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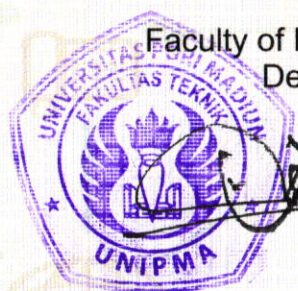
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Preface

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Preface

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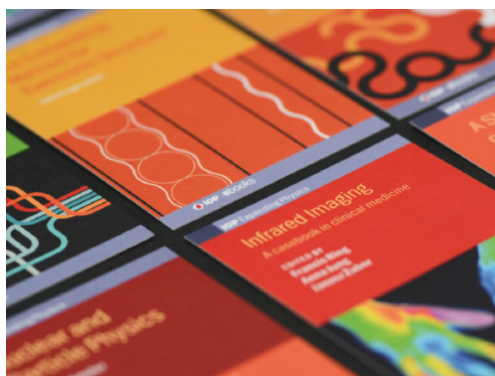
Preface

The Faculty of Engineering, Universitas PGRI, Madiun organized the 1st International Conference on Engineering and Applied Science (ICEAS 2019) on 21st August 2019 in Madiun, East Java, Indonesia. The ICEAS 2019 aims to exchange knowledge and research finding among academicians, researchers, profesionals, policy makers, and postgraduate students.

The awarness of research publication by lecturers,students, teachers, and practitioners in the Madiun area is still minimal. Because of that educational institution must be able to provide motivation and space for researcher to disseminate their research and accomodate the result of research that has been done. International Conference on Engineering and Applied Science or we call it ICEAS, is the first International Conference held by Engineering Faculty UNIPMA. This faculty have 5 departments, there are Informatics Engineering, Information System, Chemical Engineering, Industrial Engineering, and the last but not least is Electrical Engineering. This 5 departments are going through together to held this conference and brings the theme "Development of Engineering and Science Towards Revolution 4.0" .

ICEAS 2019 was attended by 158 participants, and a total of 70 papers were presented and discussed. The papers were authored by researchers from Timor Leste, Japan, and Indonesia. All papers have been scrutinized by a panel of reviewers who provide critical comments and corrections, and thereafter contributed to the improvement of the quality of the papers. Based on the reviewer's reports, 70 papers were selected and eligible to be published in the proceeding

We sincerely express our gratitude to the international/national advisory committee, presenters, organizing committee members, session chairs, the Dean and all members of the Faculty of Egnineering Universitas PGRI Madiun, student volunteers, participants, contributors and all the members ICEAS 2019. Last but not the least, we are thankful to IOP JPCS for producing the proceeding.

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Work posture analysis of gamelan craft center workers using quick methods of ergonomic risk assessment

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Work posture analysis of gamelan craft center workers using quick methods of ergonomic risk assessment

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Abstract. Gamelan craft center in Ponorogo Regency has many hazard factors and risks, one of which is ergonomic risk factors. Workers do work with bent postures, awkward postures, and frequent repetitive movements for a long time. This research aims to analyze the work posture of gamelan craft center workers using quick methods of ergonomic risk assessment. This research used the observational analytical study. Analysis of the work posture by using three methods are Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA) and Quick Exposure Checklist (QEC). Eight jobs were selected are divided into two task elements: the dominant task and risky task. Analysis of the research data using the Friedman non-parametric test. The result of work posture analysis shows that the final score in the three methods gets a high-risk level that is 56.25% (REBA), 43.75% (RULA), and 62.50% (QEC). Friedman test results showed the value of Chi-Square = 13.630, and the significant score is 0.003 (p < 0.05). So it can be concluded that the three ergonomic risk assessment methods have different effectiveness. Quick Exposure Check (QEC) is the best method among all three methods for the ergonomic risk assessment of gamelan center workers.

1. Introduction

Small and micro enterprises (SMEs) have difficulties managing Occupational Safety and Health (OSH) and hence, may experience poor OSH conditions and often lack systematic OSH management [1]. According to Sutjana, the challenge of applying OHS in the workplace is the OHS aspect does not provide benefits to industrial owners. OHS management priorities are still low and require a promotive program about OHS in the workplace [2]. Lack of the application of OSH to SMEs can result in increased workplace accidents and occupational diseases [3].

One of the SMEs in Ponorogo is a gamelan craft center that used zinc, brass, and bronze plate resources in its production process [4]. Most workers work in a seated position such as the process of cutting material (iron plates), forming the material into gamelan and the process of perfecting the gamelan (finishing). Workers often do their work with bent work postures, awkward postures, and doing repetitive movements for a long time. Un-ergonomic work posture is the ergonomic risk factors that have the potential to cause interference with skeletal muscles characterized by fatigue and pain in certain body parts [5].

The complaints caused by ergonomic risk factors can be prevented by conducting an ergonomic risk assessment. However, in the process, ergonomic risk cannot be assessed directly. Because it can disrupt the activities of workers so that most small and medium business owners, including gamelan craft, have never evaluated the work posture of their workers. Therefore, one way to resolve this is by using quick ergonomic risk assessment methods. Popular methods used are Rapid Entire Body Assessments

(REBA), Rapid Upper Limb Assessment (RULA) and Quick Exposure Check (QEC). These three methods have been widely used in identifying the level of ergonomic risk in various occupations with the primary factor being assessed is work posture [2,5,6]. This research aims to analyze the work posture of gamelan craft center workers using quick methods of ergonomic risk assessment.

2. Methods

This research used the observational analytical study. Analysis of the work posture by using three methods are REBA, RULA and QEC. The jobs selected to assess work posture are material preparation, cutting, moving, forming the iron plate, welding, combining gamelan, finishing, and rolling the gamelan. Dominant task and risky task are the basic task among those jobs. The dominant task is commonly done on the type of work. The risky task means an action tends to lead injury on the job and requires a lot of energy during the work [7]. The data of the research through the observation, documentation, interviews, and measurement of the components of:

2.1. Rapid Entire Body Assessment (REBA)

The work posture analysis using the REBA Assessment Excel Worksheet. The body part score that assessed was Group A (trunk, neck, legs) and Group B (upper arms, lower arms, wrists). An activity score represented type of muscle activity. Moreover the score is added to give the final REBA score. The observer converts the final REBA scores to the action levels (Table 1). These are bands of counts corresponding to increase urgency for the need to make changes [8].

Table 1. REBA Action Levels

REBA Score	Risk Level	Action Level	Action (including further assessment)
1	Negligible	0	None necessary
2-3	Low	1	Change may be needed
4-7	Medium	2	Further investigation, change soon
8-10	High	3	Investigate and implement change
11-15	Very high	4	Implement change

2.2. Rapid Upper Limb Assessment (RULA)

The measurement of work posture using the RULA Assessment Excel Worksheet. The body part score that assessed was Group A (arm and wrist) and Group B (neck, trunk, and legs). The postures are measured utilizing scoring sheet, body-part diagrams, and tables. Furthermore, the scores were transformed to be one of four action level [6].

Table 2. RULA Action Levels

RULA Score	Action Level	Action (including further assessment)
1-2	0	Acceptable if it is not maintained or repeated for long periods
3-4	1	Further investigation is needed, and changes may be required
5-6	2	Investigation and changes are required soon
7	3	Investigation and changes are required immediately

2.3. Quick Exposure Check (QEC)

The measurement of work posture using the QEC Calculation Tool Template. Assessment of the body part at the QEC methods includes back posture, back movement, shoulder/arm posture, shoulder/arm movement, wrist/hand posture, wrist/hand movement, neck, and worker's assessment. QEC assesses whether an ergonomic intervention can effectively reduce these exposure levels [6]. Assessment of QEC

has important role where exposure level calculated. The exposure level E is provided in percentage rate that determined the actual exposure score X and max possible total Xmax depicted in table 3.

$$E\ (\%) = \frac{X}{Xmax} + 100\%$$

Table 3. Preliminary Action Levels for the QEC

QEC Score (E) (percentage total)	Action	Equivalent RULA Score
$\leq 40\ \%$	Acceptable	1-2
41-50 %	Investigate further	3-4
51-70 %	Investigate further and change soon	5-6
>70%	Investigate and change immediately	7+

The collected data of the work postures with three ergonomic risk assessment methods, including the risk levels for each posture, were entered into SPSS version 20 for the next analysis [2]. At first, descriptive analysis was performed. The data were analyzed with the Shapiro-Wilk test (sample < 50) [9] for checking the normality distribution of data. Then Friedman non-parametric test for investigating the significant differences between the values.

3. Result and Discussion

3.1. Work Posture Assessment

The results of work posture assessment using the REBA Assessment Excel Worksheet, RULA Assessment Excel Worksheet, and QEC Calculation Tool Template. Point 1 means dominant tasks, and points 2 means a risky task is explained in table 4.

Table 4. Final Score REBA, RULA, QEC

No	Task	$REBA_1$	$REBA_2$	$RULA_1$	$RULA_2$	QEC_1	QEC_2
1	Material preparation	3	3	2	2	2	2
2	Cutting	4	4	3	3	2	3
3	Moving the iron plate	3	3	2	3	2	2
4	Forming the iron plate	2	3	1	1	1	2
5	Welding	3	3	2	2	2	2
6	Combining the gamelan	2	2	1	1	1	1
7	Finishing	3	3	2	2	2	2
8	Moving the gamelan	4	4	3	3	3	3

Based on table 4, the highest final scores are the task of cutting the iron plate and moving the gamelan. The work postures that are often done at the tasks are awkward and extreme posture, repeated positions for a long time and heavy load of the gamelan. The final score distribution in each method, as shown in table 5, 6, and 7.

3.1.1. REBA

Table 5. Final Score Distribution of REBA Assessment Excel Worksheet

Final REBA Score	N	Percentage	Action Level	Risk Level	Action
4-7	3	18.75 %	2	Medium	Further investigation, change soon
8-10	9	56.25 %	3	High	Investigate and implement change
11-15	4	25 %	4	Very High	Implement change
Total	16	100 %			

Table 5 shows that nine workers (56.25%) received a final REBA score of 8-10 with a high-risk level, so an investigation and implement change was needed.

3.1.2. RULA

Table 6. Final Score Distribution of RULA Assessment Excel Worksheet

Final RULA Score	N	Percentage	Action Level	Risk Level	Action
3-4	4	25 %	1	Medium	Further investigation is needed, and changes maybe required
5-6	7	43.75 %	2	High	Investigation and changes are required soon
7	5	31.25 %	3	Very High	Investigation and changes are required Immediately
Total	16	100 %			

Table 6 shows that twelve people (75%) received a high and very high-risk level that needed investigation and changes immediately.

3.1.3. QEC

Table 7. Distribution of QEC Calculation Tool Template

QEC Score (E) (percentage total)	N	Percentage	Action Level	Risk Level	Action
41-50 %	3	18.75 %	1	Medium	Investigate further
51-70%	10	62.5 %	2	High	Investigate further and change soon
>70%	3	18.75 %	3	Very High	Investigate and change immediately
Total	16	100 %			

Table 7 shows that ten workers (62.5%) received a QEC Score of 51-71% with a high-risk level that needed to investigate further and change action soon.

3.2. Analysis

The data were obtained from the three methods REBA, RULA, and QEC, as shown in Figures 1. In these figures, the colors indicate the action levels: the blue, red, and green colors show action levels 1, 2, and 3, respectively, in the three methods.
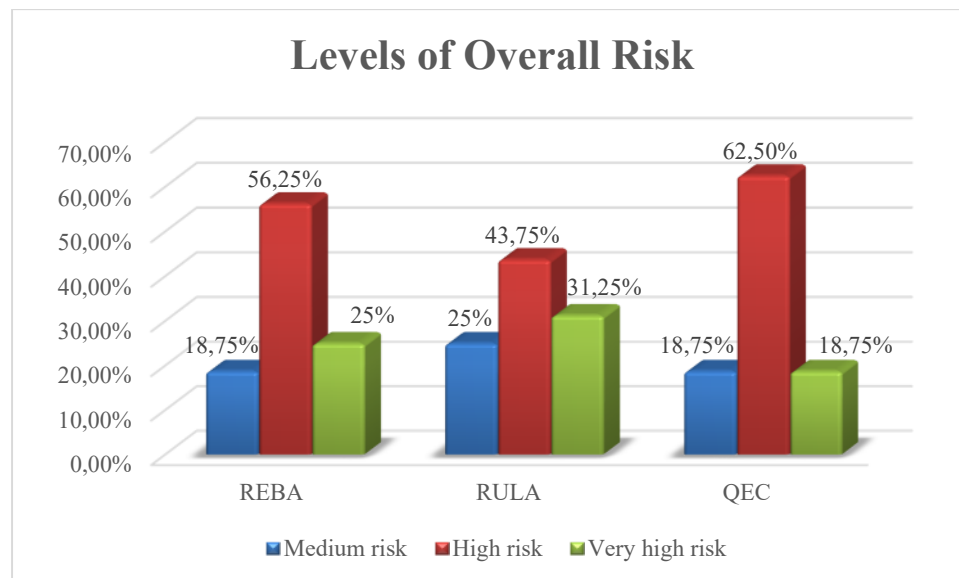

Figure 1. Levels of Overall Risk

Based on figure 1, ergonomic risk assessment using REBA, RULA, and QEC shows the final score in the three methods is at a high-risk level of 56.25% (REBA), 43.75% (RULA) and 62.50% (QEC). The action that needs to be done is to investigate further and change soon.

The results of the Shapiro-Wilk test showed that the distribution of data REBA, RULA, and QEC final score was not normal with Sig score is 0,001 ($p < 0,05$). Therefore, to find out the differences in the three methods used by the Friedman non-parametric test.

Tabel 8. Result of Friedman Non-Parametric Test

Methods	N	Std. Deviation	Chi-Square	Asymp. Sig
REBA	20	2.28		
RULA	20	2.83	13.630	0.003
QEC	20	2.88		

The result of the Friedman test showed the value of Chi-Square = 13.630, and the significant score is 0.003 ($p < 0.05$). So it can be concluded that the three ergonomic risk assessment methods have different effectiveness. The highest assessment of work posture effectiveness is by using the QEC method (std. deviation = 2.88).

Based on sensitivity and usability, QEC has a high level position. This makes QEC mostly acceptable inter and intra-observer reliability [6]. It leads that QEC has widely used of tasks based on field studies [6]. The statement supports the results of the work posture assessment in which the QEC method is most useful for assessing the work posture of gamelan craft center workers in Ponorogo Regency..

The tasks that get a high-risk level is cutting the iron plate and moving the gamelan. The work postures that are often done at the tasks are awkward and extreme postures, repeated position for a long time and heavy load of the gamelan. Besides, most of the work is done in a sitting position. Possible

actions to reduce the high-risk level are using an auxiliary machine to lifting the gamelan and suggesting frequently breaks allowed to reduce risk level of repeated tasks.

A study conducted by Ferdiansyah claimed suggested that Strain Index should be used to measure work. This fact had been shown by validity, sensitivity, and reliability testing on ergonomic evaluation methods. This indicated the primarily task using dominant hand movements [10]. Moreover, the REBA is also more sensitive compare to other methods which measure risk elements [10]. Other research that was also evaluating the work posture risk level has shown that there is no significant difference between the REBA, OWAS, and QEC methods. Also, there is a positive correlation between the three methods. The research is about comparing the sensitivity of the REBA, OWAS, and QEC methods in analyzing postures for workers in WL Aluminum [11]. Based on these research studies shows that work posture can be assessed adequately according to task characteristics using quick ergonomic risk assessment methods such as REBA, RULA, QEC, etc.

4. Conclusions
The result of work posture analysis shows that the final score in the three methods (REBA, RULA, QEC) gets a high-risk level. The action that needs to be done is to investigate further and change soon. Quick Exposure Check (QEC) is the best method for the ergonomic risk assessment of gamelan center workers among all three methods (std. deviation = 2.88).

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