Manual Material Handling Risk Assessment Using the Leitmerkmal Method on Porters at the Gorontalo Logistics Agency Warehouse

Siti Deafni Hadju[1*], Herlina Jusuf[2], Moh Rivai Nakoe[3]

[1,2,3]Public Health Study Program Faculty of Sports and Health, Gorontalo State University, Indonesia
Corresponding author:
E-mail: deafnihadju@gmail.com

Abstract.
Manual material handling (MMH) activities in the warehousing sector still have the potential to cause ergonomic risks due to heavy lifting, high work frequency, and less ergonomic work postures. This study aims to analyze the level of MMH risk in porters at the Perum BULOG Gorontalo Warehouse using the Leitmerkmal Method (LMM). The study used a quantitative approach with a descriptive design. The study population consisted of 23 porters and all were sampled using a total sampling technique. Data were collected through observation, interviews, and LMM checklists, then analyzed univariately based on the assessment of work time indicators, load mass, body posture, work conditions, and the final LMM score. The results showed that all respondents had a load rating >40 kg, most had a time rating of 1 to <4 km per day, work postures were dominated by slightly bent, work conditions were classified as ergonomic, and all respondents were in the very high risk category. The conclusion of the study shows that the risk of MMH in warehouse porters at Perum BULOG Gorontalo is at a very high level which is mainly influenced by lifting loads, working time, and body posture, so that the implementation of ergonomic control is needed to reduce the risk of musculoskeletal disorders.

Keywords: *Ergonomics, Leitmerkmal Method, Manual Material Handling, Musculoskeletal Disorders and Occupational Health.*

I. INTRODUCTION

Occupational Health and Safety (OHS) is our effort to create a healthy and safe work environment, thereby reducing the probability of workplace accidents or illnesses due to negligence, which can lead to demotivation and deficiencies in work productivity (Bahsoan et al., 2025). Technological developments and automation have transformed various work processes in the industrial sector, but human labor remains a key component in activities that require flexibility, precision, and high adaptability, particularly in manual material handling (MMH) work. MMH activities include lifting, carrying, pushing, pulling, lowering, and moving materials manually using muscle strength. Although these activities remain a crucial part of the logistics system, they are often carried out without regard to ergonomic principles, increasing the risk of occupational injuries and health problems in workers (Ali, 2021; Sinambela & Eky, 2022). Various studies have shown that non-ergonomic work postures, high lifting frequency, and carrying loads that exceed the worker's physical capacity are the main factors that trigger musculoskeletal disorders (MSDs) in MMH activities (Rajendran et al., 2021; Skals et al., 2021).

A major challenge in manual work such as loading and unloading is the risk of Musculoskeletal Disorders (MSDs), which are also frequently experienced by workers (Kasim et al., 2025). MSDs remain one of the most dominant occupational health problems worldwide. The World Health Organization reports that approximately 1.71 billion people worldwide suffer from musculoskeletal disorders, making these conditions the largest contributor to Years Lived with Disability (YLD) globally (WHO, 2022). In Indonesia, the logistics sector is one of the sectors at high risk of MSDs because most goods moving activities are still carried out manually. A report from the Ministry of Manpower of the Republic of Indonesia shows that MSDs still dominate occupational diseases in the logistics sector, while data from the International Labor Organization also shows a high prevalence of complaints in the back, neck, shoulders, knees, and legs of workers who perform repetitive physical activities (Siallagan, 2022; Hardian, 2025). This condition shows that controlling ergonomic risks in MMH work is still an important challenge in efforts to improve occupational safety and health.

Continuous MMH activities with heavy loads, long work durations, and body postures that do not comply with ergonomic principles can increase biomechanical stress on the musculoskeletal system, triggering muscle fatigue, lower back pain, and even permanent injury if not properly managed (Gunawan et al.,

2025; Prayogi et al., 2024). Therefore, identifying the level of ergonomic risk needs to be carried out systematically using assessment methods that can describe the magnitude of physical load exposure received by workers. One method that is widely used is the Leitmerkmal Method (LMM), because it can evaluate factors such as working time, load mass, body posture, and working conditions simultaneously, thus providing a more comprehensive picture of MMH risks than assessments that only focus on work posture (Tarwaka, 2019; Rajendran et al., 2021).

The Gorontalo State Logistics Agency (BULOG) is an institution whose operational activities are still dominated by manual food transfers from the warehouse to distribution vehicles and vice versa. Preliminary survey results indicate that workers lift loads of up to 50 kg with a frequency of more than 100 times per day and a distance of approximately 10 meters, accompanied by a slightly bent posture during the transportation process. In addition to complaints of back pain, there have been incidents of material falling due to loads exceeding the workers' capabilities. Initial measurements using LMM on five workers showed that all respondents were at risk level 4 (very high) with a final score exceeding 50. These findings are in line with research by Satriyandhi et al. (2025) who reported high ergonomic risks in MMH activities due to inappropriate work postures, as well as research by Hanafie et al. (2023) who showed that work duration and ergonomic conditions are the dominant factors causing the high risk of physical complaints in workers.

Based on these conditions, this study aims to analyze the risks of manual material handling on porters at the BULOG Gorontalo Warehouse using the Leitmerkmal Methode through an assessment of working time indicators, load mass, body posture, working conditions, and the overall risk level. This study is important to be conducted as a basis for compiling ergonomic control recommendations that can reduce the risk of MSDs, improve work safety, and support worker productivity in the logistics sector. The novelty of this study lies in the application of the LMM method specifically to the activities of porters at the BULOG Gorontalo Warehouse by considering all components of ergonomic risk assessment based on actual work conditions, so that it is expected to produce more comprehensive information as a basis for decision making in implementing occupational safety and health programs in the warehousing sector.

II. METHODOLOGY

This research was conducted at the Talumolo Warehouse of the General Logistics Agency (Perum BULOG), Dumbo Raya District, Gorontalo City, Gorontalo Province, from February to March 2026. The research used a quantitative approach with a descriptive research design. This approach was used to describe the level of manual material handling risk for workers based on conditions found in the field without conducting any treatment on the research objects.

The method used is the LeitmerkMal Method (LMM), a method for assessing ergonomic risks in manual material handling activities. The assessment is based on four main parameters: working time, mass, posture, and working conditions. Each parameter is scored according to the assessment criteria, resulting in a final score indicating the level of risk of manual material handling work (Tarwaka, 2019; Hardian, 2025).

The population in this study was all 23 porters working at the Perum BULOG Gorontalo Warehouse. Considering the relatively small population and the researcher could reach all members of the population, the sampling technique used was total sampling, so that the entire population was used as the research sample. Thus, the total sample of the study was 23 porters at the Perum BULOG Gorontalo Warehouse.

The research data consisted of primary and secondary data. Primary data were obtained through direct observation and interviews. Observations were conducted on manual material handling activities to assess indicators of working time, mass or load, posture, and working conditions. Interviews were conducted with workers and warehouse managers to obtain information on workplace accidents, complaints experienced by workers, and confirmation of indicators of working time and load weight during manual material handling activities. Secondary data were obtained from Perum BULOG Gorontalo, which included information on the population, sample, and research location.

The research instrument used was a LeitmerkMal Method (LMM) checklist. Assessments were conducted on four indicators: time, mass or load, posture, and working conditions. The final manual material handling risk score was calculated using the following formula:

$O = T \times (M + P + W)$

with the description O as the final score, T as time, M as mass, P as body posture, and W as working condition (Tarwaka, 2019; Hardian, 2025).

Data analysis was conducted univariately to describe the characteristics of each research variable, including working time, mass or load, body posture, working conditions, and the risk level of manual material handling. The assessment results using the LMM method were then interpreted based on risk level categories, namely low, medium, high, and very high risk, then presented in the form of a risk assessment table and descriptive description (Tarwaka, 2019; Hardian, 2025).

The research began with data collection through direct observation of manual material handling activities and interviews with workers and warehouse managers. Next, each LMM parameter was assessed: time, mass or load, posture, and working conditions.

Time assessment is based on the total distance traveled by workers carrying or moving loads in one workday, which is obtained by multiplying the distance traveled per lift by the frequency of lifts. Mass or load assessment is carried out using a weighted average if workers lift loads of varying weights. Posture assessment is carried out based on the worker's posture while carrying loads, while work conditions assessment is carried out based on the work environment conditions that affect lifting activities.

After all parameters have been assigned a rating score, a final score is calculated using the LMM formula to determine the level of manual material handling risk for each worker. The results are then interpreted according to the risk level category and can be used as a basis for determining the level of action required to address manual material handling risks at the Perum BULOG Gorontalo Warehouse (Tarwaka, 2019; Hardian, 2025).

III. RESULTS AND DISCUSSIONS

Respondent Characteristics

1. Distribution of Respondents by Gender

Table 1. Distribution of Respondents by Gender

Gender	Amount	
	n	%
Man	23	100
Amount	23	100

Source: Primary Data, 2026

Based on table 1, the distribution of respondents based on gender shows that of the 23 workers, all (100%) were male.

2. Distribution of Respondents by Age

Table 2. Distribution of Respondents by Age

Age (years)	Amount	
	n	%
<21	1	4.4
21-40	9	39.1
>40	13	56.5
Amount	23	100

Source: Primary Data, 2026

Based on table 2, the distribution of respondents based on age shows that of the 23 workers, the highest age category is in the age category >40 years, namely 13 people (56.5%), and the lowest age category is the age category <21 years, namely 1 person.

3. Distribution of Respondents Based on Length of Service

Table 3. Distribution of Respondents Based on Length of Service

Length of Service (years)	Amount	
	n	%
New Employment Period ≤5	8	34.8
Long Service Period >5	15	65.2
Amount	23	100

Source: Primary Data, 2026

Based on table 3, the distribution of respondents based on length of service shows that of the 23 workers, 15 people (65.2%) have a long service period of >5 years, while 8 people (34.8%) have a new service period of ≤5 years.

Univariate Analysis

1. Rating of MMH time indicators using LMM on porters at the Bulog Gorontalo warehouse

Table 4. Distribution of MMH time indicator ratings using LMM for porters at the Bulog Gorontalo warehouse

Time rating (Score)	Amount	
	n	%
2 (0.3 - <1 km)	7	30.4
4 (1- 4 km)	16	69.6
Amount	23	100

Source: Primary Data, 2026

Based on the data in table 4, it is known that of the 23 porters at the Bulog Gorontalo Warehouse, 16 workers with a percentage of (69.6) have the highest time rating score of 4 and the lowest time rating (score) is 2, totaling 7 workers with a percentage of (30.4).

2. Rating of MMH mass/load indicators using LMM on porters at the Bulog Gorontalo warehouse

Table 5. Distribution of Ratings of the Mass/Load Indicator MMH using LMM for Porters at the Bulog Gorontalo Warehouse

Load rating (Score)	Amount	
	n	%
25 (> 40 kg)	23	100
Amount	23	100

Source: Primary Data, 2026

Based on the data in table 5, it is known that of the 23 porters at the Gorontalo Bulog Warehouse, 23 workers with a percentage (100) have the highest load rating score at 25, which means that the load lifted is included in the category >40 kg.

3. Rating of MMH body posture indicators using LMM on porters at the Bulog Gorontalo warehouse

Table 6. Distribution of MMH Body Posture Indicator Ratings using LMM on Porters at the Bulog Gorontalo Warehouse

Posture Rating (Score)	Amount	
	n	%
2 (Bows slightly)	14	60.9
3 (Bends quite far)	9	39.1
Amount	23	100

Source: Primary Data, 2026

Based on the data in table 6, it is known that of the 23 porters at the Bulog Gorontalo Warehouse, the highest rating score posture was 14 workers with a percentage of 60.9 at rating score 2 and the lowest time rating (score) was rating (score) 3, amounting to 9 workers with a percentage of 39.1.

4. Rating of MMH Working Condition Indicators using LMM on Port Workers at Bulog Gorontalo Warehouse

Table 7. Distribution of MMH Working Condition Indicator Ratings using LMM for Porters at the Bulog Gorontalo Warehouse

Rating (Score)	Amount	
Working Conditions	n	%
0 (Good ergonomic conditions)	23	100
Friday	23	100

Source: Primary Data, 2026

Based on the data in table 7, it is known that of the 23 porters at the Bulog Gorontalo Warehouse, 23 workers with a percentage (100) have a score rating of 0, which means that the ergonomic working conditions are good.

5. MMH Risk Level using LMM on Transport Workers at the Bulog Gorontalo Warehouse

Table 8. Distribution of MMH Risk Levels using LMM among Transport Workers at the Bulog Gorontalo Warehouse

Risk Level		Amount	
		n	%
1	(Low)	0	0
2	(Currently)	0	0
3	(Tall)	0	0
4	(Very high)	23	100
Amount		23	100

Source: Primary Data, 2026

Based on the data in Table 8, it is known that of the 23 porters at the Bulog Gorontalo Warehouse, 23 workers with a percentage (100) are included in risk level 4 (very high), which means that high work freedom situations and excessive physical load often occur. And changes and improvements must be made technically and organizationally to reduce the risk.

IV. DISCUSSION

Rating of MMH time indicators using LMM on porters at the Bulog Gorontalo warehouse

The manual material handling time indicator for porters at the Bulog Gorontalo Warehouse, out of 23 respondents, the highest time rating (score) was at a rating (score) of 4, as many as 16 people (69.6%), which means that in carrying loads the total distance traveled during one working day is 1 - <4 km per day. This score result indicates that the work activities of porters at the Bulog Gorontalo warehouse still show a relatively large level of exposure in terms of frequency and transport distance. Although the transport distance in one activity is relatively short, the activity is carried out repeatedly in quite large numbers during working hours. The accumulation of these repetitive activities causes the total distance traveled in one day to be significant, so that it is included in the category of 1–<4 km.

This condition is in line with the facts in the field, workers who fall into the score 4 category, during the study it was found that they handle loads in larger quantities during the work process, such as 50 kg of rice and 10 kg of rice stacked five sacks to make 50 kg. The high volume of work causes the lifting frequency to be much greater than workers with a score of 2. If calculated, with a distance of 12 meters per lift and a frequency of tens to hundreds of times a day, the total distance traveled can reach >1 km. This is what causes the dominance of the time rating score 4.

In industrial ergonomics theory, carrying a load over a long distance can cause physical stress, leading to fatigue and an increased risk of injury (Tarwaka, 2019). This is confirmed in research.Ni Putu (2022), which states that transport distance can pose a health risk, because the transport distance exceeds the body's capacity with the load being lifted or the ability to deliver goods from one place to another for a long time, which will cause excessive muscle contractions. Prolonged contractions in the muscles result in stronger and longer stimulating stimuli and heavier loads, which will cause muscle pain. In line with research on sugarcane workers conducted byDewi et al., (2022)which emphasizes that the further the transportation distance, the higher the risk, in his research it shows that there is a significant relationship between transportation distance and health risks.

In the context of research on Bulog Gorontalo warehouse porters, the high frequency of lifting which impacts the total daily distance traveled indicates that there is considerable work time pressure on porters, which has the potential to increase work fatigue and the risk of health problems if not balanced with ergonomic work arrangements.

The presence of workers in the score category 2 indicates a slightly lower total daily transport distance, which ranges from 0.3–<1 km per day. Based on field conditions, workers in this category tend to handle a smaller number of loads, so the accumulated distance generated in one workday is also smaller. Alt-

hough the distance per load is not different from the score group 4, the total distance traveled is still lower because the movement activity is not carried out as frequently as the group with a higher score.

Respondents totaling 7 people (30.4%) are in the score category 2 with a total daily transport distance of 0.3 - <1 km. In accordance with field conditions, workers with a score of 2 have a lower lifting frequency because the type of load transported during the study was smaller in number, such as 50 kg of rice and 12 kg of oil stacked in three to four boxes. Although the weight of the load is relatively the same, because the number of items transported is smaller, the work frequency is lower so that the total daily travel distance is also smaller.

In ergonomic theory, this condition can be viewed as a lighter form of work exposure, as the body is not subjected to prolonged biomechanical stress. In the Leitmerkmal method, a lower total carrying distance reflects a lower level of work exposure because the duration of the load-carrying activity is also more limited. This is in line with research.Nurftah et al., (2021)suggests that short haul distances slightly reduce the risk of experiencing musculoskeletal disorders, because the shorter the haul distance, the less time the worker's body is exposed to the load. The haul distance is measured in meters from the start of the load to the end of the lift. Therefore, the longer the haul distance, the longer the muscles and bones experience heavy loads that damage the ligaments and layers of muscle coverings.

Rating of MMH mass/load indicators using LMM on porters at the Bulog Gorontalo warehouse

The results of the study in Table 5 regarding the distribution of the MMH mass/load indicator rating using the LMM method on porters at the Bulog Gorontalo Warehouse, that of the total of 23 respondents all (100%) were in the highest load rating score category, namely a score of 25. This indicates that all porters have a very high mass/load level, namely included in the lifting load category >40 kg.

This condition is in line with the facts in the field, where all workers carry out lifting activities with relatively large weights and are done repeatedly. The loads lifted include 50 kg of rice lifted directly, as well as 10 kg of rice but stacked as many as five sacks in one lift, reaching a total weight of 50 kg. In addition, for cooking oil commodities weighing 12 kg per box, workers lift as many as three to four boxes in one lift, so that the total load ranges between 36–48 kg. This load variation is calculated using a weighted average approach that takes into account the frequency of lifting, so that the overall physical workload of workers remains in the category >40 kg.

The high load rating is not only influenced by the weight of the load, but also by the very high lifting frequency during a single workday. Based on field conditions, workers transport approximately 500–3,000 sacks per day for 10 kg of rice, 500–1,500 sacks per day for 50 kg of rice, and 300–900 cartons per day for cooking oil. These repetitive activities increase the accumulated physical workload experienced by workers.

The provisions in the Regulation of the Minister of Manpower and Transmigration No. 01/MEN/1978 concerning Occupational Safety and Health in the Transportation of Goods, state that the safe limit for manual lifting of loads for adult male workers is a maximum of 40 kg, taking into account physical condition, frequency, and lifting method. Based on these provisions, the loads lifted by porters at the Bulog Gorontalo Warehouse, which reached 50 kg, even if done repeatedly at high frequency, can be categorized as exceeding the recommended limit.

This condition indicates a potentially high ergonomic risk, as workers not only lift loads above the safe limit but also do so repetitively in large quantities every day. Based on the physical workload theory, if workers lift loads exceeding the standard, it will cause stress on the muscles. Heavy workloads combined with high work frequency can increase the risk of muscle fatigue and injury. The mass/weight of the load lifted and the frequency of lifting while working can affect health, especially spinal health. The heavier the load, the higher the risk experienced.(Dewi et al., 2022).

This theory is in line with research byHanifa et al., (2020) stated that sOver time, when heavy loads are lifted continuously, it can cause damage to the muscles, ligaments, and tendons in the area, which can worsen pain complaints. In line with research byMahestri et al., (2021)which states that work involving heavy lifting and high frequency activities is the main factor in the occurrence of musculoskeletal disorders (MSDs).

The results of this study confirm that all porters at the Bulog Gorontalo warehouse are experiencing very high levels of physical workload, even exceeding the safe limits recommended by labor regulations. This situation requires special attention through the application of ergonomic principles, such as the use of assistive devices and the regulation of lifting loads, to minimize occupational health risks.

Rating of MMH body posture indicators using LMM on porters at the Bulog Gorontalo warehouse

The results of the manual material handling risk study using the Leitmerkmal Methode on porters at the Bulog Gorontalo Warehouse, obtained that of the total of 23 respondents, the highest rating score was at a rating of 2, namely 14 respondents with a percentage of 60.9%. The dominance of the rating score 2 in this study indicates that the 14 respondents have a slightly bent forward posture and the load is close to the body and above shoulder height. This condition can be influenced by the characteristics of the work that requires workers to maintain load balance during the process of moving goods. This is in line with the facts in the field, when lifting 50 kg of rice without stacking, workers carry the load on their shoulders with a slightly bent forward body position. This position is a form of natural body adjustment so that the load remains close to the body's center of gravity so that it is more stable when carried.

In scientific ergonomics theory, risk is determined not only by the weight of the load, but also by how the load is lifted, moved, and controlled during work activities (Tarwaka, 2019). This is in line with research by Nasution et al., (2024) which shows that improving work positions to be more ergonomic, such as reducing body flexion and adjusting the load position relative to the body, can reduce risk. This suggests that the body will naturally adjust its position to maintain balance when carrying a load, so that the position of the load closer to the center of the body is more stable and safe.

The presence of a posture rating score of 3 for 9 people (39.1%) indicates that these 9 people have a body posture that is bent quite far and has led to conditions that have the potential to cause ergonomic risks. The presence of workers with a rating score of 3 indicates that there are still workers who carry out activities with a more risky posture. Based on field conditions, this occurs in workers who are more dominant in lifting stacked loads, such as 36 kg to 48 kg oil cartons. In these conditions, workers must bend quite far so that the load remains well supported and does not fall backward. This position causes the center of the load to shift away from the body, forcing workers to adjust their posture by bending more deeply or quite far. This posture that is bent quite far causes the body position to become unnatural and non-ergonomic because the load is not only supported by the muscles but also puts enough pressure on the spine, this is indicated by complaints of pain in the shoulders and back felt by workers.

In line with research conducted byAulia et al., (2023) which states that unnatural and forced working postures, especially prolonged hunched positions, can increase the risk of lower back pain. This is due to increased pressure on the spine and restricted blood flow to the muscles, which can lead to fatigue and pain.

Differences in posture scores obtained by workers on this indicator are primarily influenced by the position of the load relative to the body when lifted or carried. The closer the load is held to the body's center of gravity, the smaller the required postural changes, resulting in a more stable working position. Conversely, if the load is farther from the body or its shape causes the center of gravity to shift forward, workers will tend to hunch over more to maintain balance (Adiyanto et al., 2019). This condition results in a less ergonomic working posture and results in a higher posture score. This is evident in lifting oil in stacked cardboard boxes, where the size and shape of the load position it relatively farther from the body compared to loads that can be supported close to the body, such as sacks of rice carried on the shoulder.

The dominance of a score of 2 on this indicator does not necessarily indicate that work activities are safe, but rather illustrates that the majority of workers are in a "fairly safe but at risk" condition. This means that if ergonomic improvements or interventions are not made, this condition has the potential to develop into a higher risk, especially for workers who are already in the score category 3. Therefore, remedial efforts are needed, such as regulating more ergonomic lifting techniques or using assistive devices to reduce stress on workers' bodies.

Rating of MMH working condition indicators using LMM on porters at the Bulog Gorontalo warehouse

The MMH working condition indicator rating using the LMM method for porters at the Bulog Gorontalo Warehouse shows that all 23 respondents (100%) are in the rating score category 0. This indicates that the working conditions at the research location are classified as good and do not provide additional risk burdens in manual material handling activities.

These conditions align with field observations, which show that the work environment at the Bulog Gorontalo warehouse offers ample space for workers to move freely. This is evident during work activities, where two to three workers can walk side by side without encountering any obstacles, both when carrying and moving loads. Furthermore, lighting conditions within the warehouse are considered good due to the extensive, open ventilation, allowing sunlight to enter optimally and illuminate the work area.

Another factor contributing to good working conditions is the absence of materials or obstacles in the work path that could interfere with workers carrying loads. The warehouse's work paths are also clean and well-organized, minimizing the risk of tripping or falling. Furthermore, level floors contribute to worker safety and comfort when lifting and moving loads. Therefore, all respondents received similar scores because they worked in the same warehouse environment. This indicates that working conditions are not an additional risk factor because the work environment is adequate and contributes to more effective work performance.

In theory, working conditions are the conditions around the workplace that will influence workers both directly and indirectly in their work.(Gunawan et al., 2025)This is in line with research bySinaga & Sihombing (2021), which states that good working conditions have a positive influence on worker performance and comfort, and can help workers carry out their tasks more effectively. The results of this study are also in line with the results of research conducted byKasjono & Pandini (2017), namely in brick making workers carry out their work in good ergonomic conditions, nothing hinders the workload and good lighting.

The risk of MMH using LMM on porters at the Bulog Gorontalo warehouse

The MMH risk analysis using the LMM method on porters at the Bulog Gorontalo Warehouse showed that all 23 respondents (100%) were in risk category 4 (very high). This indicates that manual material handling activities carried out by porters are under high workload conditions, where excessive physical loading often occurs and requires immediate corrective action both technically and organizationally.

The high level of manual material handling (MMH) risk among porters at the Bulog Gorontalo warehouse is not accidental, but rather the result of a final score calculated from four mutually reinforcing factors or indicators within the work activity. This very high risk is primarily influenced by the dominant lifting load, transport distance, and the body posture used during the transport process.

The most influential main factor is the very high load score by all workers, namely a load rating score of 25 due to the lifting load exceeding the safe capacity of >40 kg, making it the main factor in manual material handling activities for porters at the Bulog Gorontalo warehouse, which is included in risk level 4 (very high). In field work activities, all workers lift loads of >40 kg, both from rice and the results of stacking several items such as oil. This load variation is calculated using a weighted average approach by considering the frequency of lifting, so that the overall physical workload of workers remains in the heavy category (>40 kg). Not only in terms of load weight, the high load rating value is also influenced by the very high frequency of lifting in one workday, thereby increasing the accumulation of physical workload received by workers.

Regulation of the Minister of Manpower and Transmigration No. 01/MEN/1978 concerning Occupational Safety and Health in the Transport of Goods, states that the safe limit for manual lifting of loads for adult male workers is a maximum of 40 kg.(Hafifa, 2022)Based on these provisions, the load lifted by porters at the Bulog Gorontalo Warehouse of >40 kg, even if done repeatedly at high frequency, can be categorized as exceeding the recommended limit.

This condition indicates a high potential ergonomic risk, as workers not only lift loads above the safe limit but also do so repetitively in large quantities every day. Based on the theory of physical workload, if workers lift loads exceeding the standard, it will cause stress on the muscles. Heavy workloads combined with high work frequency can increase the risk of muscle fatigue and injury. The mass/weight of the load

lifted and the frequency of lifting while working can affect health, especially spinal health. The heavier the load, the higher the risk experienced.(Dewi et al., 2022).

This theory is in line with research byHanifa et al., (2020) stated that sOver time, when heavy loads are lifted continuously, it can cause damage to the muscles, ligaments, and tendons in the area, which can worsen pain complaints. In line with research byMahestri et al., (2021)which states that work involving heavy lifting and high frequency activities is the main factor in the occurrence of musculoskeletal disorders (MSDs).

This situation confirms that all porters at the Bulog Gorontalo warehouse are experiencing very high levels of physical workload, even exceeding the safe limits recommended by labor regulations. This high load causes increased biomechanical stress on the body, particularly on the spine. When the load being lifted exceeds the body's physical capacity, the muscles and supporting tissues work harder to support it, increasing the risk of muscle fatigue and injury (Tarwaka, 2019). This situation requires special attention through the application of ergonomic principles, such as the use of assistive devices and the regulation of lifting loads, to minimize occupational health risks.

The next factor is the total distance traveled while carrying a load, which ranges from 0.3 to <1 km to 1-4 km. Prolonged exposure to physical stress results in insufficient recovery time for the body, increasing the likelihood of chronic fatigue. The combination of long distances and high frequency accelerates the decline in physical work capacity. This indicates that the work activities of porters at the Bulog Gorontalo warehouse still exhibit a relatively high level of exposure, both in terms of frequency and distance traveled. Although the distance traveled per activity is relatively short, these activities are repeated frequently during working hours. The accumulation of these repetitive activities results in a significant total distance traveled in a single day.

This situation aligns with the facts on the ground, where research revealed that workers handle large amounts of weight during the work process. This high volume of work results in a significantly higher lifting frequency. This is evident from the distance of 12 meters per lift, with a frequency of tens to hundreds of lifts per day, resulting in a total distance traveled of more than 1 km. This is why time is a factor contributing to the very high level of risk in manual material handling activities for porters at the Bulog Gorontalo warehouse.

In industrial ergonomics theory, carrying a load over long distances can cause physical stress, leading to fatigue and an increased risk of injury (Tarwaka, 2019). This theory is reinforced in research.Ni Putu (2022), which states that long haul distances can pose health risks, because long hauls exceeding the body's ability to handle the load or the ability to deliver goods from one place to another can cause excessive muscle contractions. Prolonged muscle contractions result in stronger and longer-lasting stimuli, and heavier loads can cause muscle pain.

In the context of research on Bulog Gorontalo warehouse porters, the high frequency of lifting which impacts the total daily distance traveled indicates that there is considerable work time pressure on porters, which has the potential to cause health risks if not balanced with ergonomic work arrangements.

Indicators of poor ergonomic work posture also exacerbate the risk level. When lifting, workers often use a hunched or non-neutral body position. This unergonomic posture causes uneven load distribution across the body, increasing pressure on certain areas, such as the back. This condition increases the risk of injury compared to lifting with proper posture.

Porters at the Bulog Gorontalo warehouse have a slightly forward posture, with their loads close to their bodies and above shoulder height. This condition may be influenced by the nature of the work, which requires workers to maintain balance during the moving process. This also aligns with field observations: when lifting rice without stacking it, workers carry the load on their shoulders with their bodies slightly bent forward. This position is a natural adjustment for the body to keep the load close to the body's center of gravity, thus increasing stability when carried.

In scientific ergonomics theory, risk is determined not only by the weight of the load, but also by how it is lifted, moved, and controlled during work activities (Tarwaka, 2019). This aligns with research by Azwar

(2020), which states that to maintain balance, the body naturally adjusts its position when carrying a load, so a load position closer to the center of the body is more stable.

The presence of workers with a significantly bent posture indicates that some workers still engage in activities with more risky postures. Based on field conditions, this occurs among workers who predominantly lift stacked loads, such as 12 kg cartons of oil stacked in three or four pieces. In these conditions, workers must bend significantly to maintain proper support and prevent the load from falling backward. This position shifts the center of gravity away from the body, forcing workers to adjust their posture by bending more deeply or significantly further.

Work posture theory in industrial ergonomics explains that a hunched posture that is too far forward causes the body to be unnatural and unergonomic because the load is not only supported by the muscles but also puts considerable pressure on the spine (Tarwaka, 2019). This is in line with research conducted byAulia et al., (2023) which states that unnatural and forced working postures, especially prolonged hunched positions, can increase the risk of lower back pain. This is due to increased pressure on the spine and restricted blood flow to the muscles, which can lead to fatigue and pain.

The predominance of workers with a slightly hunched posture on the posture indicator does not necessarily indicate that work activities are safe, but rather illustrates that the majority of workers are in a "fairly safe but risky" condition. This means that if ergonomic improvements or interventions are not made, this condition has the potential to develop into a higher risk, especially for workers with a significantly hunched posture. Therefore, corrective measures are needed, such as regulating more ergonomic lifting techniques or using assistive devices to reduce stress on workers' bodies.

The MMH working condition indicator rating for porters at the Bulog Gorontalo Warehouse shows that all respondents work in relatively good working conditions, thus not adding to the risk burden in their activities.*manual material handling*This condition aligns with field observations, which show that the work environment at the Bulog Gorontalo warehouse offers ample space for workers to move freely. This is evident during work activities, where workers can walk side by side, two to three people, without encountering any obstacles when carrying or moving loads. Furthermore, lighting conditions inside the warehouse are considered good due to the extensive, open ventilation, allowing sunlight to enter optimally and illuminate the work area.

Another aspect of the field conditions at the Bulog Gorontalo warehouse that supports good working conditions is the absence of materials or obstacles in the work path that could interfere with workers carrying loads. The warehouse's cargo paths are also clean and well-organized, minimizing the risk of tripping or falling. Furthermore, the level floor conditions contribute to worker safety and comfort when lifting and moving loads. This indicates that working conditions do not pose an additional risk factor because the work environment is adequate and contributes to more effective work performance.

In theory, working conditions are conditions that exist around the workplace that will influence workers both directly and indirectly in their work. The results of this study are in line with the results of research conducted byKasjono & Pandini (2017), namely in brick making workers carry out their work in good ergonomic conditions, nothing hinders the workload and good lighting.

Although working conditions such as spacious spaces, good lighting, and flat floors are supportive, these factors do not significantly reduce the overall risk level. This is because load, time, and posture factors have a much higher score in determining the final MMH score or risk than work environment conditions. Therefore, the final score obtained by all respondents is included in the risk level 4 (very high), meaning that immediate changes and improvements are needed, through technical and organizational improvements to reduce risk.

The results of this study are in line with the results of research by Gunawan et al., (2025) which shows that the weight of the load, work posture, work time mutually reinforce the level of manual handling risk experienced by roustabout employees so that they are in the high risk category. The results of this study are also in line with the results of research by simanjuntak et al., (2011) which shows that work with a final score of the leitmerkmal method at a very high risk level (level 4) indicates that the work situation is in a condition of

high workload and excessive physical loading often occurs, preventive means are that changes and improvements must be made immediately, through technical and organizational improvements to reduce risk.

V. CONCLUSION

This study shows that all porters at the Perum BULOG Gorontalo Warehouse have a very high level of manual material handling risk based on an assessment using the Leitmerkmal Method (LMM). The high level of risk is mainly influenced by a combination of lifting loads exceeding 40 kg, high daily transport frequency and distance, and a work posture that is still dominated by a bent position, even though the work environment conditions generally meet ergonomic aspects. These findings indicate that load factors, working time, and body posture contribute more to increased risk than working conditions. The limitations of this study lie in the use of a descriptive design that only describes the level of risk without analyzing the relationship between variables or individual worker factors, and the implementation of the study which was only conducted at one location so that the results cannot be generalized to other logistics sectors.

Based on these results, technical and organizational improvement efforts are needed through the application of ergonomic principles, such as setting lifting load limits, using material handling aids, improving lifting techniques, and setting rest periods to reduce the risk of musculoskeletal disorders in workers. Further research is recommended to use an analytical design with a wider coverage of locations and examine the relationship between individual factors, job characteristics, and musculoskeletal disorders complaints with the risk level of manual material handling so that it can produce more comprehensive and evidence-based ergonomic control recommendations.

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