JNEST EISSN: 2961-8738 ● PISSN: 2961-8916 ● DOI: 10.56741/jnest.v5i03.2466
Article Received 30 June 2026, Revised 14 September 2026

Evaluation of Work Posture and Recommendations for Ergonomic Risk Control Among Lightweight Bricklying and Plastering Construction Workers Using the REBA Method

Brigitta Vidia Maharani*, Kartika Puspa Negara, Wisnumurti

***Abstract*—Ergonomic hazards in construction can cause fatigue, injuries, reduced productivity, and long-term musculoskeletal disorders. This study identified ergonomic risk factors, assessed working postures, and proposed control measures for lightweight bricklaying and plastering in high-rise construction. A quantitative observational case study was conducted at two construction projects. Ergonomic hazards were identified through literature review and field observation, while 317 valid posture observations from 22 workers were assessed using the Rapid Entire Body Assessment (REBA) method. Six risk factors were identified: awkward postures, forceful exertion, repetitive movements, vibration, static loading, and contact pressure. For lightweight bricklaying, the proportions of postures classified as moderate to very high risk were 100% in the low zone, 98.55% in the overhead zone, and 90.29% in the neutral zone. Corresponding proportions for plastering were 100%, 100%, and 75.86%, respectively. These findings indicate substantial ergonomic risks across tasks and working heights, warranting prompt corrective action. Recommended controls include adjusting work heights, using suitable tools and access equipment, reducing sustained awkward postures, and introducing task rotation and ergonomic training. The study integrates risk identification, analysis, evaluation, and control within a single framework, offering practical guidance for contractors and occupational safety practitioners. Its contribution lies in task- and height-specific evidence from construction settings, although generalizability is limited by the inclusion of only two projects and two work activities.**

***Index* Terms—REBA, Risk Ergonomic Management, Worker Productivity.**

I. INTRODUCTION

Musculoskeletal disorders are conditions that affect muscles, nerves, tendons, ligaments, joints, cartilage, and the spinal cord. Among construction workers, musculoskeletal disorders are one of the leading occupational health issues globally, potentially impairing workers' physical functioning and work capacity and leading to permanent disability [1]. In Malaysia, musculoskeletal disorders in the construction industry have steadily increased from 10 cases in 2005 to 675 cases in 2014 due to a lack of awareness regarding ergonomics among workers [2]. This is further supported by data showing that 32% of workplace incidents in the construction sector involve musculoskeletal injuries related to a lack of consideration of ergonomic risks in work activities [3]. These findings highlight the need for more effective measures to prevent and control ergonomic risks across industrial sectors. Generally, these musculoskeletal disorders are caused by repetitive physical work, changes in work posture—from standing upright to bending over, squatting, or working overhead depending on the job requirements—and long work hours without adequate rest [3]. Ergonomic principles emphasize the importance of aligning workstations, work equipment, and tasks with workers' physical capabilities in order to improve safety and health. The proper application of ergonomic principles is a key element in ensuring that the physical workload borne by workers does not exceed their physical capacity.

In a study in Indonesia involving concrete work and bricklaying, it was found that workers' body postures were classified as high risk in 46.88% of cases; moderate risk in 37.5%; and very high risk in 15.63% [4]. A study at an automotive plant in South India found that, based on an ergonomic analysis using the REBA method, 88 workers (44.9%) were classified as being at moderate risk, 81 workers (41.4%) at high risk, and 18 workers (9.1%) at very high risk; analysis using the RULA method indicated moderate risk for 83 workers (42.3%) and very high risk for 14 workers (7.2%) [5].

Given the high level of ergonomic risk faced by workers, ergonomic risk management is necessary to identify, assess, control, and monitor risks associated with mismatches between workers, their tasks, and their work environment. Therefore, analyzing risk factors in the construction industry is crucial for implementing measures and improving productivity. In this way selecting an appropriate ergonomic assessment method is essential, depending on whether the assessment targets the whole body or specific body regions [6]. Zengin and Asal assessed construction workers' postures using the Nordic Musculoskeletal Questionnaire. This study found that workers in the building construction sector experience discomfort throughout their entire bodies [7]. In this research, the REBA (Rapid Entire Body Assessment) method was used for ergonomic risk analysis because REBA is capable of assessing the entire body. A key strength of REBA is its ability to assess multiple body

Brigitta Vidia Maharani (Corresponding Author), **Kartika Puspa Negara**, and **Wisnumurti** are with the Department of Civil Engineering Brawijaya University, Malang, Indonesia.
Corresponding author: gitavidia@gmail.com

© 2026 IISTR

regions: the upper limbs (arms, forearms, and wrists), lower limbs, trunk, and neck. This method is useful for identifying forced postures adopted by workers and developing corrective measures if necessary [8]. Generally, risk analysis using the REBA method is commonly conducted in larger-scale manufacturing sectors; however, this study focuses on the construction industry and comprehensively links the stages of identification, analysis, and control recommendations which have often been conducted separately in the past. Control recommendations are formulated based on field findings.

II. METHOD

This study employed a quantitative observational design aimed at assessing ergonomic risks among construction workers in the context of a case study involving the construction of two high-rise buildings in Surabaya. Direct observations were conducted on workers engaged in lightweight bricklaying and plastering activities; the observed postures were subsequently assessed using the Rapid Entire Body Assessment (REBA) method to serve as a reference for formulating appropriate and practical risk control recommendations. The research methodology consisted of three main stages:

1. Risk identification, conducted through a systematic literature review on work postures in construction, preliminary observations at the project site, and visual documentation to capture the entire cycle of work movements;
2. Risk analysis using the Rapid Entire Body Assessment (REBA) method to evaluate risk scores for each body segment based on the severity of the posture. REBA is considered sensitive to the unpredictable nature of work postures and can be used across various industrial sectors, such as manufacturing, construction, healthcare, and other service industries, to implement appropriate interventions [9]–[10]. REBA evaluates work-posture observations, applied force, and activity characteristics to estimate the level of ergonomic risk. This tool is particularly useful for tasks involving whole-body movements [11]–[12];
3. Formulation of risk control recommendations based on prior literature reviews regarding ergonomic interventions in the construction sector, which were subsequently validated by the project's Occupational Safety and Health (OSH) team to ensure their suitability, feasibility, and effectiveness in field implementation.

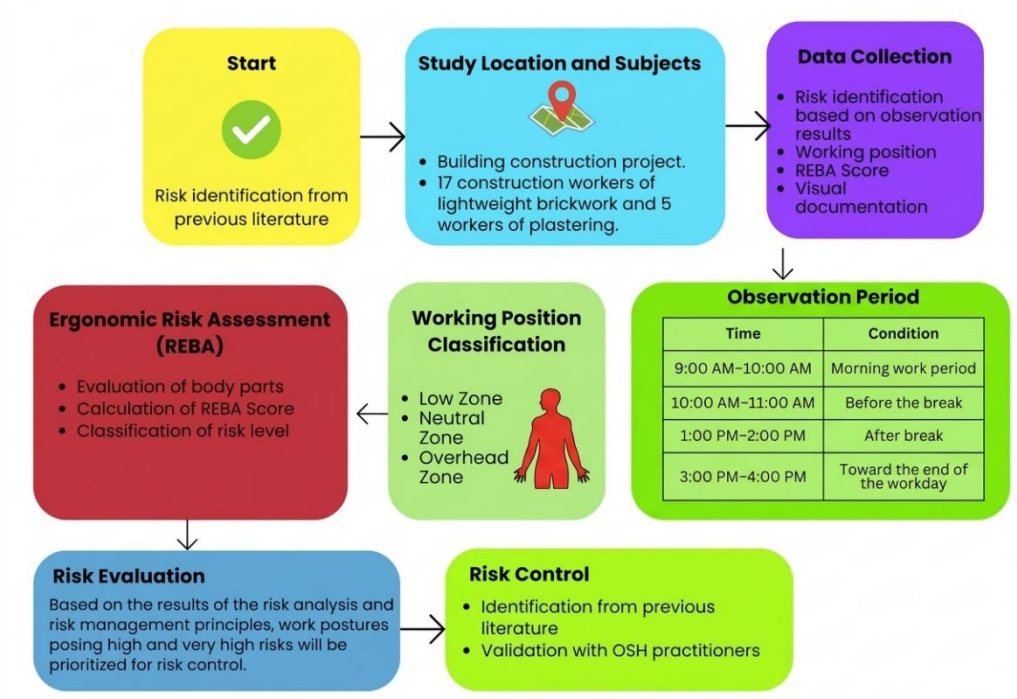


Fig. 1. Research Methodology

A. Risk Identification

Workplaces are essentially always designed to improve work and machine efficiency because humans seem to adapt so easily; unfortunately, the ways in which humans adapt in the workplace have received little attention. Today, ergonomics has become a crucial factor in workplace safety by addressing traditional and environmental risk factors, which can help prevent worker injuries [13]. The initial identification phase of this study was conducted based on a review of the literature on ergonomic risks, referencing various scientific journals that discuss work postures and musculoskeletal risks among construction workers. Factors contributing to ergonomic risks include awkward postures, pressure from heavy loads, repetitive movements, vibrations, static loading resulting from activities that require workers to maintain a position for extended periods, and contact stress on the wrists.

TABLE I. IDENTIFICATION OF ERGONOMIC RISKS

No.	Risk Factor	Cause	Exposed Muscle Group	Source
1.	Awkward Postures	Working in an uncomfortable body position and maintaining the same position for a long time.	Lower and upper back, knees, wrists, thighs, and shoulders.	[14], [15], [16]
2.	Force	Excessive exertion, such as lifting heavy objects, pushing or pulling heavy loads.	Wrists, lower and upper arms, and shoulders.	[14], [16]
3.	Repetitive	Repetitive movements that cause excessive fatigue.	Lower and upper back, knees, wrists, thighs.	[16], [17]
4.	Vibration	Use of machinery that causes vibrations in the hands and arms.	Lower and upper hand, lower and upper back.	[16]
5.	Static Loading	Activities that require workers to maintain a certain position for an extended period of time.	Wrists, shoulders, and upper back.	[16]
6.	Contact Stress	This activity puts strain on the body. For example, using a hammer.	Wrists, fingers.	[16]

B. Data Collection

This study covered two high-rise building construction projects in Surabaya involving 17 lightweight masonry workers and 5 plasterers. All workers were male, aged 20–60 years, with at least 4 years of experience, and had a height of 158–175 cm and a weight of 50–75 kg, consistent with the typical physique of Indonesians.

TABLE II. RESPONDENT CHARACTERISTICS

Name	Sex	Age	Experience (years)	Weight (kg)	Height (cm)
Worker 1	Male	38	24	58	165
Worker 2	Male	32	9	51	160
Worker 3	Male	35	19	65	165
Worker 4	Male	35	15	60	170
Worker 5	Male	24	4	65	168
Worker 6	Male	29	10	68	174
Worker 7	Male	30	10	50	165
Worker 8	Male	26	9	60	160
Worker 9	Male	35	19	57	168
Worker 10	Male	35	10	68	166
Worker 11	Male	39	16	75	175
Worker 12	Male	35	15	70	170
Worker 13	Male	34	13	75	169
Worker 14	Male	43	15	67	160
Worker 15	Male	46	15	59	162
Worker 16	Male	33	13	64	168
Worker 17	Male	48	15	55	158
Worker 18	Male	59	20	70	165
Worker 19	Male	54	15	60	160
Worker 20	Male	51	26	57	160
Worker 21	Male	51	40	60	160
Worker 22	Male	35	18	60	170

Data collection was conducted through direct observation of workers in the field during the lightweight brick laying and plastering processes. Each worker was observed four times per workday to document their condition during various work periods. This observation schedule was designed to capture changes in worker's levels of physical fatigue and productivity throughout a single workday.

TABLE III. DATA COLLECTION TIMES

Time	Condition
9:00 AM–10:00 AM	Morning work period
10:00 AM–11:00 AM	Before the break
1:00 PM–2:00 PM	After the break
3:00 PM–4:00 PM	Toward the end of the workday

The division of work zones into the low zone, neutral zone, and overhead zone is based on the concept of the ergonomic reach zone; each work area has a different level of biomechanical comfort and ergonomic risk [18].

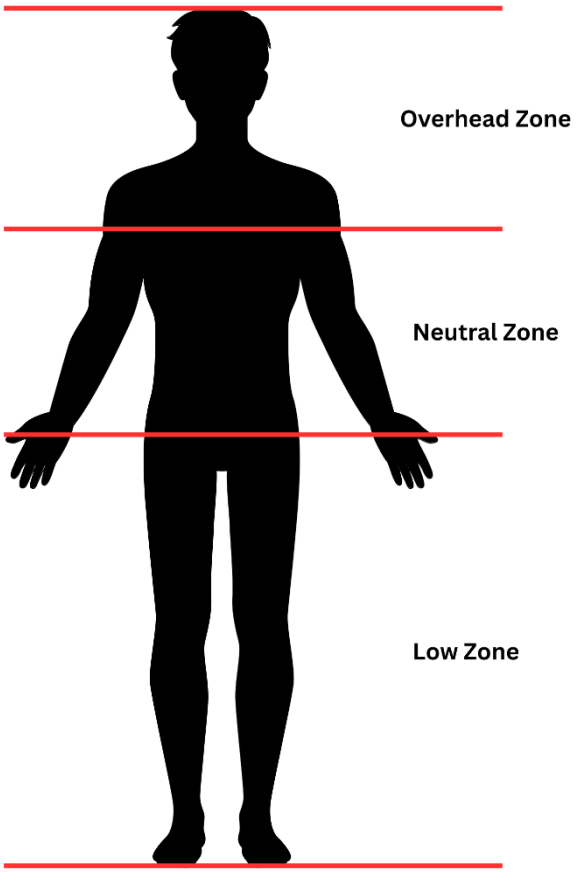


Fig. 2. Working Position

1. Low Zone
   Work positions below waist height that typically require workers to bend over.
2. Neutral Zone
   Work positions ranging from the waist to the shoulders, considered the most ergonomic work positions.
3. Overhead Zone
   Work positions above the shoulders or head that require workers to raise their arms for extended periods.

C. Risk Analysis

Based on the results of the ergonomic risk identification conducted through a literature review of various scientific journals and ergonomic guidelines, six ergonomic risk control programs were formulated and recommended as preventive measures to reduce the risk of musculoskeletal disorders (MSDs) in lightweight bricklaying and plastering work. These include training and education, workplace hazard analysis, workspace and material layout, work breaks, job rotation, and supportive equipment.

Training and education aim to enhance knowledge of ergonomics so that workers can improve their skills and habits in an effort to reduce ergonomic risks. The recommended training and education include training on proper manual handling techniques, pre-work warm-ups, and training on the use of mechanical aids [19]–[20].

It is recommended that a workplace hazard analysis be conducted routinely before each task begins as a step to identify ergonomic hazards at every stage of the work and to establish appropriate controls early on [20].

It is recommended that the layout of the workspace and materials be arranged to ensure that workstations are designed to fit the user's body size and posture, whether sitting or standing. For example, adjusting the height of a work platform is crucial for reducing strain on the back muscles, minimizing neck flexion, and preventing excessive leaning or overreaching [12].

A short break is a brief pause taken during work or other activities to rest and recharge. These breaks typically last from a few seconds to a few minutes and are designed to help reduce mental or physical fatigue, improve concentration, and prevent strain or injury. A short break can involve simple activities such as stretching, taking a brief walk, or taking a few deep breaths. The goal is to give the body and mind a moment to refresh before returning to the task at hand. Whether standing or sitting, incorporating a two-minute break every 20 to 40 minutes is a practical and effective strategy for improving ergonomics [19].

Job rotation is recommended to rotate workers among different tasks so that exposure to risky postures and repetitive movements does not persist for long periods on the same body part [19].

Supportive equipment is recommended in the form of mechanical aids such as hand trucks (arko), hand pallets, scaffolding, and other lifting aids appropriate for the task; the use of adequate aids can significantly reduce the risk of MSDs resulting from manual lifting [19].

These six ergonomic risk control programs have been comprehensively formulated based on a literature review and will subsequently be validated by the project's Occupational Safety and Health (K3) team to ensure their suitability and feasibility for implementation in the field.

III. Results and Discussions

A. Risk Identification

The identification of ergonomic risks in this study was conducted through two complementary approaches: a review of the ergonomics literature and comparison with actual field conditions. First, risk identification was based on a literature review of various accredited scientific journals and ergonomics textbooks, which consistently identified construction work—particularly bricklaying and plastering—as high-risk activities for musculoskeletal disorders (MSDs). The primary risks include awkward work postures (bending, stooping, twisting the body, reaching beyond limits), repetitive hand and arm movements, manual load handling, long work durations without breaks, workstation designs that do not conform to anthropometric standards, and environmental factors such as extreme temperatures and low lighting. Second, the findings from the literature review were then cross-referenced with actual on-site conditions through preliminary observations and visual documentation—including photos and videos—at a high-rise building construction site in Surabaya, with the aim of verifying whether the risks identified in the literature actually occur and are relevant to the reality of lightweight bricklaying and plastering work. Through this comparison process, it was found that most of the risks identified in the literature were indeed present in the field. Through this two-stage identification process, a list of ergonomic risks was compiled, which subsequently served as the basis for conducting a risk analysis using the REBA method in the next stage.

TABLE IV. Risk Identification Based on Field Observations

No.	Risk Factor	Cause	Field Observation Results
1.	Awkward Postures	Workers tilt their heads back when performing tasks in *the overhead zone* and bend over or squat when working in *the low zone*.	√
2.	Force	Workers lift 7.5 kg lightweight bricks and hold them above their heads while in an *overhead* position.	√
3.	Repetitive	The motion of bending over, reaching for a brick, and then lifting it upward. The motion of swinging a trowel against the wall to apply plaster.	√
4.	Vibration	-	x
5.	Static Loading	Workers hold a trowel above their heads for several minutes, holding lightweight bricks in place so they do not move during the cutting process.	√
6.	Contact Stress	Workers grip the trowel or brick cutter too tightly and for too long.	√

B. Risk Analysis

Observations were conducted in various work positions that arise during job performance, namely the low zone, neutral zone, and overhead zone. This study also evaluated the level of ergonomic risk exposure using the REBA method. The example of a work analysis using REBA in the table below is taken from the job of laying lightweight bricks.

Observations were conducted at various work positions that arose during the performance of the work—namely, the low zone, neutral zone, and overhead zone—to evaluate the level of exposure to ergonomic risks using the REBA method. REBA has been developed to meet the perceived need for a field tool for practitioners, specifically designed to be sensitive to the type of unpredictable work postures encountered in industry. Five risk levels are considered in the REBA score, in turn, a certain action level for ergonomic intervention (need to take action to reduce the risk): action level 0, corrective action including further assessment is not necessary; action level 1, corrective action including further assessment may be necessary; action level 2, corrective action including further assessment is necessary; action level 3, corrective action including further assessment is necessary soon; and action level 4, corrective action including further assessment is now necessary [6].

TABLE V. REBA ANALYSIS IN THE LOW ZONE

Low Zone					
No.	**Body Part**	**Angle/Condition**	**Base Score**	**Adjustment**	**Final Score**
1	Neck	39° extension	2	0	2
2	Back	103°	4	0	4
3	Feet	157° + 1 support	2	0	2
				Score A	**6**
No.	**Body Part**	**Angle/Condition**	**Base Score**	**Adjustment**	**Final Score**
1	Upper Arm	83°	3	0	3
2	Lower Arm	35°	2	0	2
3	Wrist	29°	2	0	2
				Posture Score B	**5**
				Coupling Score	**1**
				Score B	**6**
				Score C	**8**
				Activity Score	**1**
				Final REBA Score	**9**
				Interpretation	*High risk*



TABLE VI. REBA ANALYSIS IN THE NEUTRAL ZONE

Neutral zone					
No.	**Body Part**	**Angle/Condition**	**Base Score**	**Adjustment**	**Final Score**
1	Neck	31°	2	0	2
2	Back	Neutral	1	0	1
3	Leg	155°	1	0	1
				Score A	1
No.	**Body Part**	**Angle/Condition**	**Base Score**	**Adjustment**	**Final Score**
1	Upper Arm	43°	2	0	2
2	Lower Arm	17°	2	0	2
3	Wrist	14°	1	0	1
				Posture Score B	**2**
				Coupling Score	**1**
				Score B	**3**
				Score C	**1**
				Activity Score	**1**
				Final REBA Score	**2**
				Interpretation	*Low risk*



TABLE VII. REBA ANALYSIS IN THE OVERHEAD ZONE

Overhead Zone					
No	**Body Part**	**Angle/Condition**	**Base Score**	**Adjustment**	**Final Score**
1	Neck	48° extension	2	0	2
2	Back	7° extension	2	0	2
3	Leg	144°	2	0	2
				Score A	**3**
No	**Body Part**	**Angle/Condition**	**Base Score**	**Adjustment**	**Final Score**
1	Upper Arm	150°	4	0	4
2	Lower Arm	10°	2	0	2
3	Wrist	69° + twist	2	1	3
				Posture Score B	**7**
				Coupling Score	**1**
				Score B	**8**
				Score C	**7**
				Activity Score	**1**
				Final REBA Score	**8**
				Interpretation	*High risk*



TABLE VIII. REBA SCORE, RISK LEVEL, AND ACTION LEVEL

REBA Score	Level of Risk	Level of Action
1	Negligible	Not Needed
2-3	Low	May be necessary
4-7	Medium	Needed
8-10	High	Needed soon
11-15	Very High	Needed NOW

In the initial observation plan, each worker was to be observed for two workdays divided into four scheduled time periods, assuming that workers would focus solely on one primary task. However, during field implementation, staffing limitations meant that each worker was required to take on various additional tasks as urgent needs arose. This multitasking situation often caused workers to set aside their primary tasks outside the predetermined schedule, resulting in some observation periods being incomplete, interrupted, or even not carried out at all. Nevertheless, the observation results indicate that these limitations reflect operational realities that cannot be fully controlled.

TABLE IX. REBA SCORE ANALYSIS RESULTS

Day	Time of Work	Worker's Name	Body Position	REBA Score	REBA Score Interpretation
1	9:00 AM–10:00 AM	Worker 1	Low zone	10	High risk
			Neutral zone	8	High risk
			Overhead zone	7	Medium risk
	1:00 PM–2:00 PM	Worker 1	Neutral zone	6	Medium risk
			Overhead zone	10	High risk
2	9:00 AM–10:00 AM	Worker 1	Low zone	7	Medium risk
			Neutral zone	5	Medium risk
	10:00 AM–11:00 AM	Worker 1	Low zone	7	Medium risk
			Neutral zone	5	Medium risk
	1:00 PM–2:00 PM	Worker 1	Neutral zone	5	Medium risk
			Overhead zone	8	High risk
1	9:00 AM–10:00 AM	Worker 2	Neutral zone	6	Medium risk
			Overhead zone	7	Medium risk
	1:00 PM–2:00 PM	Worker 2	Overhead zone	9	High risk
	3:00 PM–4:00 PM	Worker 2	Neutral zone	6	Medium risk
			Overhead zone	9	High risk
2	9:00 AM–10:00 AM	Worker 2	Low zone	10	High risk
			Neutral zone	6	Medium risk
			Overhead zone	7	Medium risk
	10:00 AM–11:00 AM	Worker 2	Low zone	10	High risk
			Neutral zone	6	Medium risk
			Overhead zone	7	Medium risk
	1:00 PM–2:00 PM	Worker 2	Low zone	10	High risk
			Neutral zone	6	Medium risk
1	9:00 AM–10:00 AM	Worker 3	Low zone	10	High risk
			Neutral zone	6	Medium risk
2	9:00 AM–10:00 AM	Worker 3	Low zone	12	Very high risk
			Neutral zone	7	Medium risk
			Overhead zone	5	Medium risk
	1:00 PM–2:00 PM	Worker 3	Low zone	8	High risk
			Neutral zone	6	Medium risk

Observations were conducted on 22 workers during four time periods throughout the workday: 9:00–10:00 a.m., 10:00–11:00 a.m., 1:00–2:00 p.m., and 3:00–4:00 p.m. Each worker was observed for at least two workdays. Additional observation days were conducted for workers whose available observations were insufficient for the planned analysis. Work position zones were classified based on the actual postures adopted by workers during observation and categorized into low, neutral, and overhead zones. Work position zones were classified based on the actual postures adopted by workers during the observations and categorized into low, neutral, and overhead zones. Therefore, these three zones are not considered mandatory observation categories for every worker or observation period. A total of 317 valid observations were obtained for analysis, consisting of 237 work postures for lightweight brick installation (65 low-zone postures, 103 neutral-zone postures, and 69 overhead-zone postures) and 80 postures for plastering work (29 low-zone postures, 29 neutral-zone postures, and 22 overhead-zone postures).

TABLE X. DISTRIBUTION OF REBA RISK CATEGORIES IN LIGHTWEIGHT BRICKLYING

Zone	Low Risk	Medium Risk	High Risk	Very High Risk
Low Zone	0	31	30	4
Neutral Zone	10	83	7	3
Overhead Zone	1	32	36	0

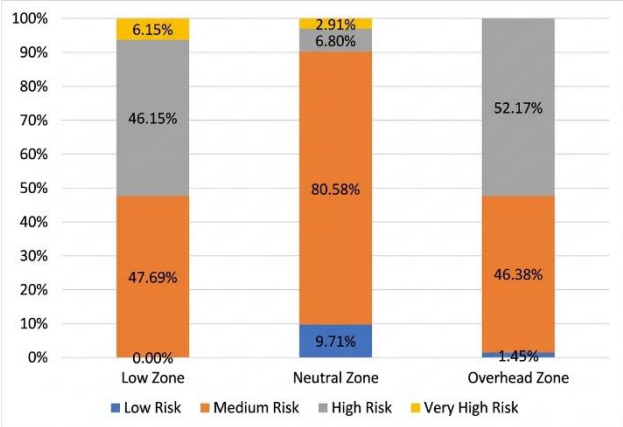


Fig. 3. Distribution of REBA Risk Categories in Lightweight Bricklying

In a study by Arifuddin et al. [4], REBA scores were calculated for workers laying lightweight bricks during the cutting and laying process. Brickwork accounts for the majority of occupational hazards in construction operations. When cutting lightweight bricks, workers assume a bent-over position—referred to in this study as the "low zone" position. Of the 6 workers, 5 adopted high-risk work postures, while 1 adopted a moderate-risk posture. During the installation of lightweight bricks, out of 10 workers who assumed a "neutral zone" position, 7 adopted a moderate-risk work posture, while 3 adopted a high-risk posture. Meanwhile, in this study, lightweight bricklaying work showed that in the low zone and neutral zone, the majority of workers adopted moderate-risk work postures, whereas in the overhead zone, the majority adopted high-risk postures. In the low zone, the REBA score was high because workers were forced to bend over, bend their knees to an extreme degree, and tilt their necks downward, resulting in a very high potential risk. In the overhead zone, the REBA score was also high because workers tended to stretch their necks and backs and raise both arms above shoulder level, while their knees tended to remain in a neutral position. Meanwhile, in the neutral zone—which represents the most natural work posture with an upright back and joints at neutral angles—the majority of data falls into the moderate-risk category. Very high-risk scores in this zone are generally caused by twisting the torso or neck as workers reach for materials beside them without moving their feet. Bricklaying accounts for the majority of occupational risks in construction activities. Lifting and moving nearly 600 to 1,000 bricks in a single workday places a heavy load on the back and shoulders, with significant forces causing concentrated pressure on specific parts of the body. It is clear that this lifting activity involves a large number of twisting and bending movements [21].

TABLE XI. DISTRIBUTION OF REBA RISK CATEGORIES IN PLASTERING

Zone	Low Risk	Medium Risk	High Risk	Very High Risk
Low Zone	0	13	16	0
Neutral Zone	7	22	0	0
Overhead Zone	0	19	3	0

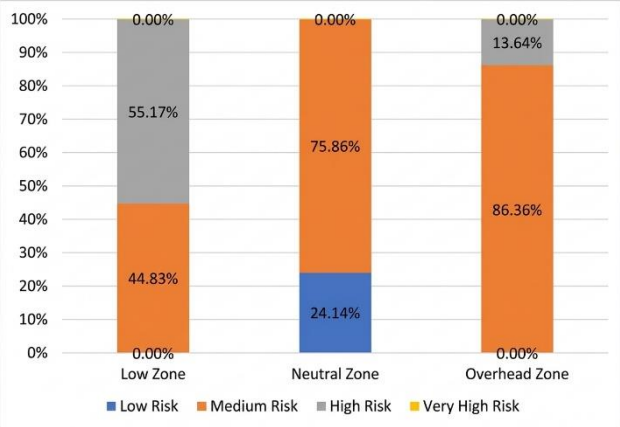


Fig. 4 Distribution of Reba Risk Categories in Plastering

In plastering work, of the 80 body postures analyzed, 54 were classified as medium risk. This is due to the high frequency of repetitive tasks performed in uncomfortable postures. The study by Rahman et al. [22], successfully analyzed eight tasks involved in wall plastering. First, workers must identify the wall area to be plastered, typically while standing. Next, workers must bend forward and twist their bodies to the left while scooping plaster from the floor using a hawk and a float. Afterward, they apply a layer of plaster to the interior wall, covering the surface with the hawk in their left hand and the float in their right hand while reaching overhead in a standing position. The worker repeats the same task—bending the back and turning the body to the left while scooping plaster from the floor and applying a layer of plaster to the interior wall—until the work on that section of the wall is complete. Of the eight tasks performed, six fall into the moderate ergonomic risk category, which can lead to pain in the back, shoulders, wrists, and elbows. In a study conducted by Mirnayani et al. [23], in Indonesia using the NBM questionnaire survey, working with bricklaying, rebar work, concrete pouring, and manual cement mixing resulted in more than 70% of workers experiencing recurrent stiffness in the lower and upper back, while 55% reported pain in the shoulders and neck area.

TABLE XII. IDENTIFICATION OF THE CAUSES OF HIGH REBA SCORES

No.	Causes of High REBA Scores	Risk Factors
1.	Back bent 60^0 – 90^0	Awkward Posture
2.	Upper arm flexion >90^0	Awkward Posture
3.	Extension of the back and neck	Awkward Posture
4.	Weight on one leg/standing on tiptoes	Awkward Posture
5.	Leg bent >60^0	Awkward Posture
6.	Twisted back/neck	Awkward Posture
7.	Lifting a 7.5 kg weight	Force & Repetitive
8.	Repetitive movements	Repetitive
9.	Static positions >1 minute	Static Loading

C. Risk Control

Mohammad et al. [24], conducted a study on 250 workers including brick carriers, mortar mixers, lightweight brick installers, overhead plasterers, excavators, and rebar cutters. They found that the body parts most frequently affected were the lower back (48%), knees (45%), shoulders (40%), and neck (30%). REBA scores indicated that 60% of workers were at high or very high ergonomic risk, while 30% were at moderate risk. Workers in the high/very high-risk category had a significantly higher likelihood of developing WMSDs [24]. A case study from Ecuador showed that 40% of workers were exposed to high risk in the upper body, 2% in the legs, 20% in the right arm, and 22% in the left arm [14].

TABLE XIII. RISK CONTROL RECOMMENDATIONS

No.	Risk Control Program	Notes
1.	Training and Education	Promoting proper manual handling techniques during toolbox talks.
		Training on material lifting and safe work positions.
2.	Workplace Hazard Analysis	Job Safety Analysis
3.	Room and material layout	Stacking lightweight bricks up to the worker's waist height.
4.	Work breaks	Monitoring of breaks
		Stretching/exercises
		Limits on overtime hours
5.	Job rotation	Workers do not perform only one type of work
6.	Support equipment	Use of adjustable scaffolding.
		Use of hand trucks and hand pallets for material handling.

Work-related musculoskeletal disorders affect workers' ability to function optimally and can lead to permanent disability; therefore, efforts to control ergonomic risks are necessary.

Risk control recommendations were developed based on the ergonomic risks identified through the REBA assessment and findings from previous studies on ergonomic risk control in construction work. The identified control measures were subsequently used to develop interview materials for three occupational safety and health (OSH) practitioners with varying levels of work experience: an OSH Officer with 14 years of experience (Source X), an OSH Inspector with 1 year of experience (Source Y), and an OSH Officer with 9 years of experience (Source Z). These interviews were conducted to obtain expert assessments regarding the feasibility and potential impact of the proposed ergonomic risk controls under actual construction site conditions. The main questions posed to the practitioners were:

1. What ergonomic control measures can be implemented to reduce the identified ergonomic risks;
2. Which control measures are considered to have the greatest potential impact in reducing these risks;
3. How often workers experience complaints or pain related to non-ergonomic work postures; and
4. What actions or solutions are taken when workers experience complaints or pain due to such work postures.

Responses from the three practitioners that were deemed relevant to construction work conditions and had the greatest potential impact, according to the practitioners, were prioritized in the final recommendations. Since validation was conducted through expert interviews, no quantitative assessment or statistical inter-rater agreement test was applied.

Based on the interview results, it was found that the company has implemented various ergonomic risk control measures comprising four main aspects.

First, regarding administrative controls, the company has conducted regular ergonomics training and awareness sessions, both through mandatory training programs—held at least once per project—and through daily toolbox talks that address ergonomic hazards, proper lifting techniques, and the use of assistive devices. This aligns with Lucy et al. [19] and Huda Adnan & Ressang [2], who state that ergonomics training and education on proper work techniques are effective preventive measures in reducing the risk of MSDs.

Second, hazard identification through Job Safety Analysis (JSA) has been consistently implemented every day before work begins, serving not only as an administrative document but also as a means to raise workers' awareness of potential hazards, in line with the view of Huda Adnan & Ressang [2], that JSA is the first step in ergonomics risk control.

Third, regarding the provision of work facilities, the company has provided tools such as hand trucks, hand pallets, and scaffolding to reduce manual lifting activities. However, based on field observations, materials are still placed quite far from the installation site, forcing workers to carry them manually over relatively long distances; therefore, the material layout needs to be optimized. This aligns with the findings of Noy et al. [25] and Lucy et al. [19], who state that proper material layout and the use of assistive tools appropriate to workers' capacity can reduce their biomechanical load.

Fourth, the company has implemented work schedule adjustments through stretching exercises, limiting maximum overtime to 10:00 PM, and providing a 15-minute break every two hours. Nevertheless, all three informants reported that ergonomic complaints—particularly lower back and shoulder pain—still arise when work volume and duration increase, with approximately 3 out of 10 workers reporting such complaints when the workload exceeds 8 hours. These conditions indicate that increased work duration and workload remain contributing factors to MSD complaints; therefore, the scheduling of rest periods and work rotations needs to be continuously improved.

Regarding health monitoring, the company conducts monitoring through awareness campaigns, the provision of medications for initial treatment, and coordination with foremen. Although the number of complaints reported by workers is relatively low, the REBA assessment results show that most work postures remain in the medium to very high-risk categories, indicating that the potential for ergonomic risks remains high despite the low number of reported complaints. Therefore, worker health monitoring needs to be continuously improved through active supervision, the provision of initial treatment, and periodic evaluations to prevent the development of more serious musculoskeletal disorders.

V. Conclusion

Based on the results of the ergonomic risk management study on lightweight bricklaying and plastering work at a high-rise building construction project in Surabaya, it can be concluded that risk identification through literature review and field observations identified six major ergonomic risk factors: awkward postures, force, repetitive movements, vibration, static loading, and contact stress. These were then analyzed using the REBA method on 317 work-posture observations from 22 workers, yielding the following findings: 5.88% of postures fell into the low-risk category, 63.62% into medium risk, 28.99% into high risk, and 1.51% into very high risk.

The high REBA scores were primarily caused by postures involving a 60°–90° back bend, upper arm flexion >90°, back and neck extension, standing on one foot or on tiptoes, leg bending >60°, twisting of the back or neck, repetitive lifting of 7.5 kg loads, repetitive movements, and static positions lasting >1 minute, therefore, the proposed control measures include ergonomics training and education, workplace hazard analysis through JSA, workspace and material layout optimization, scheduled rest breaks, job rotation, and the provision of supportive equipment—all of which have been reviewed and validated through interviews with three OSH practitioners.

Theoretically, this study enriches the body of ergonomic knowledge by demonstrating the relevance of the REBA method in the construction sector and developing a risk identification approach that combines literature review with field observations, while practically, this study contributes to construction companies by providing a basis

for evaluating existing OSH programs and identifying gaps between policies and on-site implementation; to workers by raising awareness of the importance of ergonomic posture and reporting physical complaints as early as possible; and to policymakers by offering input for the development of ergonomic SOPs and regulations to protect workers from MSD risks.

This study has several limitations, including a scope limited to two high-rise building construction projects in Surabaya and two types of work (lightweight bricklaying and plastering); the REBA method, which is quantitative and observational in nature and does not involve direct biomechanical measurements; and the validation of recommendations, which involved only three OSH practitioners without a pilot implementation test. Therefore, future research should expand its scope to include various types of jobs and locations; combine REBA with biomechanical measurement tools such as motion capture; conduct action research involving the implementation of recommendations and pre- and post-intervention effectiveness measurements; and involve more respondents including the workers themselves, to obtain a more holistic perspective.

ACKNOWLEDGMENTS

The authors would like to express their gratitude to the Education Fund Management Agency (LPDP), as well as all construction workers and project staff who participated in this study during the field observation and data collection phases.

REFERENCES

[1] N. Inyang, M. Al-Hussein, M. El-Rich, and S. Al-Jibouri, "Ergonomic analysis and the need for its integration for planning and assessing construction tasks," *J. Construct. Eng. Manag.*, vol. 138, no. 12, pp. 1370–1376, 2012, doi: 10.1061/(ASCE)CO.1943-7862.0000556.

[2] N. H. Adnan and A. Ressang, "Ergonomics awareness on construction site," *Construct. Manag. Geotechnics Transportation*, vol. 12, pp. 190-203, 2016. [Online]. Available: https://civil.utm.my/wp-content/uploads/2016/12/Ergonomics-Awareness-on-Construction-Site.pdf

[3] Y. Tao, H. Hu, J. Xue, Z. Zhang, and F. Xu, "Evaluation of ergonomic risks for construction workers based on multicriteria decision framework with the integration of spherical fuzzy set and alternative queuing method," *Sustainability*, vol. 16, no. 10, e3950, 2024, doi: 10.3390/su16103950.

[4] R. Arifuddin, R. U. Latief, Y. Thahirah, and M. R. Fadlillah, "Ergonomic risk analysis of workers in construction project: A case study of concrete and brick wall work," *Int. J. Eng. Trends Technol.*, vol. 73, no. 3, pp. 1–12, 2025, doi: 10.14445/22315381/IJETT-V73I3P101.

[5] M. Kumaresan, S. B. Darivemula, S. Bala, and S. Kadas, "Musculoskeletal disorders among long-standing workers working for more than 6-hours a day in an automobile factory in South India," *J. Emergencies, Trauma, and Shock*, vol. 18, no. 3, pp. 119–125, 2025, doi: 10.4103/jets.jets_161_24.

[6] O. Tandazo, V. Jaramillo-Carrión, E. Valarezo, M. Sanchís-Almenara, L. Montalbán-Domingo, and J. Catalá-Alís, "Ergonomic risk assessment in construction: Case study Ecuador," *Heliyon*, vol. 11, no. 4, Art. no. e42751, 2025, doi: 10.1016/j.heliyon.2025.e42751.

[7] M. A. Zengin and Ö. Asal, "Evaluation of employee postures in building construction with different ergonomic risk assessment methods," *J. Faculty Eng. Architecture of Gazi University*, vol. 35, no. 3, pp. 1615–1630, 2020, doi: 10.17341/gazimmfd.548028.

[8] M. Hita-Gutiérrez, M. Gómez-Galán, M. Díaz-Pérez, and Á.-J. Callejón-Ferre, "An overview of REBA method applications in the world," *Int. J. Environ. Res. Public Health*, vol. 17, no. 8, Art. no. 2635, 2020, doi: 10.3390/ijerph17082635.

[9] D. Al Madani and A. Dababneh, "Rapid entire body assessment: A literature review," *Am. J. Eng. Appl. Sci.*, vol. 9, no. 1, pp. 107–118, 2016, doi: 10.3844/ajeassp.2016.107.118.

[10] K. Fahzan, "Ergonomic risk assessment on welding practical work on learning process at Malaysia Polytechnic Diploma of Engineering Programme," *IOP Conf. Series: Materials Sci. Eng.*, vol. 864, no. 1, Art. no. 012102, 2020, doi: 10.1088/1757-899X/864/1/012102.

[11] M. Motamedzadeh, F. Rostami, and R. Gheibi, "Effects of ergonomic interventions in a steel melting and casting complex," *J. Occupational Hygiene Engineering*, vol. 4, no. 2, pp. 34–40, 2017, doi: 10.18869/acadpub.johe.4.2.34.

[12] I. Aslan, "Exploring the appropriate ergonomic risk assessment method," in *Proc. 8th Int. Conf. on Health, Eng. and Appl. Sci. (ICHEAS)*, Rome, Italy, pp. 509–520, Nov. 15–17, 2024. [Online]. Available: https://www.researchgate.net/publication/388059179_Exploring_the_Appropriate_Ergonomic_Risk_Assessment_Method

[13] N. Jaffar, A. H. Abdul-Tharim, I. F. Mohd-Kamar, and N. S. Lop, "A literature review of ergonomics risk factors in construction industry," *Procedia Eng.*, vol. 20, pp. 89–97, 2011, doi: 10.1016/j.proeng.2011.11.142.

[14] A. N. E. Putri, N. M. H. Amrin, and M. E. Halulanga, "Ergonomic risk identification and occupational safety and health (OSH) based intervention: A pilot study," *An Idea Health J.*, vol. 6, no. 2, pp. 209–220, 2026, doi: 10.53690/ihj.v6i02.632.

[15] I. Y. Wuni, G. Q. Shen, and B.-G. Hwang, "Risks of modular integrated construction: A review and future research directions," *Front. Eng. Manag.*, vol. 7, no. 1, pp. 63–80, 2020, doi: 10.1007/s42524-019-0059-7.

[16] N. Suzila, B. Lop, N. M. Salleh, F. Miza, and Y. Zain, "Ergonomic risk factors (ERF) and their association with musculoskeletal disorders (MSDs) among Malaysian construction trade workers: Concreters," *Int. J. Acad. Res. Bus. Soc. Sci.*, vol. 9, no. 9, pp. 1269–1282, 2019, doi: 10.6007/IJARBSS/v9-i9/6420.

[17] O. Turbaningsih, U. Mutaharah, and P. Saputra, "The study of potential application of modular construction in the development of Indonesia's new capital city," *J. Teknik Sipil*, vol. 29, no. 3, pp. 207–216, 2022, doi: 10.5614/jts.2022.29.3.1.

[18] S. Tsuichihara, Y. Watanabe, K. Hara, and Y. Takahashi, "Effect analysis of each reach zone in ergonomics during putting and pulling movement of shelf on VR experiment," in *HCI Int. 2022—Late Breaking Papers: Ergonomics and Product Design*, vol. 13522, pp. 336–347, 2022, doi: 10.1007/978-3-031-21704-3_21.

[19] A. L. R. F. Faisting and T. de O. Sato, "Effectiveness of ergonomic training to reduce physical demands and musculoskeletal symptoms—An overview of systematic reviews," *Int. J. Industr. Ergonomics*, vol. 74, e102845, 2019, doi: 10.1016/j.ergon.2019.102845.

[20] Department of Occupational Safety and Health Malaysia, "Occupational musculoskeletal diseases statistic 2005–2014," Social Security Organisation (SOCSO/PERKESO), Malaysia, 2014.

[21] A. Ahankoob and A. Charehzehi, "Mitigating ergonomic injuries in construction industry," *IOSR J. Mechanical and Civil Eng.*, vol. 6, no. 2, pp. 36–42, 2013, doi: 10.9790/1684-0623642.

[22] M. N. A. Rahman, M. R. A. Rani, and J. M. Rohani, "Investigation of work-related musculoskeletal disorders in wall plastering jobs within the construction industry," *Work*, vol. 43, no. 4, pp. 507–514, 2012, doi: 10.3233/WOR-2012-1404.

[23] M. Mirnayani, M. F. N. Aulady, and R. H. Novianto, "Ergonomic risk assessment of construction workers using RULA, REBA, and NBM methods: A case study in Bandung, Indonesia," *Lean Construction J.*, pp. 249–262, 2026, doi: 10.60164/cft04ppwoy.

[24] S. M. F. Akhtar, N. Mumtaz, and A. R. Khan, "Prevalence and nature of ergonomic hazards among construction workers in India: A cross-sectional study," *Safety*, vol. 11, no. 3, e62, 2025, doi: 10.3390/safety11030062.

[25] R. Noy, Y. Shkedy, and Y. Vaisbuch, "Ergonomic injuries and their complications: Prevention and treatment," *Operative Techniques in Otolaryngology-Head and Neck Surgery*, vol. 36, no. 2, pp. 118–123, 2025, doi: 10.1016/j.otot.2025.05.006.



Brigitta Vidia Maharani is a master's student in the Department of Civil Engineering, Faculty of Engineering, Universitas Brawijaya, Malang, Indonesia. Her academic and research interests focus on construction worker productivity, occupational ergonomics, and workplace safety. Her research explores ergonomic risk factors and their implications for worker performance, health, and productivity, particularly in construction environments. (email: gitavidia@gmail.com).



Kartika Puspa Negara is a lecturer and researcher in the Department of Civil Engineering, Faculty of Engineering, Universitas Brawijaya, Malang, Indonesia. His primary area of specialization is construction management, with academic interests in construction project planning, resource management, productivity, and project performance. His scholarly activities focus on improving management practices, operational efficiency, and effectiveness in construction projects. (email: kartika_puspa@ub.ac.id).



Wisnumurti is a lecturer and researcher in the Department of Civil Engineering, Faculty of Engineering, Universitas Brawijaya, Malang, Indonesia. His primary area of specialization is structural engineering, with academic interests in structural analysis, design, and performance of civil engineering structures. His scholarly work contributes to advancing structural engineering knowledge and supporting the development of safe, reliable, and sustainable infrastructure. (email: wsmurti@ub.ac.id).