



The Strategy of Workforce Management Based on Risk Assessment of Manual Handling Work with Suitability of Work Environment in Makasar Industrial Area, Indonesia

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Abstract

BACKGROUND: A good work environment suitability has a major impact on health and safety, and it encourages a more productive workforce. When it is incompatible with labor, it can lead to unintended impacts and various risks.

AIM: We aimed to investigate the strategy of workforce management based on risk assessment of manual handling work with suitability of work environment in Makasar industrial area, Indonesia.

METHODS: Twenty three workforce samples are selected from Makassar Industrial Area (KIMA), Indonesia. The risk of manual handling work is assessed based on the suitability of the work environment to the workforce's response using Guttman scale, in which the answer YES = 1 means there is a risk, while the answer NO = 0 means there is no risk. However, the scales are the reproducibility coefficient ≥ 0.90 and scalability coefficient ≥ 0.60 , and Guttman scale score is calculated from $T_n = \text{total answers of "YES" for the KPI in the scale}$. Meanwhile, the SWOT-4Q is used to analyze the strategy of industry supervisor samples.

RESULTS: For the workforce, eight of nine risk assessments do not show risk, and only "high vibration intensity in the workplace," with a percentage of 78.26%, affects the excessive condition. The strategy used by the supervisors in quadrant I is in accordance with the strength of the risk assessment and has a great opportunity to reduce risk. The management maximally exploits the big opportunity of the manual handling work.

CONCLUSIONS: The results showed that most of the workforce did not experience the risk of manual handling work with the suitability of the work environment. In addition, industrial supervisors should implement a growth strategy because they can enlarge the industry by taking advantage of the advantages of manual handling work to maximize the exploitation of large manual handling work opportunities.

Edited by: Sasho Stolecki
Citation: Basri K, Basri KS. The Strategy of Workforce Management Based on Risk Assessment of Manual Handling Work with Suitability of Work Environment in Makasar Industrial Area, Indonesia. Open Access Maced J Med Sci. 2022 Mar 26; 10(E):888-893. <https://doi.org/10.3889/oamjms.2022.8433>
Keywords: Work environment; Most with no risk; Growth strategy
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Received: 29-Dec-2021
Revised: 17-Jan-2022
Accepted: 16-Mar-2022
Copyright: © 2022 Basri K, Sarinah Basri K
Funding: This research did not receive any financial support
Competing Interests: The authors have declared that no competing interests exist
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Introduction

The work environment is important in an organization [1]. It has become an essential component of work-life for the workforces because they spend most of their time at work [2]. A good work environment does affect the work health and attitude of the workforces in their work [3]. The risk factors in the work environment could include season, lighting, rooms, floors, and slippery flat spaces that a person steps on while carrying burdens. The slippery floors, in particular, are usually because of bumpy as well as messy workplace [3], [4], [5], [6], [7], [8]. It is worth noting that the extreme work environment like heat, coldness, wind, and humidity need to be assessed [9], [10], [11], [12], [13], [14], [15], [16], [17], [18].

The assessment must be done if there is a high vibration intensity in the workplace, manual handling work done in closed rooms, unsatisfied lighting intensity to do manual handling work, not well-maintained floor stairs, ladder, and passage, and a high degree of smoke,

dust, gas, and vapor [19], [20]. A clean and healthy work environment can minimize diseases on one side, and it provides a work atmosphere that motivates the workforces to do their best on the other. Then, such conditions can protect the workforce from workplace accidents as long as there is no additional work burden such as the unprofitable condition or annoying work environment [7]. It is suggested to arrange it in such a way therefore that such factors be not the additional burden [6].

Therefore, a new work environment will arise along with the application of technology in the production and distribution process. For example, the dry temperature around 30°C–34°C, even up to 40°C or 45°C, can be neutralized [8]. It is acknowledged that there is a relationship between blood pressure and work shift in the workforce. Then, lighting can often be a cause of dazzling for the workforce. The source of lighting, therefore, needs to be well managed [8], [9]. However, the lighting must be suitable for the work environment to avoid unwanted impacts, as reported by research

on the epidemiology of cardiovascular and work environments [11]. It relates to many nonchemical factors dealing with stress in the work environment, physical activities in workplaces, work shifts, noises, and electromagnetic areas.

International Labour Organization (2016) notes that more and more evidence has pointed to the effects of psychosocial risk and associated with job pressure on the health, safety, and welfare of workers and organizations [21]. The research shows a relationship between work volume, work control, social relationship in a work environment with mental exhaustion, physical work burden, and musculoskeletal morbidity at the neck, shoulder, and extremity, and lower part of the body of the workforce [13]. Work environments also relate to the risk of other diseases as evidenced by studies on vibration affecting the whole body, hardworking, rotating or bending or standing many times, and concentrating demand, which are the risky factors for waist pain [12]. The risk of the disease will be more severe if such movements are adjusted for a certain age, gender, education, and work duration. It is even indicated by other studies that high work requirements, low policy on skills, and low security can be the risk factors to cause neck pain, and the work shift is not obeyed [14].

At least there is other research that has a higher prevalence of almost every work environment factor [15]. The use of the Copenhagen Psychosocial Questionnaire also demonstrates the relevance of the work environment by facilitating the researcher's adjustment to the work environment and workplace [16]. It is difficult for the workforces over 60 years of age to participate due to such a bad work environment [19]. However, the perception toward the better change of work environment is well concluded using the Work Environment Impact Scale model, which is beneficial to give information for the change, and the accommodation in the work environment can contribute to individual workforce [20].

So far, much research has been done on workforces applying various methods presenting risk assessments of manual handling work with the suitability of the work environment. However, the lack of research exploring management strategies for workforces exposed to risk in manual handling work is the main reason this study is being conducted. Likewise, Makassar Industrial Area (Kawasan Industri Makassar/KIMA) in Indonesia, a timber export management industry, became the research location with the consideration that it was easy to find industrial workforces who worked manually handling with the suitability of the work environment in that location. The Guttman scale was used to assess the risk of manual handling work with the suitability of the work environment. Using the risk assessment applying the Design of SWOT-4Q, the industry supervisors were investigated to analyze their strategy in managing the workforces based on the risk assessments provided.

Methods

Research type

This is quantitative research applying a survey design [22]. The research needs a certain number of respondents to complete a standard questionnaire in the form of a list of observations with risk identification, checklists of risk assessment factors, risk assessment spreadsheets, and risk control spreadsheets. Another instrument is about management strategy given to industry supervisors of workforces in the industry area. The research was conducted in the Makassar Industry Area (KIMA), South Sulawesi, Indonesia.

Population and samples

This research applies the so-called saturated samples, meaning the population is the sample [23], and due to the population being under 30, there are 23 workforces doing the manual handling work. They all were found to have fulfilled seven ways of manual handling work with the suitability of the work environment based on the risk assessment, including lifting, putting down, pushing, pulling, holding back or restraining, carrying, and dislocating burdens. Meanwhile, the total industry supervisor samples were decided, adjusting the number of workforces in the industry. Thus, the samples included production managers and HRD/PR managers.

Research instrument

The detail of the research instrument for both the workforces and industry supervisors is presented in Table 1 enclosed in this writing.

Technique and procedure of data collection

The techniques of data collection applied in this research include observation and closed interview. The observation took place when the workforces were doing manual handling work, while the closed interview took place before, during, and after the workforces did the manual handling work. At the same time, data collection on industrial supervisors' strategies in managing the workforce based on the risk assessment of manual handling work suitable with the environment also used those two procedures.

Data processing and data analysis

Data processing

The data processing refers to data distribution of risk assessment of manual handling work with the suitability of work environment toward the workforces,

Table 1: Details of instrument for workforces and industry supervisors

Variable	Instrument		Assessment/design	Average of answers		Samples
	Indicator	KPI		Worth	Value	
Risk assessment of manual handling work with the suitability of work environment	2	9	Guttman scale (quantitative)	Workforces (1–100)	-	Workforces
Strategy of managing workforces based on the risk assessments of manual handling work with the suitability of work environment	2	9	SWOT-4Q (quantitative)	Industry supervisors (1–100)	Workforces (1–100)	Industry supervisor
Total	4	18				

SWOT: Strength, weakness, opportunity, and threat.

where YES = 1 is used to answer KPI if there is an increase of risk of manual handling, while NO = 0 is used if there is no risk of manual handling.

Then, the steps recommended [24], [25] were implemented, including (a) organizing nine KPI; (b) doing KPI pretest of sample $n = 23$ workforces; (c) ignoring KPI of extreme answers; (d) ordering the answers in Guttman table according to increasing total scores, while in the column, the KPI is ordered according to the increasing answers; (e) calculating the reproducibility coefficient (RC) and the scalability coefficient (SC), and the scale of $RC \geq 0.90$ and of $SC \geq 0.60$ can be accepted, and (f) the score of Guttman scale is calculated from the $T_n = \text{total answers of "YES"}$ for the KPI in the scale.

From the result of the calculation above, it is obtained that RC is $1 - e/n = 1 - 8/207 = 0.96$, and it is accepted because 0.96 is higher than 0.90 ($0.961 > 0.90$). Similarly, the SC is $1 - e/x = 1 - 8/0.5 (148) = 0.892$, and it is accepted because 0.892 is higher than 0.60 ($0.892 > 0.60$).

Data analysis

The data analysis includes the data of risk assessment and the data of SWOT-4Q design.

1. The risk assessment of manual handling work with the suitability of the work environment.

Based on the data processing toward the risk assessment of the manual handling work suitable with the work environment presented above, the data are analyzed using descriptive statistics. The result of this analysis is continued with the analysis of the workforces' management strategy, which is suitable for the work environment.

2. The SWOT-4Q design.

The data analysis of workforce management is done by applying SWOT-4Q design to analyze the strategy of workforce management based on: a) result of workforce data based on the risk assessment of manual handling work with the suitability of work environment and b) result of supervisor data based on the result of risk assessment data of the manual handling work with the suitability of the work environment. The framework of the concept of SWOT-4Q matrices and steps of ordering matrices based on which the average score of the strategy of industry counselor is obtained [26].

Results

Based on the suitability assessment, 71.50% of the workforces did not experience risk in their work environment (Table 2) regarded as the positive factors of the passive statement of its KPI.

Table 2: Results of data about the risk assessment of manual handling work with the suitability of work environment

Number	Indicator/KPI	Answers (%)	
		Yes	No
	Environment condition		
1	Extreme work environment: Hot, cold, windy, or humid	43.48	56.52
2	High vibration intensity in the workplace	78.26	21.74
3	Unsatisfied lighting intensity of lighting to do manual handling work	17.39	82.61
4	High degree of smoke, dust, gas, or vapor	17.39	82.61
	Work condition		
1	Slippery and bumpy floor	13.04	86.96
2	Different altitude floors in the workplace	21.74	78.26
3	Sloppy workplace because of carelessness	30.43	69.57
4	Manual handling work done in closed space (room)	26.09	73.91
5	Not well-maintained floor stairs, ladder, and passage	8.70	91.30
	Average	28.50	71.50

KPI: Key performance indicators.

Then, of the nine assessments, it is interesting that only "high vibration intensity in the workplace," with a percentage of 78.26%, shows risk, such as backbone pains. However, there is one other that is close to the risk percentage limit, that is, "extreme work environment: hot, cold, wind, or humid" with a percentage of 43.48%. If it is not anticipated, it causes excess heat and humidity to increase the total physical load on the workforce leading to increased fatigue and greater risk. Low temperatures also increase cardiovascular and respiratory, and high temperatures increase acute nonspecific symptoms, for example, dry eyes and respiratory symptoms [27].

The analysis of SWOT-4Q results of the work environment

Based on the SWOT-4Q analysis and the data presented in Table 3, the average total value is calculated based on which the difference of average value is also calculated (Table 4). Since the difference between both average values is positive, the strategy is between quadrant I, as shown in Figure 1.

Description: S = Strength; W = Weakness; O = Opportunity; and T = Threat.

Figure 1 presents the reason why industry supervisors should apply a growth strategy agreed with the strength of risk assessment and the big opportunity of the available risk decreases. It is, therefore, the management

Table 3: Results of data analysis about the management strategy of workforces based on risk assessment of manual handling work with the suitability of work environment

KPI for workforces (a)	Answer (%)		The strategy of industry supervisors (d)	Worth (%)			
	Yes (b)	No (c)		S (e)	W (f)	O (g)	T (h)
1. Floor condition and its bumpy floor surface	13.04	86.96	S: Standard work area, which the floor and surface suitable for foot support (stepping stone) of workforces O: The low risk for workforces to get slipped or stubbed as they comfortably step	13.5	■	■	■
2. Different floor heights in the workplace	21.74	78.26	S: The height of the floor can be adjusted with the process of manual handling work in the work base (anvil) O: Workforces feel more comfortable as they know their workload can be finished because the floor height is suitably standard in the workplace	11.5	■	■	■
3. Disorderly workplace because of carelessness	30.43	69.57	S: The workplace facilitates the workforce to move back and forth as it is free from particles (dust) and oil O: Reduce danger risk for the workforces to act	11.0	■	■	■
4. Extreme work environment: Hot, cold, windy, humid	43.48	56.52	S: Placement of the work process according to the work area, and the work area is equipped with adequate ventilation and lighting, as well as free and comfortable air circulation O: Maintain the health of the workforce; and the result of the work process is stable to temperature, humidity, and to controlled objects	11.5	■	■	■
5. High vibration intensity in the workforce	78.26	21.74	W: The work base (anvil) has no device to reduce noise and preventive vibration T: The work results are not kept from vibration that can destroy to happen, and the health of workforces is not kept maintained, mainly their hearing and preventive	100	■	■	■
6. Manual handling work done in a closed space (room)	26.09	73.91	S: The placement of the work is neatly arranged because it is in an open space, and air circulation always blows maximally, which means the workforce is comfortable in manual handling work and the work base is maintained stable O: Comfort of the workforces, the temperature stability in workplaces and work base, and free from firing. The workforces, work tools, and the like are easily evacuated when there is an accident	11.5	■	■	■
7. Unsatisfied lighting intensity to do manual handling work	17.39	82.61	S: There are lighting tools on the work base, the light intensity fits the NAB, and natural lightening because of the open work area O: Reduce the risk of manual handling work and the risk of the work accident, and the quality of work burden can be controlled	13.5	■	■	■
8. Not well-maintained floor stairs, ladder, and passage	8.70	91.30	S: The passage is free for work movement, and the scheme of the work process is gradually suitable with the level and types of work O: The transport process of products is faster, and the movement of workforces is more efficient and free	14.5	■	■	■
9. High degree of smoke, dust, gas, and vapor	17.39	82.61	S: Each work bases is facilitated with a dash collector, and the chimney is higher than the building O: The breathing heart of the workforces is well kept. There is no doubt in doing the manual handling work	13.5	■	■	■
Averagea (%)	28.50	71.50	Total (%)	100	100	100	100

S: Strength, W: Weakness, O: Opportunity, T: Threat

Table 4: Difference of average value of result analysis of management strategy of workforces based on risk assessment of manual handling work with the suitability of work environment

Average	Difference	Value
The average value of strength		7893.50
The average value of weakness		7826.00
	Positive Difference	67.50
The average value of opportunity		7888.90
The average value of threat		7826.00
	Positive Difference	62.90

maximally exploits big opportunity of manual handling work by using the strategies such as (a) providing criteria of work standard; (b) fulfilling criteria of work safety and health of the workforces in their work environment proving minimal risk (28.50) because of the following reasons; (a) the floors are flat and are not slippery, meaning nobody is lapsed and stubbed when dealing with big size materials; (b) the flat surface of floors avoiding the workforces from falling down and getting seriously tired; (c) good care on tidiness in the workplace has made the work can go on well; (d) a conducive work environment agreed with any change of weather; (e) the work is done in open spaces that make the workforces feel unhampered when finishing work; (f) a satisfied lightening intensity which is good to finish manual handling works satisfactorily; thus, no physical accident happens; (g) condition of floor stairs, ladder, and passage is well kept avoiding accidents to happen; and (h) no dangerous substance found that can affect the ability of the workforces in doing the manual handling work.

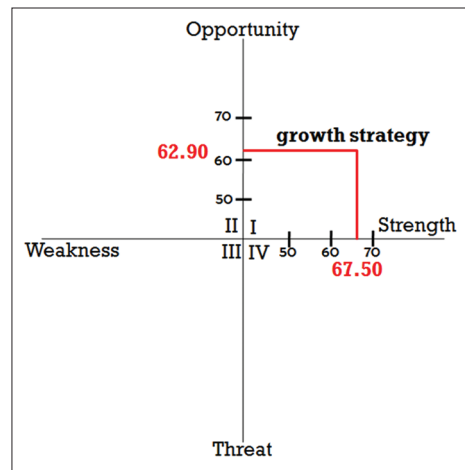


Figure 1: Position of growth strategy towards the suitability of work environment

Discussion

This section deals with the discussion of the risk assessment of manual handling work with the suitability of the work environment. Based on the result analysis, as shown by the data in Table 3, 71.50% of the workforces did not experience work risk. One out of nine suitability assessments shows an increase, that is, there is “high vibration intensity in the workplace,” with a percentage of 78.26%. This vibration has caused work risk because the seats or floors vibrated affecting the

whole body, mainly the painful backbone. In addition, such bad conditions also caused hands touching or holding electricity tools to be painful. That kind of vibration can affect the whole body, mainly the waist, feeling pain because of often turning around, bending, standing, concentrating, and so on [12].

However, the other one of the assessments approaches a risk percentage limit, that is, there is an "extreme work environment, such as hot, cold, windy, or humid" with a percentage of 43.48%. If this condition is not anticipated, feeling hotter or more humid will affect more burden of the whole body of the workforces leading to feeling more exhaustive easily and certainly higher work risk. Therefore, it is important to suggest that the wet or moist temperature of 30°C must be related to the humidity of 65%–95%, regarded as a guide to protect workforces from the bad work temperature [8].

The discussion of the result of SWOT-4Q design toward the suitability of the work environment is presented next. The industry supervisors should apply the growth strategy, as has been proved by the analysis result shown based on the data in Table 4. This growth strategy agrees with the strength of its risk assessment and the magnitude of the available risk reduction opportunities, which seeks to enlarge the industry by taking advantage of the advantages of manual handling work with the suitability of the work environment that has successfully assessed its risks to maximize the exploitation of large manual handling work opportunities.

This strategy to manage the work environment has proved to have minimal risk (only an average of 22.22%) due to the following reasons based on the data. First, the percentage of minimum risk of uneven or slippery floor conditions and the bumpy floor surface is 13.04%, caused by the presence of strength in the work area that is in accordance with standards, and the floor and surface of the work area to stand on are also in accordance with the foot pedestal of the workforce so that it provides opportunities for workforces to safe to work. This result rejects the concerns of a study that states the floor and other surfaces under the feet are one of the factors in the work environment that influence the risk for slips, trips, and falls while handling loads [4]. Second, the risk probability of different floor heights in the workplace is only 21.74% due to the strength at the floor height, which is adjusted to the manual handling work process on the work base. Therefore, it provides the opportunity for the workforce to be more comfortable and attentive to complete the workload because of the suitability of the floor height in the workplace. Such condition has helped the workforces to be free from work risks of falling or being injured by fatigue. Third, the workplace is neat and well organized. It is only 30.43% of the observation concluded that the workplace is untidy due to a lack of attention. This is also another strength obtained from the workplace that has facilitated the workforces to move back and

forth, freeing them from particles such as dust and oil. This condition has minimized dangerous risks for the workforces. Fourth, the risk percentage of extreme work environment: heat, cold, wind, or humidity is 43.48% as a result of the work area equipped with ventilation and lighting, as well as free and comfortable air circulation. Accordingly, it has the opportunity to maintain the health of the workforce, which guarantees stable work results and controls humid temperature leading to finishing manual handling work effectively.

Fifth, the possibility of manual handling work being carried out in a closed room is only 26.09%, which means most of the manual handling work is done in an open space or room. This is another strength because orderly placing the work results in the open space of maximal air circulation. This condition helped the workforce to do manual handling work comfortably and stably. Sixth, the minimal risk of not having enough lighting intensity to carry out manual handling work is only 17.39%. This is in line with the existence of lighting equipment on each or above the work base, the intensity of light in accordance with the permitted NAM, and natural lighting because the work area is open. These conditions helped minimize risks of manual handling work and accidents happen and control the quality of work burden. From the industry supervisors' side, the satisfied lightening intensity has helped to do the manual handling work well, and the workforces are free from any accidents, as it is suggested by Ridley (2008) to provide enough light for the sensitive or soft work [3]. It is very necessary to avoid eye injury or aberration [10]. Similarly, the unsatisfied lighting intensity in workplaces can cause eye exhaustion [6], [7]. Seventh, the floor stairs, ladder, and passage have been well cared for. The risk of these things being treated badly is only 8.70%. This is also a strength of the management strategy, that is, the passage must be free to move, to go, and to come during doing the manual handling work. The process scheme must be gradually placed suitably with levels and kinds of work. This all has made carriage or transport process of products easily and quickly done, and the movement of the workforces is more efficient and freely. Eighth, the last risk assessment is the suitable thickness of smoke, dust, gas, and vapor, which the bad risk is only 17.39%. This is the last strength shown by the research data, where each work base is facilitated with a satisfied dash collector and a higher chimney than its building. This has given a good opportunity for the workforces to keep healthy respiration when doing the manual handling work. This finding supports that the shift worker groups show a higher prevalence than almost all worse work environment factors [15]. However, there is an exception, that is, about the dust, or the dangerous vapor that has a big impact on the health or the attitude of the workforces [3]. The minimal risk rejects fears resulting from gas, vapor, smoke, and dust breathed, which then affects the whole body to function optimally, leading to decreasing the work capacity [6], [7].

Conclusion

Most of the workforce did not experience the risk of manual handling work with the suitability of the work environment. Industrial supervisors should implement a growth strategy in accordance with the strength of their assessment and the amount of risk reduction available, in which they try to enlarge the industry by taking advantage of the advantages of manual handling work with the suitability of the work environment that has successfully assessed the risks to maximize the exploitation of large manual handling work opportunities. Which was valued at the risk of becoming increasingly involved in exploiting the opportunities of great manual handling works.

Acknowledgments

The author would like to thank the Chairman of Nusa Cendana University for allowing the writer to do this research in Makassar, South Sulawesi. The writer also extends the writer's heartfelt thanks to the Governor of South Sulawesi, who has facilitated the administration of this research.

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