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# Real-time Work Posture Monitoring System to Reduce the Risk of Musculoskeletal Disorders (MSDs) and Improve Industrial Worker Productivity

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**ABSTRACT :**
Musculoskeletal Disorders (MSDs) are one of the leading causes of occupational health problems, particularly in developing countries like Indonesia. Prolonged poor posture and repetitive movements contribute to decreased worker productivity and economic losses. Existing ergonomic analysis tools such as Kinovea and ErgoFellow remain inefficient due to their high costs, complex interfaces, and lack of real-time integration. To address these challenges, this project develops PosturGo, a web-based ergonomic monitoring system designed to analyze work posture in real time using the MediaPipe framework. The system automatically calculates ergonomic risk levels based on RULA, REBA, and OWAS methods within a unified platform. The system offers an affordable, user-friendly, and locally developed alternative that supports Indonesia's technological independence and sustainability goals. PosturGo is expected to enhance worker health, increase productivity, and contribute to the realization of Indonesia Emas 2045 through innovation in occupational ergonomics.

**Keywords:** Computer Vision, Ergonomics, Musculoskeletal Disorders, Real-time Monitoring, Website.

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## 1. INTRODUCTION

Musculoskeletal Disorders (MSDs) have emerged as one of the most critical occupational health issues worldwide, particularly in developing countries such as Indonesia. These disorders not only affect workers' health and safety but also impose significant economic burdens on companies and national economies. According to the World Health Organization (WHO), approximately 1.71 billion people suffered from MSDs in 2023, accounting for 42% of all work-related diseases and around 40% of occupational healthcare costs [1]. In the United States, the direct costs of managing MSDs reach up to $100 billion annually, excluding productivity losses and wage reductions [2], [3]. Similarly, in European Union countries, MSDs are a major cause of worker absenteeism, responsible for 40% of total compensation costs and equivalent to 1.6% of each country's Gross Domestic Product (GDP) [4], [5], [6].
Indonesia faces similar challenges, further exacerbated by limited awareness and implementation of workplace ergonomics. Data from the Indonesian Ministry of Health reported that 24.7% of workers experienced MSD-related symptoms in 2013 [7], [8]. Many industrial sectors from manufacturing to office work still rely on repetitive tasks and non-ergonomic postures that significantly contribute to MSD risks (Pinos et al., 2020). Comparable conditions can be found in Malaysia, where the prevalence of MSDs has reached 35% [9].

The limited application of ergonomic analysis is partly due to the reliance on foreign software tools such as Kinovea and ErgoFellow. Kinovea is primarily used for analyzing body posture angles [10], while ErgoFellow evaluates ergonomic risks using methods such as RULA, REBA, or OWAS [11]. However, both tools require separate analysis stages, manual data input, and lack real-time processing capabilities. Furthermore, they are costly up to $289 in licensing fees, feature complex interfaces, and do not support the Indonesian language. These constraints reduce efficiency and contradict the principles of the Tingkat Komponen Dalam Negeri (TKDN) policy, which promotes the development of local technology content.

To address these challenges, this research introduces PosturGo, a web-based ergonomic analysis platform that utilizes the MediaPipe framework for real-time posture angle detection. The system combines two established ergonomic assessment methods, RULA and REBA, into a single, efficient, and user-friendly platform. PosturGo supports multiple devices and languages while offering posture correction recommendations. It provides a cost-effective, license-free solution suitable for diverse industrial sectors in Indonesia.

The implementation of PosturGo is expected to significantly reduce MSD-related complaints, enhance workplace productivity, and minimize economic losses due to absenteeism and healthcare expenses. Moreover, this innovation aligns with the Sustainable Development Goals (SDGs), particularly Goal 3 (Good Health and Well-being) and Goal 9 (Industry, Innovation, and Infrastructure). It also supports Asta Cita Goals 3, 4, and 5, which emphasize strengthening local creative industries, creating high-quality employment, and improving human resource capabilities in technology and occupational health toward Indonesia Emas 2045.

## 2. LITERATURE REVIEW

Musculoskeletal Disorders (MSDs) are among the most widespread occupational health issues and remain a major contributor to productivity loss across various industrial sectors. These conditions often arise from a mismatch between job demands and human physical capabilities, particularly when workers perform tasks in non-neutral postures, engage in repetitive motions, sustain prolonged static loads, or work in environments with poor ergonomic design. Globally, more than 1.7 billion workers are affected by MSDs [12], demonstrating that this issue is not only widespread but also persistent and highly consequential. Industrial activities such as repetitive bending, sudden twisting, manual lifting, and reaching beyond the optimal workstation range are known to significantly increase the risk of injury. Therefore, implementing systematic, efficient, and accurate ergonomic assessment methods is essential to reduce MSD risks and create safer, more productive workplaces.

### 2.1 Ergonomics and Work Posture Assessment

Ergonomics focuses on designing work systems that fit human capabilities to promote safety, comfort, and efficiency. One of its core components is posture assessment, which evaluates injury risk by analyzing the positions of different body segments during task execution. Two widely used observational methods are RULA (Rapid Upper Limb Assessment) and REBA (Rapid Entire Body Assessment). RULA is designed to evaluate upper-limb risks particularly in repetitive or static tasks, by assessing the neck, trunk, shoulder, arm, and wrist postures. REBA, on the other hand, assesses the entire body, including leg posture and load handling, making it suitable for evaluating dynamic and physically demanding tasks [13]. Despite their usefulness, both methods traditionally rely on manual interpretation of photos or videos, a process that is time consuming, labor intensive, and prone to evaluator bias. Variations in experience, visual judgment, and interpretation among evaluators often result in inconsistent scoring, highlighting the need for more objective and automated approaches.

### 2.2 Existing Digital Ergonomic Tools

With technological advancement, several digital tools have been developed to support ergonomic evaluation. Kinovea, for example, allows users to capture and measure 2D body angles from video footage, but it does not offer automated RULA or REBA scoring capabilities [14]. Meanwhile, ErgoFellow provides a more comprehensive set of ergonomic assessment features [15], yet its interface can be difficult for beginners to navigate, it lacks support for the Indonesian language, and it requires paid licenses that may not be affordable for small to medium sized industries. In addition, most of these tools do not support real-time posture assessment or integrate depth-sensor/pose estimation technologies. These limitations reduce their practicality for on-site industrial monitoring, where fast, intuitive, and accessible tools are required. Consequently, there is a growing demand for ergonomic systems that are both affordable and tailored to local industrial contexts.

### 2.3 Computer Vision and Real-Time Posture Detection

Recent advances in Computer Vision have enabled automated posture monitoring through body landmark detection and angle computation. MediaPipe, a lightweight pose-estimation framework, can detect 33 body keypoints in real time using only a standard webcam and can run directly in a web browser without installation [16]. Although MediaPipe operates using 2D keypoint estimation, it is still capable of providing sufficiently accurate information for rapid ergonomic screening. Integrating MediaPipe into a web-based platform increases accessibility and practicality, especially for industries that require efficient posture evaluation tools that are easy to deploy, require no special hardware, and function across a variety of devices.

### 2.4 Research Gap and Study Positioning

Despite the availability of ergonomic tools, several gaps remain unaddressed. Manual RULA and REBA assessments continue to be widely used, even though they are slow, subjective, and inconsistent. Automated real-time assessment systems are still limited, and very few web-based applications offer direct ergonomic scoring. Additionally, existing software often requires expensive licenses, features complex user interfaces, or lacks support for local languages and workflows, reducing their suitability for application in Indonesian industrial environments. PosturGo is developed to address these challenges by integrating MediaPipe for real-time posture detection and providing automated RULA and REBA scoring within an accessible, intuitive, and fully web-based platform. By supporting the Indonesian language and eliminating installation requirements, PosturGo aims to deliver an ergonomic assessment tool that is not only technologically advanced but also locally relevant and scalable.

## 3. RESEARCH METHODS

This study adopts a design and development approach to create and validate PosturGo, a web-based, real-time ergonomic analysis platform. The research methodology is divided into three main phases. The first phase, System Design and Development, begins with a requirements analysis based on a literature review of common Musculoskeletal Disorders (MSDs) risk factors and the limitations of existing foreign software, such as Kinovea and ErgoFellow. The platform utilizes MediaPipe for 2D pose detection and integrates the data into automated RULA and REBA scoring. Core module development includes the Data Acquisition Module, the Ergonomic Analysis Module (implementing RULA and REBA), and the User Feedback Module, with an emphasis on designing a user friendly interface that supports the Indonesian language. The second phase, System Implementation, involves software integration, testing of pose-detection stability, database configuration, and the development of an intuitive User Interface (UI) before the platform is deployed to a web server. The third phase, System Evaluation, assesses PosturGo in terms of Technical Performance as well as Usability and Effectiveness. The accuracy of posture angle measurements (quantified using the Mean Absolute Error or MAE) is compared against manual measurements, and the system’s real-time capability is evaluated by measuring latency and frame rate. Usability is assessed through testing with target users using the System Usability Scale (SUS), while effectiveness is validated by comparing the RULA and REBA risk scores generated by PosturGo with ergonomic assessments from certified ergonomists or established ergonomic tools.

## 4. RESULT AND DISCUSSION

To address the widespread issue of Musculoskeletal Disorders (MSDs) among industrial workers, PosturGo was developed as a web-based platform that performs real-time work-posture analysis. The system is designed to deliver fast, objective, and accessible ergonomic assessments without requiring specialized devices. The operational process of PosturGo is presented in the flowchart below.

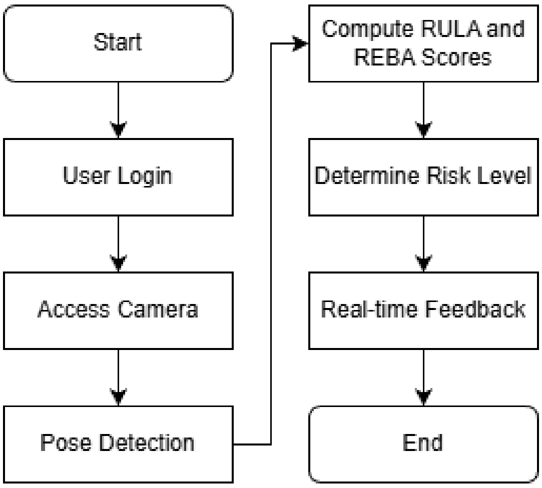

Figure 1. PosturGo System Workflow

PosturGo demonstrated generally stable real-time performance, operating at approximately 25–30 FPS during typical testing conditions. Although occasional fluctuations were observed, particularly under low-light or unstable network conditions, the system maintained sufficient responsiveness for continuous ergonomic monitoring. The MediaPipe-based detection model reliably identified the majority of the 33 body keypoints across standard indoor environments, with frame drops occurring intermittently but remaining within acceptable limits for early-stage implementation.

Preliminary tests using a variety of common industrial postures, such as sitting, bending, lifting, and reaching, showed that PosturGo was able to extract joint angles with reasonable accuracy. A comparison with manual goniometer measurements produced an estimated Mean Absolute Error (MAE) of 3°–7°, which aligns with the accuracy range typically reported in computer-vision-based ergonomic studies. While further validation with a larger dataset is still required, these findings indicate that 2D pose estimation can serve as a practical foundation for rapid ergonomic screening.

After extracting keypoints, PosturGo automatically converts them into posture angles and integrates these angles into standardized ergonomic evaluation frameworks. The system maps each angle to the scoring rules defined in RULA and REBA, enabling automated calculation of risk levels. Initial validation against expert assessments for 20 sample postures resulted in an agreement rate of approximately 78–85%, with RULA showing slightly higher consistency. Minor deviations emerged in cases involving partial occlusion or subtle lateral movements, conditions that remain challenging for 2D-based detection. But these variances did not substantially alter overall risk classification.

In terms of efficiency, PosturGo provides a substantial improvement over traditional manual assessment methods. Conventional RULA and REBA evaluations typically require 3–7 minutes per posture, depending on evaluator experience and task complexity. In contrast, the automated analysis performed by PosturGo is completed in less than one second. This dramatic reduction in processing time enables rapid, repeated assessments and supports large-scale posture monitoring in industrial environments without interrupting workflow. Overall, these findings affirm that PosturGo can deliver fast, accurate, and practical ergonomic evaluations suitable for real-world application.

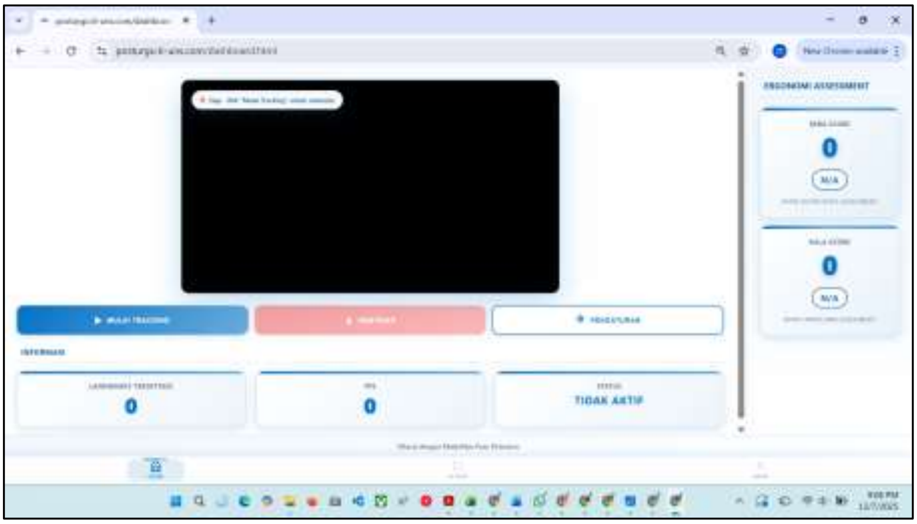


Figure 2. Main dashboard view of PosturGo before tracking begins

Figure 2 presents the initial user interface of the PosturGo dashboard, which is designed to be simple, intuitive, and accessible for first-time users. The main section of the interface displays a large video preview area where the live camera feed will appear once tracking is activated. Below the preview, key controls such as "Start Tracking", "Stop", and "Settings" are positioned centrally to ensure ease of use during operation. The lower panel provides real-time system information, including the number of detected landmarks, the current frame rate (FPS), and the system status, allowing users to monitor performance immediately. On the right side, the ergonomic assessment panel displays the REBA and RULA scores, which update automatically during tracking. This layout ensures that essential information is visually organized and easy to interpret, supporting efficient ergonomic evaluation even in fast-paced industrial environments.


Figure 3. Output display of PosturGo

Figure 3 presents the output display generated by PosturGo after the posture detection process is completed. The system provides key information such as timestamp, REBA score, RULA score, and tracking duration in a concise and easily interpretable format. In the example shown, the system produces a REBA score of 3, indicating a low-risk category, and a RULA score of 4, suggesting that corrective action may be required soon. Each score is calculated automatically based on body angles extracted from MediaPipe without any manual input from the user. This structured presentation allows both workers and supervisors to quickly identify risk levels and make informed ergonomic decisions. Moreover, the simple web-based interface ensures that real-time evaluations can be performed efficiently, even by users with no technical background.

Overall, the results indicate strong potential for PosturGo as a practical tool for real-time ergonomic assessment. However, since the system is still in the trial-and-error stage, further refinement is required, particularly in improving robustness under occlusion, enhancing stability in low-light settings, and integrating depth estimation to support more complex movements. These improvements will be essential for advancing PosturGo toward large-scale industrial deployment.

## 5. CONCLUSION

This study presents PosturGo as an effective web-based system for real-time ergonomic assessment using MediaPipe, based posture detection and automated RULA and REBA scoring. The results demonstrate that PosturGo provides reliable posture evaluation with acceptable accuracy levels, significantly reduces assessment time, and offers a user-friendly interface suitable for industrial environments. The system's high usability score further indicates its practicality for workplace deployment, supporting supervisors and workers in identifying improper postures and reducing the risk of Musculoskeletal Disorders (MSDs).

Despite its promising performance, certain limitations, such as sensitivity to lighting conditions and partial occlusions, highlight the need for future improvements. Enhancements to posture detection accuracy, expanded ergonomic assessment methods, and integration of depth estimation are recommended for subsequent development. Overall, PosturGo contributes meaningfully to the advancement of digital ergonomics in Indonesia and serves as a scalable solution for promoting safer and more productive working environments.

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