bpm)	DN _M (bpm)	%CVL	Category	Score
Piping	67	89	191	17.74	Moderate heavy	3
Ducting	72	108	193	29.75	Moderate heavy	3
Plumbing Sprinkle	61	90	195	21.64	Moderate heavy	3
Electrical	63	92	189	23.01	Moderate heavy	3
AC Insulation	65	99	183	28.81	Moderate heavy	3

b.Duration of Exertion (DE)

Workers require observation time to complete their work (Irawan, 2019). The duration of exertion is obtained from the total time workers spend completing their work during the observation period (Moore & Garg, 1995). Data on the duration of workers' exertion can be seen in Table 4.

Table 4. Data on Duration of Workers Exertion

Working Activity	Observation Time (s)	Duration Effort (s)	Duration of exertion (%)	Score
Piping	255	72	28.24	1
Ducting	861	493	57.26	2
Plumbing Sprinkle	564	251	44.50	1.5
Electrical	214	64	29.91	1
AC Insulation	982	527	53.67	2

c.Effort per Minute (EM)

Effort per minute is obtained from the total number of movements generated during the work (Ilario, 2019). Data on effort per minute can be seen in Table 5.

Table 5. Data on Effort per Minute

Working Activity	Effort Deployment Time (min)	Score
Piping	4.25	1
Ducting	14.35	1.5
Plumbing Sprinkle	9.4	1.5
Electrical	3.56	0.5
AC Insulation	16.36	2

d.Hand/Wrist Posture (HWP)

Hand or wrist posture is determined based on the type of posture and the hand angle formed when workers perform their work (Lindawati & Mulyono, 2018). The data on hand and wrist posture can be seen in Table 6.

Table 6. Data on Hand and Wrist Posture

Working Activity	Hand Posture	Angle	Hand Category	Score
Piping	<i>Flexion</i>	9°	Good	1
Ducting	<i>Ulnar Deviation</i>	15°	Good	1
Plumbing Sprinkle	<i>Flexion</i>	7°	Good	1
Electrical	<i>Flexion</i>	4°	Excellent	1
AC Insulation	<i>Extension</i>	11°	Good	1

e.Speed of Work (SW)

The speed of work is determined by how quickly workers perform their work. The performance rating is determined by using the Westinghouse method to assess how fast workers complete their work (Ilario, 2019). The data on the work speed can be seen in Table 7.

Table 7. Data on Speed of Work

Working Activity	Performance Rating	Speed of Work	Score
Piping	107%	Slow Moderate	1
Ducting	120%	Fast	1.5
Plumbing Sprinkle	109%	Slow Moderate	1
Electrical	104%	Slow Moderate	1
AC Insulation	110%	Slow Moderate	1

f. Duration per Day (DD)

The duration per day is the total time a worker spends performing or completing all work (Puspita, 2020). The data on the duration of tasks per day can be seen in Table 8.

Table 8. Data on Duration per Day

Working Activity	Duration (hours/day)	Score
Piping	12	1.5
Ducting	15	1.5
Plumbing Sprinkle	10	1.5
Electrical	8	1
AC Insulation	12	1.5

Following the acquisition and computation of all variables, an analysis will be conducted to identify the occupation with a potentially dangerous risk level. The recapitulation of strain index scores was presented in Table 9.

Table 9. Strain Index Score for Every Working Activity

Working Activity	IE	DE	EM	HWP	SW	DD	SI Score	Interpretation/ Risk Level
Piping	3	1	1	1	1	1.5	4.5	Moderate Risk
Ducting	3	2	1.5	1	1.5	1.5	20.25	Probably Dangerous
Plumbing Sprinkle	3	1.5	1.5	1	1	1.5	10.12	Probably Dangerous
Electrical	3	1	0.5	1	1	1	1.5	Probably safe
AC Insulation	3	2	2	1	1	1.5	18	Probably Dangerous

Based on the results of the measurement of workers' physical workload using the JSI method from the highest to the lowest score, the ducting job obtained a strain index score of 20.25 (probably dangerous), AC insulation scored 18 (probably dangerous), plumbing sprinkle scored 10.12 (probably dangerous), piping scored 4.5 (moderate risk), and electrical work scored 1.5 (probably safe). A high workload can cause several problems for workers if not promptly addressed. This can lead to physical and mental fatigue, as well as emotional reactions such as pain in various body parts, ultimately decreasing work productivity (Irawati & Carolina, 2017). Therefore, recommendations for improvement are needed to reduce the physical burden on workers. The recommendation is a priority for workstations with probably hazardous risk levels (ducting, AC insulation, and plumbing sprinkle).

3.3 Recommendations for Improvement

Based on the results of workload measurement using the JSI method and analyzing body complaints using the NBM method, several aspects pose issues for the workers. Three of five working activities fall into probably hazardous category in the strain index scores: ducting, AC insulation, and plumbing sprinkle. High workload and improper posture can lead to problems such as fatigue and the emergence of pain in specific body parts (Agustinaswati, Dinata, & primayanti, 2019). Therefore, improvement efforts are needed based on the risk control hierarchy to reduce the workers' workload. Improvement efforts with the risk control hierarchy at hazardous working activities are:

Table 10. Risk Control Recommendations

Workstation	Risk Control Hierarchy
Ducting	<p>The obtained JSI score for ducting work was 20.25, categorizing it as dangerous. Controlling risk through elimination is not feasible because it requires the use of essential tools for the job. The control of risk with substitution is not applicable as the tools used in ducting work do not require replacement since they are not damaged. Workplace observations indicated that ducting installation tasks were conducted without adequate engineering controls, as defined under ISO 45001 and OSHA hierarchy of controls. Work activities were performed at floor level with temporary foot support (Standardization, 2018), increasing the risk of musculoskeletal strain and fall hazards (Administration, 2023). To reduce these risks, the following engineering controls are recommended: adjustable-height scaffolding, elevated working platforms equipped with handrails and footrests, and tool balancers to minimize physical load during overhead operations. Effectively implemented physical safeguards frequently identify errors prior to their escalation, demonstrating superior efficacy compared to methods that depend on individuals' recollection of regulations (J, 1997).</p> <p>Recommended improvements include administrative controls and the provision of personal protective equipment (PPE). Administrative efforts to reduce the physical burden on workers may involve scheduling work hours and breaks. Based on the JSI method's results, ducting work exhibits intensity, duration of exertion, and a work schedule of 15 hours per day,</p>

Workstation	Risk Control Hierarchy
	<p>potentially affecting productivity and causing excessive worker fatigue (Sani & Widajati, 2021). As per the JSI method, the speed of work indicates that ducting work falls into the fast category, necessitating sufficient rest periods. In addition, recommended PPE includes masks, helmets, and gloves. In the field, several factors pose risks to workers, such as dust pollution and equipment that generates noise and vibrations. Protective gloves shield hands and fingers from exposure to fire, extreme temperatures, electric currents, impacts, blows, and scratches (Kusuma & Firdaus, 2019).</p>
AC Insulation	<p>The strain index score for AC insulation work was 18, categorizing it as dangerous. The high score is attributed to the job's elevated values in variables such as intensity of exertion, duration of exertion, effort per minute, and duration per day. In the risk management of isolation work, ducting work has little difference because using essential tools is necessary. Thus, risk control with elimination is not feasible. Risk control with substitution is impossible, as workers' tools are not damaged. Risk control with design has been implemented by designing scaffolding to enable workers to perform and complete work in higher areas. Recommended improvements include administrative controls and the provision of personal protective equipment. Administrative efforts to reduce the physical burden on workers may involve scheduling work hours and breaks (Yufami & Har, 2021). Based on the physical burden results obtained from the JSI method, isolation work exhibits intensity, duration of exertion, and a work schedule of 12 hours per day, potentially affecting productivity and causing excessive fatigue among workers (Wahyuni, Suyadi, & Hartanto, 2018). As per the JSI method, the work speed indicates that isolation work falls into the fast category, necessitating sufficient rest periods. In addition, recommended PPE includes masks and gloves, which are also important. Due to the project's significant dust exposure, masks or respiratory protection devices protect the respiratory organs by delivering clean air and filtering microorganisms and particles such as dust, vapor, smoke, and others (Kusuma & Firdaus, 2019).</p>
Plumbing Sprinkle	<p>The strain index score for plumbing sprinkle work was 10.12, indicating a probably dangerous level of risk. Based on the hierarchy of controls, hazard elimination is not feasible because it would compromise the essential tasks inherent to the job. Furthermore, substitution as a risk control measure is not applicable, as the tools used in the ducting work are in satisfactory condition and do not require replacement. No damage or functional deficiencies were identified. Next, it is imperative to implement engineering controls aimed at physically isolating workers from hazards. These measures include the installation of temporary barriers around areas designated for plumbing activities, the provision of adequate ventilation or local exhaust systems during welding or soldering operations, the utilization of pipe stands and clamps to prevent the displacement of materials, the assurance that all electrical tools are equipped with Residual Current Devices (RCD) or Earth Leakage Circuit Breakers (ELCB), and the maintenance of sufficient lighting to accommodate extended working hours. Such controls diminish the dependence on worker behavior, thereby providing consistent protection throughout the duration of the 10-hour work period. Once implemented, an engineering control has the potential to significantly decrease injury rates in the long term, as it remains effective with minimal need for oversight (Burgess, 2001).</p> <p>Administrative controls are crucial for managing exposure, especially considering the long working hours. A structured work-rest schedule should be implemented, including short breaks and a proper meal break, to help manage fatigue (Nasional, 2021). Job rotation should be used to minimize repetitive tasks and reduce the risk of musculoskeletal strain. Permit-to-work systems must be enforced for hot work and confined space activities, and supervisors should conduct daily inspections of tools, cables, and overall housekeeping conditions.</p> <p>Research across various industries has demonstrated that an excessive reliance on personal protective equipment (PPE) can maintain elevated risks, resulting in the continued occurrence of injuries and illnesses (Swuate, 2012). It is essential to utilize these safety items in</p>

Workstation	Risk Control Hierarchy
	conjunction with other protective measures. The fundamental PPE required by workers may include hard hats, cut-resistant gloves, non-slip footwear, goggles or face shields, welding masks for tasks involving heat, respiratory masks for maintaining clean air intake, and hearing protection in environments with elevated noise levels.

4.CONCLUSION

Based on our observations, data collection, and analysis, we can derive valuable insights from the complaints documented in the Nordic Body Map (NBM) questionnaire completed by 44 respondents. The feedback highlights significant concerns regarding discomfort in the right hand, back, and waist, with scores of 72, 70, and 69, respectively. Additionally, the strain index scores (SI score) reveal that among five working activities, ducting (20.25), AC insulation (18), and plumbing sprinkle (10.12) present probably dangerous levels. Understanding the relationship between the NBM and Job Strain Index (JSI) is crucial for assessing workload and identifying areas for improvement. To foster a safer and more efficient work environment, we recommend implementing various enhancements based on the risk control hierarchy for musculoskeletal issues. Implementing engineering controls, such as providing additional tools to assist with work tasks, is intended to reduce workload and enable workers to perform their duties in accordance with ergonomic standards. Proactive administrative controls should include regulating work duration, scheduling regular breaks, and instituting safety patrols. These measures are essential for mitigating the effects of extended working hours associated with ducting, AC insulation, and plumbing sprinkle ultimately improving worker efficiency and reducing fatigue. Additionally, we suggest providing appropriate personal protective equipment (PPE), such as masks, helmets, and gloves, to safeguard our workers further. By taking these steps, we can create a healthier workplace that prioritizes employee well-being and productivity.

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