
ERGONOMIC RISK ANALYSIS USING QUICK EXPOSURE CHECK METHOD ON PRODUCTION EMPLOYEES AT CV MADYOTOMO

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ABSTRACT

CV Madyotomo is a printing company in Karanganyar, Central Java, that produces student worksheet books (LKS) through a series of manual and semi-mechanical production processes. Production employees are routinely exposed to repetitive manual handling, such as lifting paper rolls, feeding printing machines, and stacking finished books, which increases the risk of work-related musculoskeletal disorders when working postures are not properly managed. This study aims to assess the ergonomic risk level of production employees at CV Madyotomo using the Quick Exposure Check (QEC) method, which evaluates exposure based on back, shoulder/arm, wrist/hand, and neck posture combined with movement frequency, workload, and work duration. All 19 production employees across five workstations were involved as respondents through a total sampling technique, using paired observer and worker questionnaires. The results show that no workstation falls into the safe category, with average exposure levels ranging from 46.96% to 88.63%. The Goss and Stitching/Muller workstations recorded the highest exposure levels and require immediate corrective action, mainly due to manual paper-roll handling and repetitive lifting during the binding process. Ergonomic improvement recommendations include the provision of lifting aids, adjustment of work table and conveyor height, and administrative controls such as job rotation and stretching programs to reduce exposure levels and prevent musculoskeletal disorders among production employees.

KEYWORDS

Ergonomics; Quick Exposure Check; Musculoskeletal Disorders; Printing Industry; Work Posture



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INTRODUCTION

The printing industry is one of the manufacturing sectors that still relies heavily on manual work activities, such as repeatedly lifting, pushing, and moving raw materials and finished products. This sector also frequently faces production demands with tight time targets, making workers prone to prolonged exposure to unnatural working postures. Such conditions can trigger musculoskeletal disorders (MSDs) if not balanced with proper workplace layout and ergonomic work methods (Rosidah & Fahmi, 2025). MSDs are among the most common occupational diseases found in the manufacturing sector, with major risk factors including awkward posture, excessive load, repetitive movement, and prolonged exposure duration (Da Costa & Vieira, 2010).

CV Madyotomo is a printing company in Surakarta that produces Student Worksheet Books (LKS), located at Jl. Watuburik No. 10, Wonorejo, Gondangrejo Subdistrict, Karanganyar Regency, Central Java. The production process at this company involves five main workstations, namely the Harris Machine, Goss Machine, Sharpline Machine, Komori Lithrone Machine, and Stitching/Muller Machine, with a total of 19 employees in the production division. Work activities at these five stations generally involve lifting paper rolls, monitoring and feeding printing machines, stacking printed output, and binding processes carried out manually or semi-mechanically, which may pose ergonomic risks to production employees. Beyond ergonomic issues, CV Madyotomo has also previously been the subject of research related to production machine reliability, in which Alice et al. (2025) designed a preventive maintenance schedule for the Stitching/Muller Machine using the Reliability Centered Maintenance (RCM) method, showing that machine reliability and occupational safety at this company remain an ongoing concern, although the ergonomic aspects of production employees' work still require further study.

Various previous studies have shown that shop-floor problems, whether related to working posture or product quality, require systematic and measurable evaluation methods so that they can be properly followed up. Sepfrian et al. (2023) analyzed the working posture of sewing and overlock operators at PT Asiana Garment using the Rapid Entire Body Assessment (REBA) method, and found that sewing operators were at a medium risk level while overlock operators were at a high risk level, requiring a redesign of the work chair based on workers' anthropometric data. That study confirmed that posture-score-based methods can objectively map risk levels while also directing concrete recommendations for workplace facility improvement. On the other hand, in the context of production quality control, Diansari et al. (2024) applied the Statistical Quality Control (SQC) method to the foam cup printing process at PT. XYZ and found that although the production data on one machine was in control, the resulting capability process value (Cpk) was still below 1, meaning the process was not yet capable of meeting consumer specifications. This finding shows that threshold-category-based evaluation, whether for working posture or product quality, is still necessary to ensure that a condition that appears "in control" is not necessarily truly "safe" or "adequate", so that monitoring and follow-up must continue to be carried out on an ongoing basis.

One method commonly used to assess ergonomic risk based on posture and workload is the Quick Exposure Check (QEC). This method assesses a worker's risk exposure level based on a combination of posture observation by the researcher (back, shoulder/arm, wrist/hand, and neck) and the worker's perception of workload, duration, and stress level (Patradhiani et al., 2025). Research by Hermawan and Sugiono (2024) at CV Jade Indoprata, a printing company in Malang, used the QEC method and the Ovako Work Posture Analysis System (OWAS) and found that the printing and binding processes

were the dominant source of MSD complaints due to stooped posture and repetitive movement. Affandi (2024) also showed that the QEC method is effective for identifying the body segments with the highest risk levels in high-intensity manual work. Meanwhile, Wulandari and Saputra (2025), in the book-packaging industry, found that adjusting work table height significantly lowered the QEC exposure level, while Kusumadewi et al. (2025) emphasized the importance of anthropometric data as the basis for designing ergonomic work facilities. Besides QEC, hazard-identification-based approaches such as the Bowtie method have also been used across various industrial sectors to more comprehensively map sources of ergonomic risk (Ispasoiu et al., 2021).

Based on the description above, an ergonomic risk evaluation of CV Madyotomo's production employees is important to conduct, given that their work activities involve manual lifting and static working postures over long durations, yet an objective assessment using the QEC method has never been carried out across all workstations at the company. This study aims to analyze the ergonomic risk level of CV Madyotomo's production employees using the Quick Exposure Check (QEC) method across five workstations, and to formulate ergonomic improvement recommendations based on the assessment results.

RESEARCH METHOD

This study is a descriptive quantitative study aiming to objectively measure the ergonomic risk level of CV Madyotomo's production employees using the Quick Exposure Check (QEC) method. The object of the study is CV Madyotomo, a printing company that produces Student Worksheet Books (LKS), located at Jl. Watuburik No. 10, Wonorejo, Gondangrejo Subdistrict, Karanganyar Regency, Central Java.

The study population covers all 30 employees of CV Madyotomo, 19 of whom work in the production division, divided into five workstations: SK-1 (Harris Machine), SK-2 (Goss Machine), SK-3 (Sharpline Machine), SK-4 (Komori Lithrone Machine), and SK-5 (Stitching/Muller Machine). The sample was determined using the total sampling (saturated sampling) method, meaning all 19 production employees were made respondents of the study, given that the relatively small population size allowed all of them to be reached and included without a selection process.

QEC data collection was carried out through two stages of questionnaires: the observer questionnaire, completed by the researcher based on observation and documentation of employees' working postures, covering variables A through G (back posture, static/dynamic activity, working height, movement frequency, shoulder/arm posture, wrist posture, and neck posture); and the worker questionnaire, completed directly by the workers, covering variables H through O (workload, work duration, hand force exertion, visual demand, driving a vehicle/tool, vibration, work pace, and stress level).

The raw questionnaire scores were then converted using the QEC scoring tables to obtain an exposure score for each body category (back, shoulder/arm, wrist, and neck), which were subsequently summed into a total exposure score (X). This total score was converted into an exposure level percentage using the formula $E(\%) = (X / X \text{ maximum}) \times 100\%$, with the maximum X value set at 176.

Based on the exposure level calculations for each respondent, the average exposure score and exposure level were recapitulated for each workstation to determine improvement priorities. The analysis proceeded with formulating ergonomic improvement recommendations in the form of technical improvements (engineering control) and administrative improvements (administrative control) based on the workstations with the highest risk categories. The resulting exposure level was then grouped into four action categories as presented in Table 1.

Table 1. Action-Level Categories Based on QEC Exposure Level

QEC Score (%)	Category	Action
< 40%	Category 1	Safe
40 – 49%	Category 2	Further investigation needed
50 – 69%	Category 3	Immediate improvement needed
> 70%	Category 4	Urgent action required

Source: Patradhiani et al. (2025)

RESULT AND DISCUSSION

The study respondents consisted of 19 production employees of CV Madyotomo, all of whom were male, with ages ranging from 19 to 44 years. The distribution of respondents across workstations was 5 people at SK-1 (Harris Machine), 4 people at SK-2 (Goss Machine), 4 people at SK-3 (Sharpline Machine), 3 people at SK-4 (Komori Lithrone Machine), and 3 people at SK-5 (Stitching/Muller Machine).

The QEC measurement results for all respondents showed that of the 19 employees analyzed, only 1 respondent (5.3%) fell into Category 1 (safe), while 3 respondents (15.8%) fell into Category 2, 6 respondents (31.6%) fell into Category 3, and 9 respondents (47.4%) fell into Category 4, requiring further investigation and immediate improvement. The recapitulation of the average QEC exposure score and exposure level for each workstation is presented in Table 2.

Table 2. Recapitulation of Average QEC Exposure Score and Exposure Level per Workstation

Workstation	n	Back	Shoulder/ Arm	Wrist/ Hand	Neck	Total Score (X)	Exposure Level (%)	Category
SK-1 (Harris Machine)	5	28.80	32.80	26.80	11.60	112.00	63.63	Category 3
SK-2 (Goss Machine)	4	39.50	42.00	38.50	15.50	156.00	88.63	Category 4
SK-3 (Sharpline Machine)	4	23.00	32.50	27.00	13.00	106.00	60.22	Category 3
SK-4 (Komori Lithrone Machine)	3	13.33	24.00	20.66	12.00	82.66	46.96	Category 2
SK-5 (Stitching/Muller Machine)	3	34.00	30.00	30.00	14.00	125.66	71.40	Category 4

Source: Processed data (2026)

Based on Table 2, none of the workstations at CV Madyotomo fall into the safe category (Category 1). Workstation SK-2 (Goss Machine) has the highest average exposure level, at 88.63%, classified as Category 4, mainly due to the manual lifting and replacing of paper rolls, which involves repeated bending and twisting postures. Workstation SK-5 (Stitching/Muller Machine) ranks second with an exposure level of 71.40% (Category 4), related to the repeated lifting and stacking of book piles during the binding process. Workstation SK-1 (Harris Machine) and Workstation SK-3 (Sharpline Machine) fall into Category 3 with exposure levels of 63.63% and 60.22%, respectively, while Workstation SK-4 (Komori Lithrone Machine) recorded the lowest exposure level at 46.96%, yet still classified as Category 2, meaning it still requires further investigation rather than being in the safe category. A comparison of QEC exposure levels across all workstations is presented in Figure 1.

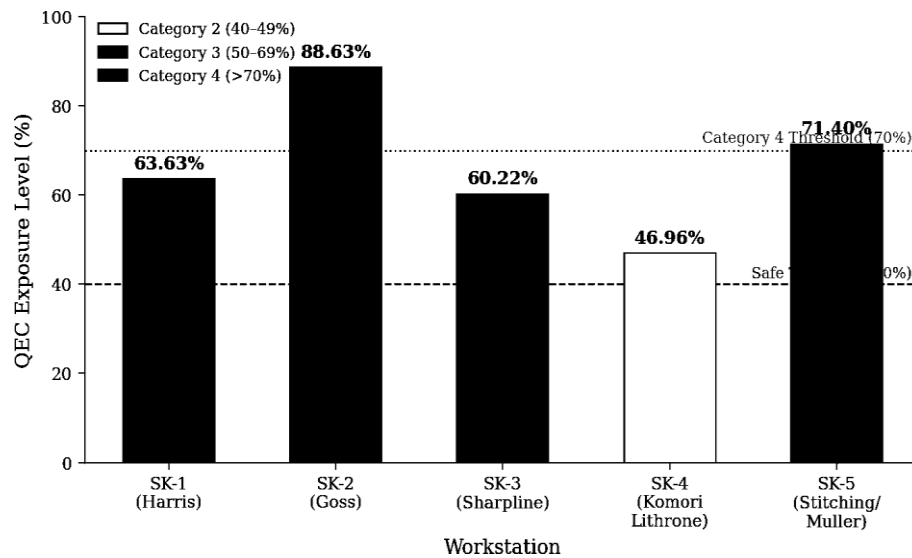


Figure 1. Chart of QEC Exposure Level per Workstation (Processed data, 2026)

This finding is consistent with the research by Hermawan and Sugiono (2024) at CV Jade Indoprata, which also found that the printing and binding processes in the printing industry were the main sources of ergonomic risk due to stooped posture and repetitive movement. Compared with the study by Patradhiani et al. (2025) on a small pempek-processing enterprise where all workstations fell into Category 4 with exposure levels between 80.68% and 92.04% because the production process was entirely manual, the results at CV Madyotomo show a more varied range of risk categories (Category 2 to Category 4). This variation indicates that workstations already assisted by automatic machines, such as the Komori Lithrone Machine, have a relatively lower risk exposure level compared to workstations still dominated by manual lifting activities, such as the Goss Machine and Stitching/Muller Machine, thereby confirming that manual handling activity remains a major risk factor regardless of the industrial sector (Da Costa & Vieira, 2010).

Compared with the REBA approach applied by Sepfrian et al. (2023) at PT Asiana Garment, the QEC method used in this study has a broader assessment scope, as it not only evaluates body posture angles but also considers workers' perceptions of workload, duration, and stress level through the worker questionnaire. Nevertheless, both methods produced similar conclusions, namely that workstations with repetitive manual lifting activities consistently fall into high-risk categories and require immediate workplace facility improvement, as shown by the recommendation to redesign the work chair based on anthropometric data for the overlook operator at PT Asiana Garment. The threshold-category principle underlying QEC also shares a philosophical resemblance with the control-chart approach in the SQC method applied by Diansari et al. (2024), where an “in control” category on the P control chart does not automatically mean the process is “capable” of meeting specifications ($Cpk < 1$). This analogy is relevant to the finding at Workstation SK-4 (Komori Lithrone Machine), which, despite recording the lowest exposure level, still falls into Category 2 (not the safe category), and therefore cannot be disregarded and still requires further preventive action.

Based on the QEC analysis results, ergonomic improvement recommendations were formulated with priority given to the workstations with the highest risk categories, as summarized in Table 3.

Table 3. Priority and Ergonomic Improvement Recommendations Based on QEC Results

Priority	Workstation	Category	Technical Recommendation	Administrative Recommendation
1	SK-2 (Goss Machine)	Category 4 (88.63%)	Lifting aid for paper rolls (hand pallet/hydraulic trolley)	Job rotation, routine stretching
2	SK-5 (Stitching/Muller Machine)	Category 4 (71.40%)	Adjust table/conveyor height to shoulder reach	Job rotation, routine stretching
3	SK-1 (Harris Machine)	Category 3 (63.63%)	Ergonomic work chair based on anthropometric data	Ergonomics training
4	SK-3 (Sharpline Machine)	Category 3 (60.22%)	Wrist support; evaluate tool grip design	Ergonomics training
5	SK-4 (Komori Lithrone Machine)	Category 2 (46.96%)	Adjust height of paper-supply platform	Periodic monitoring

Source: Processed data (2026)

Technical improvement at Workstation SK-2 (Goss Machine) involves providing a lifting aid (hand pallet or hydraulic trolley) to reduce the burden of manually lifting paper rolls, while at Workstation SK-5 (Stitching/Muller Machine), an adjustment of table or conveyor height to match workers' shoulder reach is proposed, in line with the findings of Wulandari and Saputra (2025), which showed that adjusting work table height in the book-packaging industry can significantly reduce the QEC exposure level. The design of chair and worktable dimensions at Workstation SK-1 and Workstation SK-3 should be based on workers' anthropometric data, as recommended by Kusumadewi et al. (2025), so that the resulting work facilities truly match the body dimensions of their users. In addition to technical improvements, all workstations also require administrative improvements in the form of periodic job rotation, stretching programs before and during working hours, ergonomics training for employees, and adequate rest-break scheduling to reduce the accumulation of muscle fatigue caused by static and repetitive working postures.

CONCLUSION

Based on the results of the Quick Exposure Check (QEC) analysis of 19 production employees of CV Madyotomo across five workstations, it can be concluded that none of the workstations fall into the safe category, with average exposure levels ranging from 46.96% to 88.63%. Workstation SK-2 (Goss Machine) and Workstation SK-5 (Stitching/Muller Machine) fall into Category 4 and are the top priority for improvement as they require immediate action, while Workstation SK-1 (Harris Machine) and Workstation SK-3 (Sharpline Machine) fall into Category 3, requiring gradual improvement, and Workstation SK-4 (Komori Lithrone Machine) falls into Category 2, which still requires further investigation. The main risk factors identified are manual lifting and material-handling activities, particularly paper rolls and stacks of printed books.

The proposed improvement recommendations include technical improvements such as providing lifting aids, adjusting table and conveyor height, and designing work facilities based on anthropometric data, as well as administrative improvements such as job rotation, stretching programs, and ergonomics training for employees. Implementing these recommendations is expected to reduce the QEC exposure level across all workstations, lower the risk of musculoskeletal disorders, and improve the comfort and work productivity of CV Madyotomo's production employees. Future research is recommended to conduct periodic QEC evaluations to monitor the effectiveness of the improvements that have been implemented.

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