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Original Article

Ergonomic Risk Analysis of Workers in Construction Project: A Case Study of Concrete and Brick Wall Work

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Abstract *- Construction projects are still prone to accidents. The risk of worker ergonomics is a significant factor driving construction project accident rates. The awkward postures carried out by these workers can impact the emergence of occupational diseases, including Musculoskeletal Disorders (MSDs). The characteristics of construction projects are physical, which causes fatigue to be the main cause of accidents. Concrete work and brick wall work is a very physical work that causes high fatigue. Based on this, it is very important to study ergonomic risk factors in depth at work in construction projects as part of recognizing preventive measures to overcome accidents in construction projects. The research method is a questionnaire survey of 32 respondents in a construction project and direct observation in the field. The ergonomic risk level assessment method uses the Rapid Entire Body Assessment (REBA) method. The findings show that the highest level of MSD complaints in concrete work and wall installation is Back Pain at 90.63%, then Right Upper Arm Pain at 84.38%. Meanwhile, the lowest level of MSD complaints was Left Foot Pain at 21.88%. Based on the ergonomic risk analysis using the REBA method, it is known that the highest ergonomic risk level in concrete work and brick wall work is the High Ergonomic Risk level of 46.88%, then the Moderate Ergonomic Risk level is 37.50%, and the Very High-Risk level is 15.63 %. Based on the chi-squared test, behavior shows a significant relationship between MSD claims and ergonomic risks faced by workers and value (p=0.001).*

Keywords *- Construction project, MSD, Ergonomic, REBA, Risk management.*

1. Introduction

Construction is one of the largest industries in various countries and a significant contributor to national economic growth [1]. Although the construction industry is one of the most influential industries, it is experiencing several challenges [2]. Consequently, various risks, occupational hazards, accidents, and injuries are predominant for workers on construction sites [3]. In addition, poor safety performance, gross inefficiencies and low productivity are common challenges in the construction industry [2].

Accidents are still a significant issue in construction projects caused by multifactors that must be the responsibility of all project participants (clients, consultants, contractors, workers) [4]. The occupational health problems of construction workers are obstacles faced by construction projects. Various types of hazardous working conditions, polluted environments, poor use of Personal Protective Equipment (PPEs), prolonged exposure to hazardous work postures, low awareness of health hazards and poor hygiene practices. It affects worker health [5]. Back pain is another dominant health complication for construction workers [6]. The workers also maintain different types of working posture, which harms their musculoskeletal system [7]. The trend of increasing the number of work accidents shows that 32% are musculoskeletal injuries due to work activities without regard to the ergonomic risks that occur [8]. Construction projects are becoming more difficult and complex due to high-risk operations [9]. Everyday construction work exposes workers to one or more ergonomic risk factors (clumsy posture, static forces, vibration, repetitiveness, environmental risks, contact stress) and potential musculoskeletal problems may increase or decrease [10]. According to the principles of ergonomics, workers should be in harmony with their workspace, workstation, and surrounding environment; this has a direct bearing on the worker's safety and health.

Additionally, the objective is to improve employee comfort and productivity [11]. Work-related MSD arises due to construction workers' exposure to substantially difficult activities such as excessive exertion, repetitive movements, and awkward posture compared to workers in other industries. Increase generally high percentage [12]. With ergonomic hazards prevalent and increasing, it is very important to investigate how ergonomics can reduce work-related injuries in construction projects [13]. This research investigates the extent of ergonomic risk in construction projects focusing on concrete and wall installation work.

2. Literature Review

2.1. Construction Project

Before beginning any construction project, designers use a project brief to create a product, like a building, that meets the owner's functional needs. [14]. Construction projects refer to high-stakes ventures involving the use of resources such as people, materials, and equipment. [15]. High accident rates are a feature of the construction sector because of activity, environment, and work dynamics [16].

2.2. Safety and Health in Construction Project

This industry has a long history of poor health and safety effects. Construction projects' complex, multi-stakeholder, dynamic operating environment and organizational structure are often criticized for causing accidents and injuries to workers [17]. Health and safety management measures need to be better implemented at construction sites by construction companies [18]. Safety, Health, and Environment emerged from Law No. 1 of 1970 concerning Work Safety, which regulates occupational health and safety requirements, namely preventing and reducing accidents [19].

2.3. Ergonomics

Ergonomics is the science of adjusting or balancing all equipment used in activities and hobbies to all the potentiality and qualifications of the human body to develop the overall aspect of life, art, and the benefit of technology [20]. The purpose of ergonomics is to provide devices, machines, systems, exercise, activity, and work situations that are secure, complacent, and convenient to use in the workplace. Ergonomics studies these capacities, limitations and qualities [21]. Furthermore, the output from the application of the ergonomic aspect is that it can provide economic benefits to the company [22]. The ergonomic design of workplaces, work equipment, tools, products, environments and systems involved in working with people to maximize the efficiency and productivity of coworking systems ensures safety, health and well-being, considering physical, material, biomechanical, emotional factors and worker potentiality. Ergonomics generally tries to adapt to people's work rather than personal tasks [23]. To avoid workplace stress that can affect worker safety health and group potency, a fundamental principle of ergonomics is that the activity requires a level that doesn't exceed the limit. The goal of any ergonomic program is to meet company goals by providing employees with a comfortable and productive workplace. Applying ergonomics abolishes barriers to excellent, efficient and secure individual activity by tailoring parameters, projects and products for employees. You should focus on getting rid of it. Ergonomists consider workers, workplaces, and work designs to assess how well individuals fit into their occupations.

2.4. Musculoskeletal Disorders (MSDs)

Musculoskeletal symptoms can range in severity from very minor to agonizing ones and are felt in the skeletal muscles. Damage to joints, ligaments, and tendons may result if the muscles are subjected to static stresses often and for an extended period of time [24]. Muscular pressure, which can result in lingering muscle pain, high-frequency vibrations that generate increased muscle contractions and disrupt blood flow, lactic acid accumulation, and the eventual onset of muscle discomfort were the main causes of musculoskeletal complaints. Workers' strength, agility, and sensitivity can all be negatively impacted by prolonged exposure to cold or heat. Some medical specialists also believe that individual characteristics, including age, gender, smoking habits, level of physical activity, physical strength, and body size, may impact skeletal muscle problems. Several tools in ergonomics studies can be used to identify risks in construction work, including the Nordic Body Map (NBM). This relatively easy and accurate tool can be used to identify ergonomic risks. The NBM is a subjective measurement of muscle soreness in workers. The NBM Questionnaire is the most commonly used type of ergonomic questionnaire to detect worker discomfort because it is standardized and clearly presented. Complete the NBM questionnaire, which aims to find out which parts of the worker's body feel pain before and after work in the workplace [25]. The NBM Check List has 28 points or questions starting from 0 to 27 number points, which are assessed using a Likert scale to see the level of MSDs complaints objectively. All are grouped into four parts, namely the neck, the upper limb (shoulders, elbows, hands, and wrists), the lower limb (hips, thighs, knees, ankles, and feet), and the low back (upper and lower back) [26].

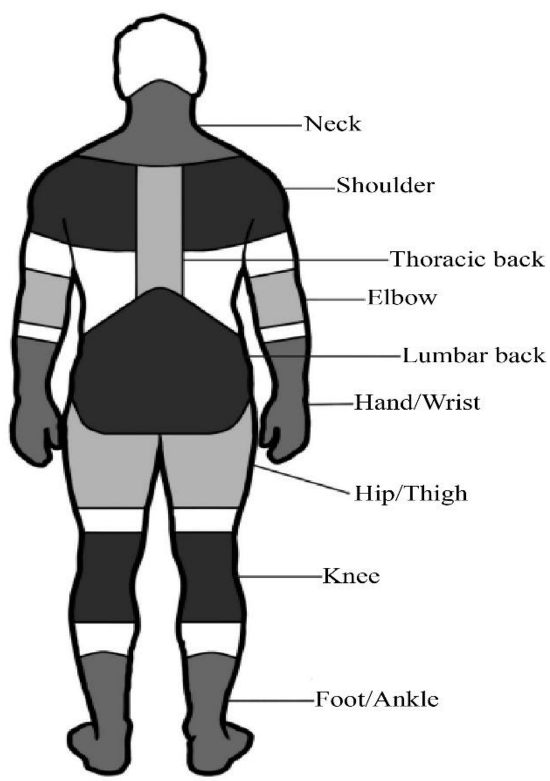

Fig. 1 Part of the main body

2.5. Rapid Entire Body Assessment (REBA)

REBA was assembled by Hignett S and McAtamney. REBA is a fast and easy-to-use observable postural analysis appliance for total body movement and provides action zones for musculoskeletal accountability [28]. It is the outcome of coordinated research by ergonomists, physiotherapists, and nurses who identified and examined 600 different working postures. REBA can analyze the joint posture of the upper extremities (arm, forearm, wrist), torso, neck and lower extremities.

In addition, it distinguishes between different grip patterns and muscle activation. Five levels of danger, from low to extreme. Several steps must be passed first to determine the REBA score. The first calculates the score in table A, including neck, torso and legs. Then table B covers the biceps, forearms and wrists. After receiving the end marks for Table A and Table B, enter these into Table C to determine the category of action. Research in the construction industry shows that REBA is a reliable and practical tool for assessing ergonomic risks in various types of physical labour, such as wall erection, concrete casting, and other building works.

In a study, REBA was applied to construction workers in a housing project, and the results showed that more than 70% of workers had REBA scores that placed them in the medium to high ergonomic risk category. This indicates that construction workers are prone to musculoskeletal disorders, especially in jobs requiring bending postures and heavy lifting. Another study by Hita-Gutiérrez et al. [29] compared REBA with other ergonomic assessment methods, such as Rapid Upper Limb Assessment (RULA), and found that REBA is more suitable for construction work as it covers the whole body, not just the upper part. In addition, REBA is considered more efficient in identifying high-risk postures often found in jobs with repetitive movements and heavy loads. The reliability of REBA was also tested in various studies, and the results showed that this method has good inter-rater reliability. A researcher found that REBA can be used consistently by raters with different backgrounds, which makes it a reliable tool to be applied in the construction field. In the context of this study, the REBA was relied upon to provide an overview of the ergonomic risks of concrete and brick wall work, thus enabling the identification of high-risk postures and the development of more effective interventions.

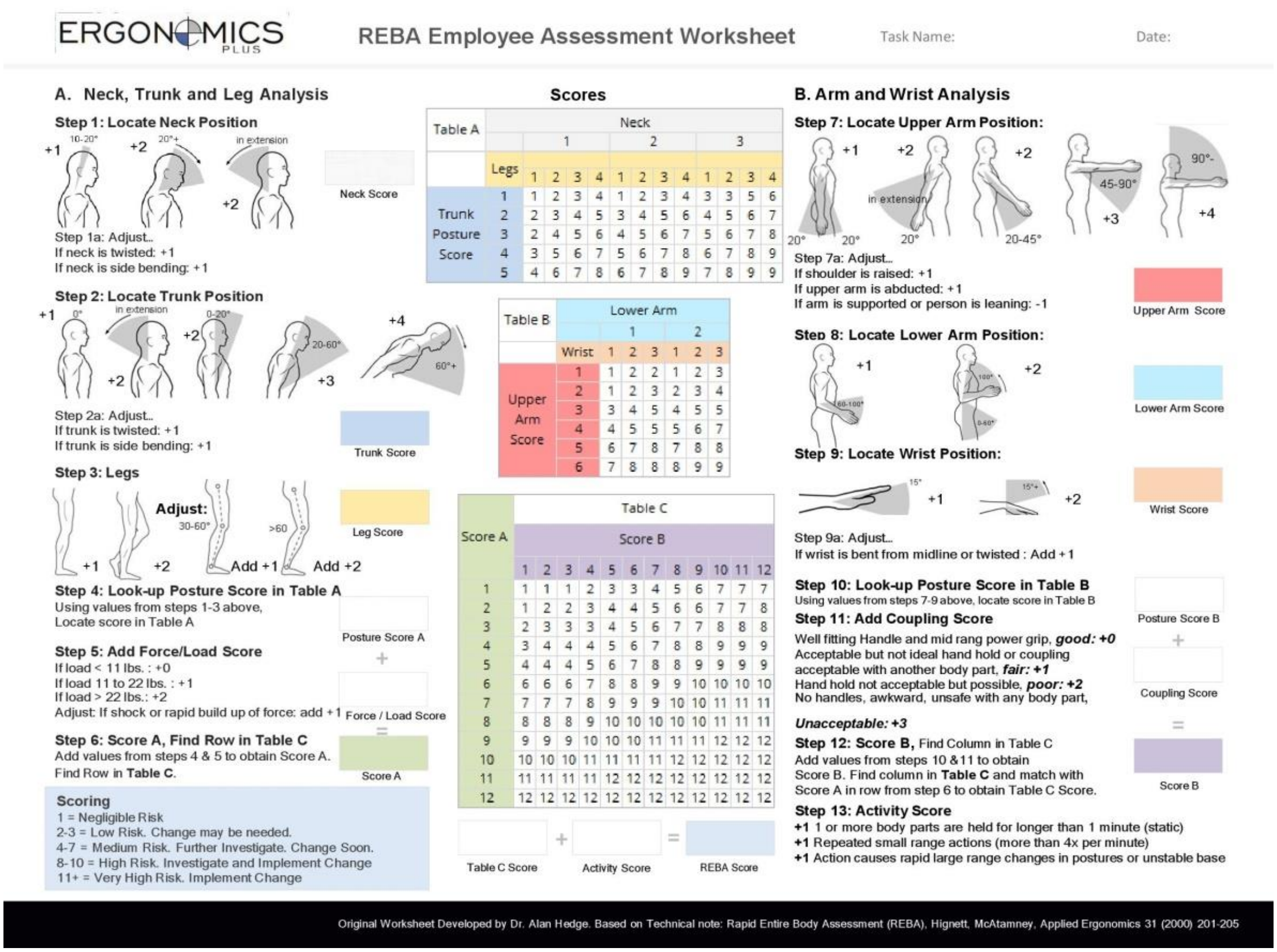

Fig. 2 REBA employee assessment worksheet

3. Research Gap

In construction projects, workers face various ergonomic risks that can impact their health, especially those related to muscle and bone injuries. Ergonomics research generally focuses on heavy labour such as lifting, material transfer or the use of heavy equipment. However, little attention has been paid to concrete and brick wall work, even though this type of work has unique characteristics that can pose specific ergonomic risks. In concrete wall work, workers often perform activities such as pouring concrete into moulds or compacting with heavy equipment. The postures maintained over long periods, coupled with the use of heavy tools, create a high risk of back, shoulder and hand injuries. Bricklaying requires repetitive movements, such as lifting and placing bricks and mixing and applying mortar. Workers are often bent or squat, putting additional strain on the lower back, knees and wrists. The characteristics of this work, in both concrete and brick walls, suggest that ergonomic risks arise from non-ideal working postures, repetitive tasks, and exposure to heavy physical loads. While this may seem obvious, there is limited detailed and specific research on how such work affects workers' ergonomic health.

Most studies combine different types of construction work without distinguishing the characteristics of specific tasks such as concrete and brick wall work. For example, the ergonomic risks of workers installing brick walls differ from those working on material lifting at other project sites. These unique job characteristics are not always covered in general studies. The use of various manual tools such as hammers or cement scoops in brickwork, as well as the vibrations of heavy equipment in concrete wall work, have not been analysed in the context of ergonomics. Such activities require specific postures and can potentially result in injuries to different body parts compared to other activities in the construction sector.

Concrete wall workers must often work at heights, maintain body balance, and use heavy equipment such as concrete vibrators. This poses risks to the back, neck and hands due to unnatural working postures and repetitive use of heavy equipment. Repetitive movements such as lifting bricks, applying mortar, and placing bricks in high or low positions require unergonomic postures (squatting, bending, lifting above the shoulders). This can lead to injuries to the lower back, shoulders, wrists and knees.

By understanding the unique risks of each type of work, more specific preventive measures can be implemented, for example, tool modification, proper work posture training, and limiting working time in poor ergonomic positions. Injuries due to poor ergonomics are detrimental to workers and impact overall project productivity. If injuries can be reduced, worker productivity increases, and project time can be more effectively utilised. The lack of specific research on ergonomic risks in concrete and brick wall work creates a significant gap in the understanding of worker health and safety in construction projects. Further research focusing on in-depth ergonomic analyses in this type of work will help design more effective intervention strategies to maintain worker health and increase project productivity. The prevalence of Musculoskeletal Disorders (MSDs) varies between different industry sectors, depending on the ergonomic risk factors present. In the construction sector, the prevalence of MSDs is very high, reaching 70-90%, mainly due to poor posture, heavy lifting, and often outdoor working conditions. Workers in this sector often face tasks that force them to bend over or lift large loads, which increases the risk of injury.

Ergonomic assessments using tools such as REBA show that many jobs in construction have a high risk of unhealthy postures. In the manufacturing sector, the prevalence of MSDs reaches 60-80%, with the main risks being repetitive motion and static postures, especially in workers involved in assembly or machine operation. RULA and REBA assessments are used to identify problems in the upper body, such as the arms and hands, which are often injured due to high workloads. The agricultural sector also has a prevalence of MSDs between 60-70%, with risks related to transporting crops and unergonomic postures during field activities. Although work in this sector varies depending on the type of task, REBA is often used to assess and reduce the risk of injury. In the healthcare sector, the prevalence of MSDs ranges from 50-75%, especially among nurses and medical personnel who frequently lift patients or work in awkward postures. While the use of patient lifting aids and training in ergonomic techniques can help reduce injuries, high work pressure often detracts from the implementation of effective ergonomic practices.

4. Methodology

4.1. Data Collection

4.1.1. Questionnaire Survey

The first data collection was done using a questionnaire survey. A total of 32 respondents were selected from 10 construction projects that were randomly selected. Respondents involved were workers who worked directly in concrete casting and wall installation work. The developed questionnaire refers to the NBM Check List. Respondents filled out a questionnaire and completed in-depth interviews. Furthermore, the questionnaire results will be processed to determine the MSD level. MSD complaint indicators in this study were based on 28 points on the respondent's body based on the NBM checklist format.

4.1.2. Observatory Survey

Additionally, a second data collection stage was conducted through direct field observations. Observation is made by directly observing the worker and documenting the worker's activities with pictures and recordings of the worker's performance in each work cycle. In addition, an angular estimation analysis is performed on the point or posture of the worker's body.

4.2. Data Analysis

4.2.1. First Phase

Questionnaire data were refined through descriptive analysis using SPSS software to determine the frequency distribution and currency of worker trouble with MSDs based on the NBM checklist. The population used in this study were all workers who worked in one unit of the Building A construction project on casting work and light brick installation work, namely 32 workers. In this study, the saturated sampling method was used, which means that the number of samples used in the study was as many as the population, namely 32 workers, and the population is as many as 32 workers.

Table 1. MSDs level classification

Total Score	Level of MSDs Score	Corrective action
28-49	Low	No Need
50-70	Moderate	Maybe Necessary
71-91	Severe	Necessary Soon
92-112	Very Severe	Necessary Now

4.2.2. Second Phase

Observation data in the form of videos and photos while working using the MB Ruler software. The method of analyzing observational data uses the REBA method.

The concept of the REBA method is to give a score to the posture of the neck, torso, legs, upper arms, forearms, and wrists and to combine the load score and the score of workers' activities carried out while working. The calculation of the REBA method is shown in Table 2 and Figure 3.

Table 2. Action level score of REBA

Action Level	REBA Score	Ergonomic Risk Level	Corrective Action
0	1	0	No Need
1	2-3	Low	Maybe Necessary
2	4-7	Moderate	Necessary
3	8-10	High	Necessary Soon
4	11+	Very High	Necessary Now

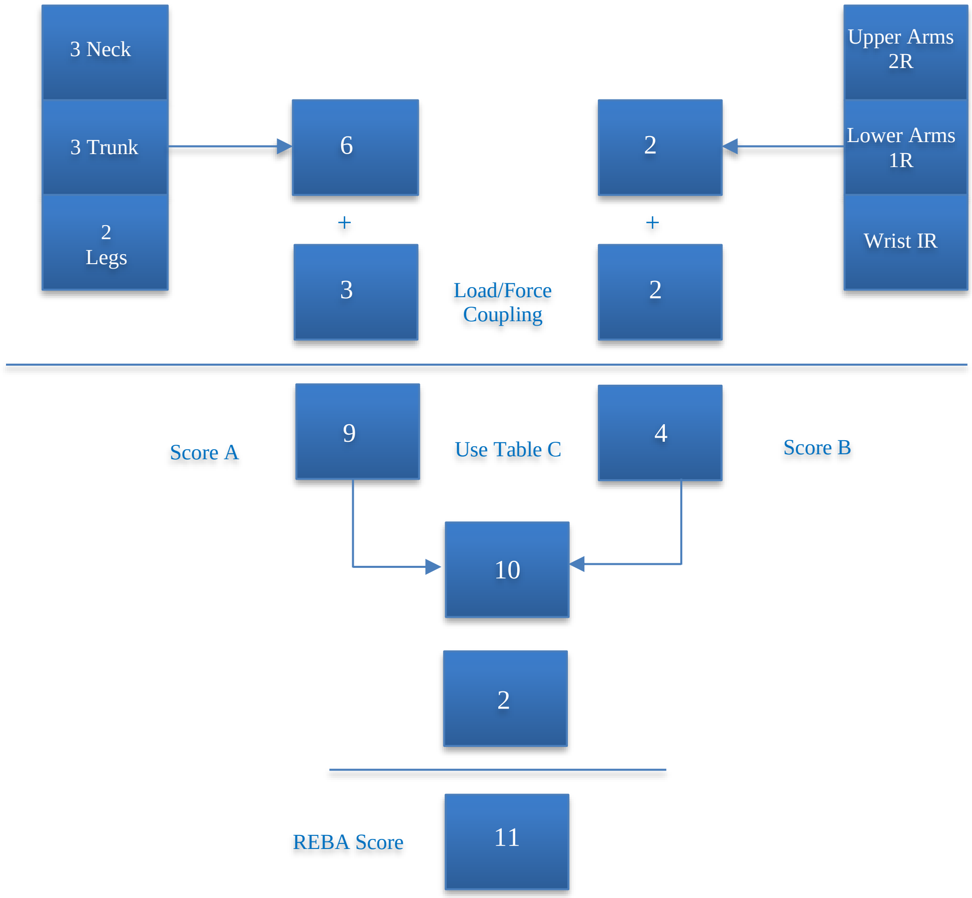

Fig. 3 REBA method assessment

4.2.3. Third Phase

The third step of data analysis was used to determine if there was a link between MSD claims and the level of ergonomic risk faced by workers. Analysis was carried out using a correlation test using the SPSS software to determine the relationship between the two measurements studied: variable X (ergonomic risk level and individual factors) and variable Y (MSDs complaints in workers).

5. Result and Discussion

5.1. MSDs Complaint Rates

MSDs were complaints on parts of the skeletal muscles felt by respondents ranging from very mild to very painful complaints in the form of pain or tenderness in muscles, stiffness and cramps in the workplace. Based on the results of the refined data, the density of MSD complaints obtained is in Table 3. Based on questionnaire data processing, it was found that the highest level of MSD complaints of workers in concrete casting and brick wall installation work was the highest in the Severe category, 56%. The findings show that MSD complaints in concrete and brick wall work are severe and need better handling.

Table 3. Frequency level of respondents

Level of MSDs Score	Frequency	Percentage
Low	0	0%
Moderate	11	34,4%
Severe	18	56,3%
Very Severe	3	9,4%
Total	32	100%

Table 4. Distribution of respondents based on the body part of workers

Location	Feel the Complaints of MSDs			
	Yes		No	
	N	%	N	%
Upper neck Pain/stiff	20	62,50%	12	37,50%
Lower Neck Pain	24	75,00%	8	25,00%
Left Shoulder Pain	23	71,88%	9	28,13%
Right Shoulder Pain	26	81,25%	6	18,75%
Left Upper Arm Pain	23	71,88%	9	28,13%
Back Pain	29	90,63%	3	9,38%
Right Upper Arm Pain	27	84,38%	5	15,63%
Waist Pain	26	81,25%	6	18,75%
Buttock Pain	25	78,13%	7	21,87%
Bottom Pain	9	28,13%	23	71,87%
Left Elbow Pain	17	53,13%	15	46,87%
Right Elbow Pain	19	59,38%	13	40,62%
Left Lower Arm Pain	18	56,25%	14	43,75%
Right lower Arm Pain	22	68,75%	10	31,25%
Left Wrist Pain	16	50,00%	16	50,00%
Right Wrist Pain	19	59,38%	13	40,62%
Left-Hand Pain	18	56,25%	14	43,75%
Right-Hand Pain	22	68,75%	10	31,25%
Left Thigh Pain	16	50,00%	16	50,00%
Right Thigh Pain	19	59,38%	13	40,62%
Left Knee Pain	21	65,63%	11	34,37%
Right Knee Pain	23	71,88%	9	28,12%
Left Calf Pain	26	81,25%	6	18,75%
Right Calf Pain	26	81,25%	6	18,75%
Left Ankle Pain	9	28,13%	23	71,87%
Right Ankle Pain	12	37,50%	20	62,50%
Left Foot Pain	7	21,88%	25	78,12%
Right Foot Pain	8	25,00%	24	75,00%

The frequency distribution of respondents based on the part of the body that feels MSDs complaints is shown in Table 4. Table 8 shows that back pain in concrete and wall construction had the highest MSD complaint rate at 90.63%, followed by right arm pain at 84.38%. Meanwhile, the lowest level of MSD complaints was Left Foot Pain at 21.88%.

According to research in the global construction industry, MSDs are often the leading cause of work absenteeism and decreased worker productivity. Studies conducted by the Occupational Safety and Health Administration (OSHA) in the United States report that approximately 75% of construction workers experience injuries related to MSDs during their careers. In this context, your study's 90.63% back pain rate indicates a much higher risk at the project site studied than the global average.

Similar studies in the Southeast Asian region show that the prevalence of MSDs in construction workers ranges from 60% to 80%. For example, a study in Thailand found that 78% of construction workers experienced back injuries during work. This puts your findings (90.63%) above the average for the Southeast Asia region, which may be due to contextual factors such as harsher working conditions, lack of ergonomic equipment, or insufficient OHS training.

5.2. Ergonomic Risk Level to Workers

Measurement of Work Posture Risk Level in Foundry Work. In the concrete work, there are three stages of work observed, namely, (i) pouring of the ready-mix concrete, (ii) compacting the ready-mix concrete using a vibrator, and (iii) leveling the concrete surface.

5.2.1. Pouring of the Ready-mix Concrete

Readymix concrete in the Batching Plant is transported using a Mixer Truck to the casting location. The concrete is then transported from the mixer truck to the pour point by a concrete pump operated by a worker, as shown in Figure 4.

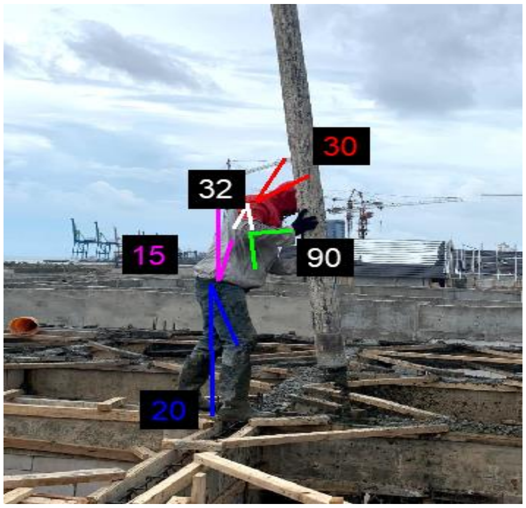

Fig. 4 Posture at the pouring work

At this stage, it can be seen that the position of the worker's neck is bent at an angle of 30˚, and when working, the neck of the worker is turned left and right so that when seen on the REBA worksheet, it is given a score of 3. The position of the back is in a flexion position with an angle of 15˚, and during work, the back rotates left and right so that it is given a score of 3. For leg posture, it is known to stand on 2 legs, but one of the legs bends at an angle of 20˚ so that it is given a score of 3. Then, all these scores are entered in Table A so that the total value of Table A is obtained of 9. Two points are added for any load over 10kg lifted by the worker, and one point is given for any sudden or rapid increase in load during the work. The worker's upper arm position is flexed at an angle of 32°, so it gets 2 points. The worker's forearm forms a 90° angle, so he gets 2 points. The wrist position has a score of 1 because it is bent at an angle of less than 15 degrees. This score is added to the condition score grip/clutch not acceptable, but since this is possible, a score of 2 is added. Adding the score from Table B to the gripping score gives a score of 4.

Table 5. Result of table A and load/force

Table A		**Neck**											
		1				**2**				**3**			
	Legs	1	2	3	4	1	2	3	4	1	2	3	4
Trunk Posture Score	1	1	2	3	4	1	2	3	4	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9
Load/Force													
0		1				2				3			
<5 Kg		5-10 Kg				>10 Kg				Shock or Rapid Build-Up of Force			

Table 6. Result of table B and coupling

Table B		**Lower Arm**					
		1			2		
	Wrist	1	2	3	1	2	3
Upper Arm	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9
Handle							
0 Good		1 Fair		2 Poor		3 Unacceptable	
Well-fitting handle and a mid-range, power grip.		The handhold is acceptable but not ideal, and coupling is acceptable via another body part.		Handhold is not acceptable, although possible.		Awkward, unsafe grip, no handles, coupling is unacceptable using other body parts.	

Score A and score B are then entered in Table C so that a C score of 10 will be obtained. Score C is then added to a score of 1 because one part of the worker's body is static for more than 1 minute, and the work causes the worker's posture to change from its initial position, so a score is added to the activity of 1. This brings the final REBA score to 12. Based on the calculation of the REBA score, the worker has an ergonomic risk level of 4, indicating a very high musculoskeletal risk level. This means that changes and improvements should be made immediately.

Table 7. Result of table C and activity score

Score A	**Table C**											
	Score B											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9

6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	9	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Activity Score		
(+1)	(+1)	(+1)
1 or more body parts are static, e.g. held for longer than 1 minute	Repeated small-range actions, e.g. repeated more than 4 times per minute (not including walking)	Actions cause rapid large-range changes in postures or unstable base

Table 8. Scoring value at the pouring concrete mixing

No	Variable	Score	Description
1	Trunk	3	Fleksion 15˚
			(+1 trunk is side bending)
2	Neck	3	Fleksion 30˚ (+1 Neck is twisted)
3	Legs	3	Legs Bending
			(+1 legs bend 20˚)
4	Force/load	3	Force/load >10 Kg
			Shock or Rapid Build-Up of Force
5	Upper Arm	2	Fleksion 32˚
6	Lower Arm	1	Fleksion 90˚
7	Wirst	1	Fleksion <15˚
8	Coupling	2	Handhold is not acceptable, although possible
9	Activity Score	2	Repeated and Rapid Large-Range Changes In Posture
Score REBA		12	Very High

Three workers were observed at the stage of pouring the readymix concrete. With the same calculation for worker 1, the ergonomic risk level values for each worker in each activity are listed in Table 9.

Table 9. Recapitulation of ergonomic risk levels at the pouring concrete mixing

Worker	Score	Ergonomic Risk Level	Action
Worker 1	12	Very High	Necessary now
Worker 2	13	Very High	Necessary now
Worker 3	12	Very High	Necessary now

5.2.2. Compaction of the Ready-Mix Concrete

At the compaction stage using a vibrator, there were five workers observed. Table 10 summarizes the ergonomic risk level for each worker at the stage of compacting the concrete mixture using a vibrator. From the results of the data analysis, two workers at the concrete mix compaction stage had a high ergonomic risk level. Two workers had a very high ergonomics risk level, and as many as one person had a moderate ergonomic risk level.

Table 10. Recapitulation of ergonomic risk levels at the compaction of concrete mix

Worker	Score	Ergonomic Risk Level	Action
Worker 1	10	High	Necessary Soon
Worker 2	12	Very High	Necessary now
Worker 3	7	Medium	Necessary
Worker 4	9	High	Necessary Soon
Worker 5	11	Very High	Necessary now

5.2.3. Levelling the Concrete Surface

Eight workers were observed at the stage of equalizing the concrete mixture. The following table summarizes the ergonomic risk level for each worker at the stage of even distribution of the concrete mix.

Fig. 5 Posture at the stages of levelling work

Table 11. Recapitulation of ergonomic risk levels at the levelling work

Worker	Score	Ergonomic Risk Level	Action
Worker 1	6	Medium	Necessary
Worker 2	9	High	Necessary Soon
Worker 3	10	High	Necessary Soon
Worker 4	5	Medium	Necessary
Worker 5	11	High	Necessary Soon
Worker 6	6	Medium	Necessary
Worker 7	10	High	Necessary Soon
Worker 8	10	High	Necessary Soon

From the results of the data analysis, five workers at the concrete mix equalization stage had a high ergonomic risk level. As many as three people had a moderate ergonomic risk level.

5.3. Assessment of the Risk Level of Working Posture in Brick Wall Work

When installing lightweight bricks, two stages of work are carried out:

The stage of cutting the light bricks and the stage of installing the light bricks. All of these stages were assessed with ergonomic analysis using the REBA method.

5.3.1. Light Brick Cutting

At the light brick-cutting stage, there were six workers observed. The following table summarizes the level of ergonomic risk for each worker at light brick-cutting work.

From the results of the data analysis, five workers at the light brick-cutting stage had a high ergonomic risk level. As many as one person had a moderate ergonomic risk level.

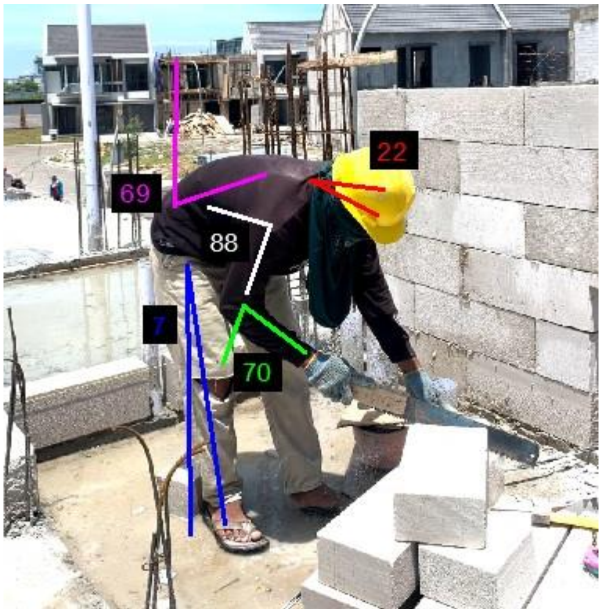

Fig. 6 Posture at the stages of light-cutting work

Table 12. Recapitulation of ergonomic risk levels at the light brick-cutting

Worker	Score	Ergonomic Risk Level	Action
Worker 1	8	High	Necessary Soon
Worker 2	8	High	Necessary Soon
Worker 3	9	High	Necessary Soon
Worker 4	10	High	Necessary Soon
Worker 5	6	Medium	Necessary
Worker 6	10	High	Necessary Soon

5.3.2. Lightweight Brick Work

At the lightweight brick installation stage, there were ten workers observed. The following table summarizes the ergonomic risk level for each worker at the lightweight brick installation.

Fig. 7 Posture at the stages of laying light brick

Table 13. Recapitulation of ergonomic risk levels at the laying light brick

Worker	Score	Ergonomic Risk Level	Action
Worker 1	4	Medium	Necessary
Worker 2	5	Medium	Necessary
Worker 3	5	Medium	Necessary
Worker 4	8	High	Necessary Soon
Worker 5	4	Medium	Necessary
Worker 6	5	Medium	Necessary
Worker 7	5	Medium	Necessary
Worker 8	10	High	Necessary Soon
Worker 9	9	High	Necessary Soon
Worker 10	5	Medium	Necessary

From the results of the data analysis, three workers at the lightweight brick installation stage had a high level of ergonomic risk, which meant that they needed immediate corrective action. Also, up to 7 people with moderate ergonomic risk (corrective action required).

5.4. Analysis of the Relationship between MSDs Complaint Level and Ergonomic Risk

The results of the analysis of the relationship between the level of ergonomic risk and complaints of MSDs in workers can be seen in Table 14.

Table 14. Correlation between ergonomic risk level and MSDs complaint in light brick casting and laying workers

Ergonomic Risk Level	MSDs Complaints						Total		P Value
	Moderate		Severe		Very Severe				
	N	%	N	%	N	%	N	%	
Medium	9	28.13	1	9.38	0	0	12	37.50	0,001
High	2	6.25	4	37.50	1	3.13	15	46.88	
Very High	0	0	7	9.38	2	6.25	5	15.65	
Total	11	34,38	18	56,25	3	9.38	32	100	

Statistical test results showed that workers at high ergonomic risk (scores 8-10) suffered the most MSDs, with up to 12 workers having moderate levels of complaints. Based on cross-tabulation results, statistical chi-square test analysis yielded a value of ($p=0.001$) < ($\alpha = 0.05$).

Thus, there is a significant association between working posture and complaints of MSDs among concrete workers and brick-wall workers.

5.5. Relationship between Individual Factors and Complaints of MSDs in Workers

5.5.1. Age

The results of an analysis of the association between worker age and complaints of MSDs are shown in Table 15.

Table 15. Relationship between age and MSDs complaints in workers

Age (years old)	MSDs Complaints						Total		P Value
	Moderate		Severe		Very Severe				
	N	%	N	%	N	%	N	%	
17-25	3	9,38	1	3,13	0	0	4	12,50	0,124
26-35	4	12,50	4	12,50	0	0	8	25,00	
36-45	3	9,38	7	21,88	3	9,38	13	40,63	
46-55	1	3,13	6	18,75	0	0	7	21,88	
Total	11	34,38	18	56,25	3	9,38	32	100,00	

Therefore, it can be interpreted that there is no serious association between the age of lightweight brick casters and bricklayers and complaints of MSDs.

5.5.2. Experience

The results of the analysis of the relationship between worker experience and complaints of MSDs in workers can be seen in Table 16.

Table 16. Relationship between years of the service and MSDs complaints in light brick casting and brick laying workers

Years of Service	MSDs Complaints						Total		P Value
	Moderate		Severe		Very Severe				
	N	%	N	%	N	%	N	%	
>5 years	7	28,13%	3	9,38%	0	0%	10	31,25%	0,018
6-10 years	4	12,50%	10	31,25%	1	3,13%	15	46,88%	
<10 years	0	0,00%	5	15,63%	2	6,25%	7	21,88%	
Total	11	40,63%	18	56,25%	3	9,38%	32	100,00%	

Based on the cross-tabulation results performed, analysis using the statistical chi-square test yielded a value of ($p=0.018$) < ($\alpha = 0.05$). Thus, it can be interpreted that there is an important association between the tenure of light brick casters and bricklayers and complaints of MSDs.

5.5.3. Length of Working

Table 17 shows the results of an analysis of the relationship between worker working hours and complaints of MSDs.

Table 17. Relationship between the length of working and MSDs complaints in light brick casting and brick laying workers

Length of Working	MSDs Complaints						Total		P Value
	Moderate		Severe		Very Severe				
	N	%	N	%	N	%	N	%	
<8 hours	11	28,13%	6	18,75%	1	0%	18	56,25%	0,001
>8 hours	0	12,50%	12	37,50%	2	6,25%	14	43,75%	
Total	11	28,13%	18	56,25%	3	6,25%	32	100,00%	

Based on the cross-tabulation results performed, statistical chi-square analysis yielded a value of ($p=0.001$) < ($\alpha = 0.05$). Therefore, it can be interpreted that there is an important association between working hours and worker complaints of MSDs. P-value = 0.001 means there is a 0.1% (very small) chance that the observed results are due to chance alone if the null hypothesis is true. In other words, there is 99.9% confidence that there is a real relationship or effect between the variables being tested. In this context, a small p-value (usually below 0.05) the study results are statistically significant, and the null hypothesis is rejected. This means that the findings in the study are very likely to reflect a real relationship rather than just a random or chance result. If a p-value = 0.001 is obtained from analysing the relationship between work postures and injury risk, it indicates a very strong correlation between non-ergonomic postures and an increased risk of Musculoskeletal Disorders (MSDs). This reinforces the finding that poor posture or strenuous physical activity can significantly increase the risk of workplace injuries.

6. Conclusion

The findings show that the highest level of MSD complaints in concrete work and wall installation is Back Pain at 90.63%, then Right Upper Arm Pain at 84.38%. Meanwhile, the lowest level of MSD complaints was Left Foot Pain at 21.88%. Based on an ergonomic risk analysis using the REBA method, construction project workers have the highest ergonomic risk: 15 (46.88%). We found the risk level to be moderate. Up to 12 workers (37.50%). About the very high ergonomic risks faced by 5 workers (15.63%). Based on the analysis conducted it shows that there is a significant relationship between ergonomic risk and MSD complaints experienced by workers with a value ($p=0.001$) < ($\alpha=0.05$). The results of research specific to the ergonomic risks of concrete and brick walling can be used to develop construction safety policies that are more focused on this type of work. For example, regular risk assessments could be conducted specifically for concrete or brick wall installation workers to identify frequent injuries and develop appropriate prevention protocols.

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