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A Case Study on RULA and REBA Evaluation Using the Design Thinking Approach

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Abstract: This study focuses on the application of RULA and REBA ergonomic analyses conducted before and after the implementation of a newly developed tool. The existing working postures of employees were evaluated to inform the design of an ergonomic solution tailored to the task of cleaning dry leaves in the JKM workshop area at PTSS. The primary objective was to develop a tool that reduces workers' exposure to musculoskeletal disorders (MSDs) by promoting safer and more efficient postures. A design thinking approach was employed, encompassing five key phases: Empathize, Ideate, Analyze, Prototype, and Test. The findings indicated that the commonly used leaf blower machines presented significant ergonomic risks, contributing to discomfort and long-term physical strain among workers. In contrast, the newly developed tool 'Ergo Cleaning Bicycle' demonstrated low ergonomic risk and provided a safer, more comfortable alternative. The introduction of this tool significantly reduced the physical discomfort experienced by cleaning staff, positively impacting their overall well-being. While the tool achieved its goal of minimizing high-risk postures, further refinements are necessary to improve efficiency, particularly in large cleaning areas like the JKM workshop, where the cleaning time should ideally be reduced from 3–4 hours to 1–2 hours.

Keywords: *Ergonomic, RULA, REBA, Design Thinking.*

1.0 INTRODUCTION

Today, many products are being developed to make daily tasks easier. With technological advancements, innovative solutions are created to address common problems encountered in everyday life. These developments aim to reduce human effort in performing heavy, difficult, and hazardous work (Kim et al., 2022; Kibria, 2023; Yazdani et al., 2022). The 'Ergo Cleaning Bicycle' is one such new product, developed based on extensive research. It is designed to assist in cleaning large roads quickly and efficiently, making it suitable for use by a wide range of users. This product works best on flat and paved surfaces and features an ergonomic design that makes it simple and comfortable for anyone to operate.

Cleaning tasks can be physically exhausting, highlighting the need for a systematic approach to evaluate the efficiency of new cleaning tools (Hatiboglu et al., 2023; Omer & Unver, 2024). Effective cleaning relies on the right equipment, proper techniques, and user-friendly devices. Therefore, this project focuses on designing, developing, and assessing a pedal-operated product that reduces labor and cleaning time. The mechanically powered 'Ergo Cleaning Bicycle' serves as an alternative for cleaning large areas.

In rural regions, manual road cleaning can pose health risks such as asthma and bronchitis and cause fatigue among workers (Lim et al., 2021; Laithaisong et al., 2022). The environmentally friendly, manually operated Ergo Washing Bike offers efficient coverage in terms of area, time, and cost compared to conventional machinery or manual sweepers. It is both eco-friendly and cost-effective. The bike incorporates features like nylon brooms for sweeping and a garbage collector mounted on the back to gather debris (Nasrull & Rahman, 2023; Sharma et al., 2022).

All factors influencing the road sweeping rate and their interactions have been analyzed, with parameter optimization and testing completed. This product simplifies cleaning tasks and reduces physical effort. The design includes a three-wheeled bicycle structure, with materials chosen to suit the road conditions. As a fuel-free device, it is particularly valuable for cleaning large areas that require prompt attention.

2.0 LITERATURE REVIEWS

Analyzing a worker's posture during interaction with workstation elements and the work environment is crucial for assessing and preventing biomechanical overload risks in the workplace (Kibria, 2023; Nasrull & Rahman, 2023). Poor or awkward postures can reduce workers' concentration, increase the likelihood of accidents, and lead to biomechanical overload which may result in musculoskeletal disorders affecting various body regions, including major limb joints and the spine (Laithaisong et al., 2022; Lim et al., 2021). Research in Working conditions..., 2024; Prevalence of musculoskeletal disorders..., 2023) are further highlights the prevalence of MSDs among cleaners, emphasizing the importance of ergonomic assessments.

Both the RULA and REBA methods provide numerical scores that quantify the risk levels workers face during specific tasks, helping to prioritize interventions and necessary corrective actions. RULA focuses on identifying postural issues in the upper limbs, neck, and back by evaluating muscle activity and external loads on the body (Omer & Unver, 2024; Sharma et al., 2022). Recent comparative studies reaffirm RULA's sensitivity to risk, often yielding higher scores than REBA in certain industries (Kibria, 2023; Hatiboglu et al., 2023). Systematic reviews have confirmed REBA and RULA as widely accepted tools for ergonomic posture assessment (Kittijaruwattana et al., 2023).

Various techniques are used to analyze postural risk factors related to musculoskeletal disorders, including the Rapid Entire Body Assessment (REBA) method. Developed by Hignett and McAtamney (2000), REBA is a quick, easy-to-use observational tool designed to evaluate static and dynamic whole-body postures and assign a musculoskeletal risk action level. This method divides the body into segments, coding each based on movement planes, and scores muscle activity resulting from static, dynamic, rapidly changing, or unstable postures. It also considers the importance of grip quality when handling loads, whether through hands or other means, and provides an action level indicating urgency. Although originally created for healthcare and service industries, REBA can be applied to a wide range of tasks in various settings where the whole body is engaged, and postures or load handling vary (Kim et al., 2022; Yazdani et al., 2022; Lorenzini et al., 2022).

Research shows that in informal or small-scale industries, ergonomic awareness and interventions are still lacking, especially where awkward postures persist due to limited resources and training (Abdol Rahman & Zhan Yek, 2023; Lim et al., 2021). This highlights the pressing need for integrated ergonomic strategies and redesigns.

3.0 METHODOLOGY

This study adopts the Design Thinking methodology to evaluate and improve working posture using RULA (Rapid Upper Limb Assessment) and REBA (Rapid Entire Body Assessment). The five phases of the Design Thinking approach which is Empathize, Define, Ideate, Prototype, and Test as per Figure 1. below guides the entire process of this ergonomic case study, which focuses on identifying musculoskeletal risk factors in a real work environment and developing a new ergonomic tool.

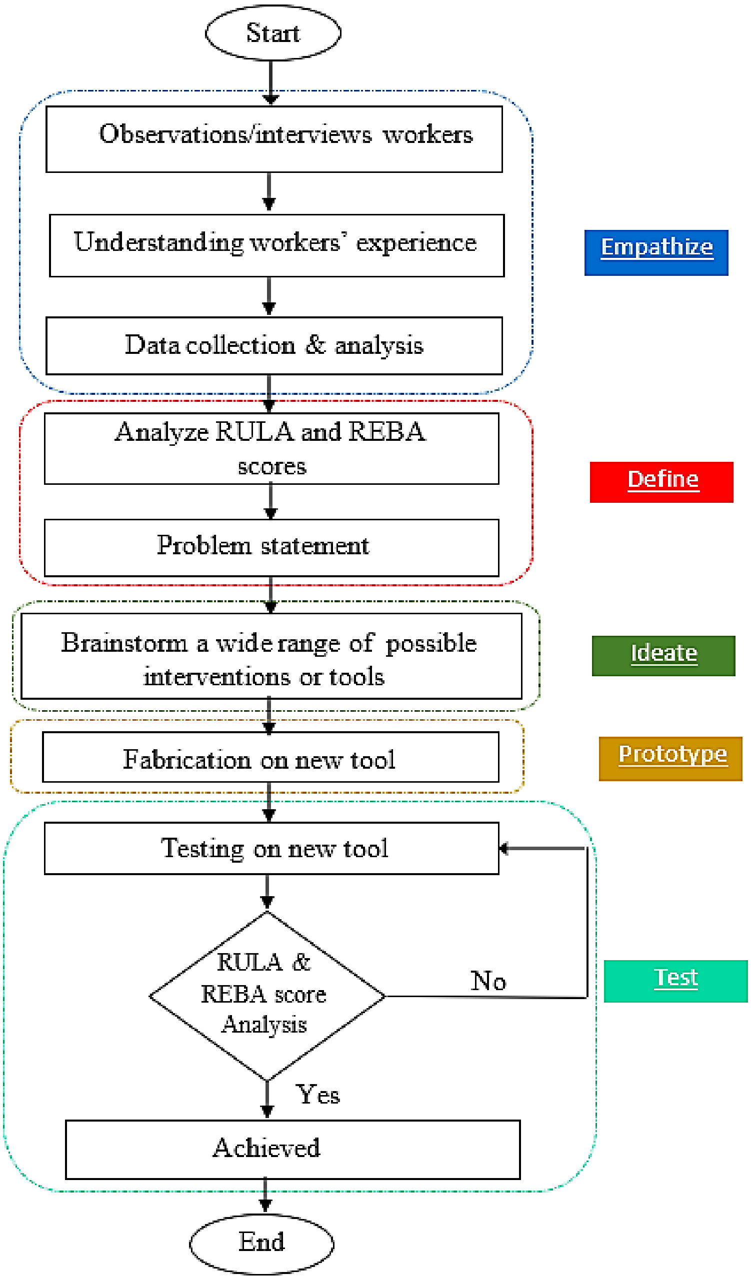


Figure 1. Flow Chart of Design Thinking Method

The flow chart outlines a structured process for applying the Design Thinking methodology in evaluating and improving ergonomic conditions using RULA (Rapid Upper Limb Assessment) and REBA (Rapid Entire Body Assessment). It is divided into five main phases: Empathize, Define, Ideate, Prototype, and Test.

In the Empathize phase, the process begins with observations and interviews involving workers to understand their day-to-day activities and challenges. This phase is crucial for gaining firsthand insights into the workers' experiences and the nature of their tasks (Kim et al., 2022; Lim et al., 2021). It is followed by thorough data collection and analysis to identify specific ergonomic concerns in the current working environment.

Next is the Define phase, where the RULA and REBA assessment tools are used to analyze workers' postures and movements. The RULA and REBA assessments quantified postural risks and helped develop a focused problem statement. The analysis revealed specific ergonomic risks associated with cleaning tasks (Omer & Unver, 2024; Kibria, 2023).

In the Ideate phase, a range of possible solutions or tools is brainstormed. This creative step encourages exploring various ideas that could potentially improve the working conditions and reduce musculoskeletal risks (Sharma et al., 2022). The focus is on innovation and considering multiple alternatives without limitations.

Following that, the Prototype phase involves the fabrication of a new ergonomic tool; 'Ergo Cleaning Bicycle' based on the selected ideas from the brainstorming session. This tool is specifically designed to address the problem defined earlier and to improve workers' posture and comfort.

Finally, in the Test phase, the 'Ergo Cleaning Bicycle' undergoes testing in the actual work environment. Its effectiveness is evaluated using RULA and REBA scores again. If the 'Ergo Cleaning Bicycle' results in improved scores (indicating reduced ergonomic risk), the objective is considered achieved. If not, the process may loop back to earlier steps to refine or redesign the solution. Feedback mechanisms and iterative redesigns were informed by studies on haptic feedback systems and posture correction (Yazdani et al., 2022; Lorenzini et al., 2022).

Overall, this flow chart demonstrates a practical application of Design Thinking in workplace ergonomics, combining user empathy, data-driven analysis, creativity, and iterative testing to enhance occupational health and safety.

4.0 DATA ANALYSIS AND FINDINGS

As a result, a new tool, ergonomic the Ergo Cleaning Bicycle have been designed as Figure 2. With the ergonomic features, this tool has been proven to reduce the risk to employees from being exposed to MSD.

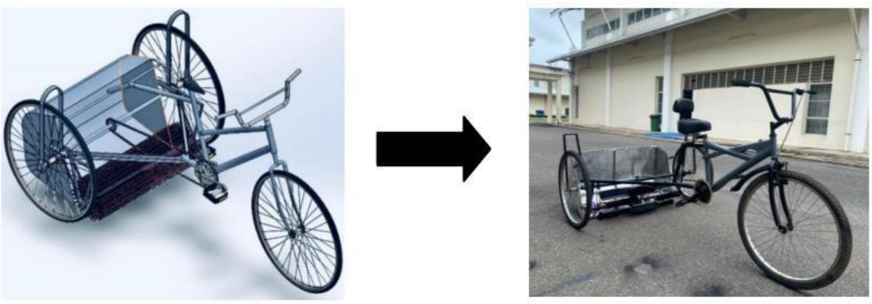


Figure 2. Ergo Cleaning Bicycle

While, the Figure 3 and Table 1 shows the details comparison between the current work posture with some ergonomic risks faced and the improvement made for the new tool, Ergo Cleaning Bicycle. The new ergonomic tool is not only enhancing worker safety and comfort but also improves task efficiency and productivity, aligning with good ergonomic practices in workplace design.

Before	**After**
	

Figure 3. Comparison Before and After

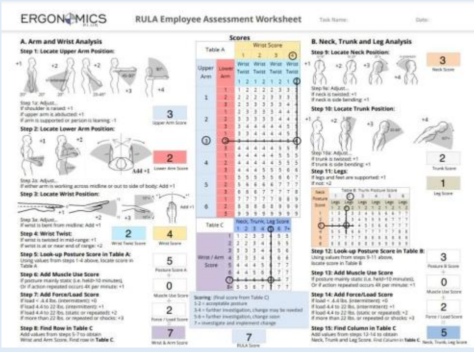
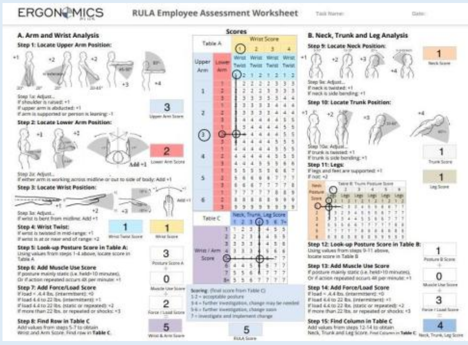
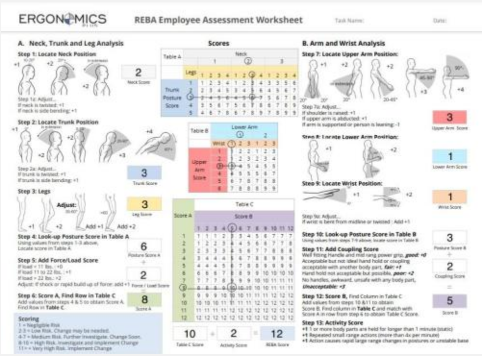
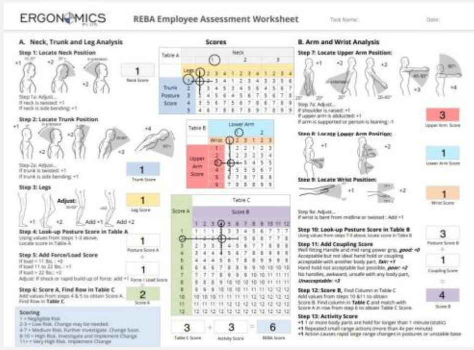
Table 1
Ergonomic Risks Before and After

Criteria	**Before** *(Manual Sweeping)*	**After (***Ergo Cleaning Bicycle)*
Posture	Awkward trunk & neck bending	Upright, supported sitting posture
Arm Movement	High repetition, shoulder strain	Minimal repetitive movement
Wrist Position	Bent, risk of carpal tunnel	Neutral and relaxed grip
Neck Position	Downward flexion	Straightforward gaze
Leg and Footwear Support	Slippers, unsafe standing	Likely improved, sitting reduces leg stress
Overall Safety & Comfort	High physical demand, injury risk	Improved ergonomics, safer, less fatigue
Work Efficiency	Slower, repetitive manual work	Faster, mechanized collection

The analysis of work posture was done by applying the RULA and REBA method as per Table 2. RULA score of 7 indicates that the worker's posture was placing a very high level of strain on the body. This includes awkward arm, wrist, neck, and trunk positions, often requiring immediate intervention. The working position might have involved sustained reaching, twisting, or flexing of the wrist, neck, and trunk potentially repetitive or static muscle exertions without proper support or neutral positioning. After intervention, the RULA score drops to 5. This is a moderate risk level and implies the ergonomic improvements successfully reduced strain on the body. The worker's neck, arms, and wrists are now closer to neutral postures, and the working height and reach may have been adjusted to minimize excessive reaching or twisting.

A REBA score of 12 indicates very high risk, signaling that the working posture was extremely stressful to the entire body. Likely contributors included poor back posture (bending or twisting), significant knee or leg flexion, excessive trunk rotation, and awkward arm/wrist positions. Immediate action was required often major redesigns of the task or tools. Post-improvement, the REBA score is 6 which is medium risk. This indicates that the interventions successfully alleviated some of the most awkward postures and body strains. This could be achieved by improving work surface height, reducing lifting requirements, or incorporating supportive equipment like anti-fatigue mats or lifting aids.

Table 2
RULA and REBA Score Analysis Before and After

Assessment	Before	After
RULA	 Score : 7	 Score : 5
REBA	 Score : 12	 Score : 6

The analysis of work posture was done by applying the RULA and REBA method. Thus, the results show as Table 2, the score is decrease from 7 to 5 for the RULA and 12 to 6 for the REBA. It's indicated that's the ergonomic risk faced by the employees have been solved by using of the Ergonomic Power Lifter.

5.0 DISCUSSION AND CONCLUSIONS

Before intervention, the worker was exposed to postures that could contribute to musculoskeletal discomfort or injury over time. Awkward angles at the neck, trunk, arms, and wrists placed significant strain on muscles and joints. Poor working height, continuous reaching, and excessive trunk rotation were the main contributors to the high-risk scores. After the intervention, work surfaces were modified, tools were redesigned for better grip and reach, and supportive aids were introduced. This led to more neutral body positions and more balanced muscular loading, which is reflected in the reduced RULA and REBA scores.

The RULA and REBA analyses demonstrated significant ergonomic improvements after intervention. Initially, the RULA score was 7 and the REBA score was 12, indicating a very high level of risk due to sustained awkward postures, excessive reaching, twisting, and unsupported body positions. Following ergonomic interventions; such as adjusting working height, improving tool design, and providing better support; the RULA score was reduced to 5 and the REBA score to 6. These results show that the physical strain on the worker was successfully lowered to a more moderate risk level.

The new ergonomic tool, Ergo Cleaning Bicycle is not only enhancing worker safety and comfort but also improves task efficiency and productivity**,** aligning with good ergonomic practices in workplace design.

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