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Identification of Body Discomfort and Ergonomic Risk for Ergonomic Workstation Improvement among Fakulti Teknologi Kejuruteraan (FTK) Staff

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Abstract

Ergonomically sound workspace design is essential for ensuring the continued well-being and productivity of the organization, but manually arranged offices are usually poorly designed and lack structural consideration, which results in negative consequences for postural health of workers. The current design of desks in most higher educational establishments features a lack of adjustability and high degree of static sitting strain, hence making the employees vulnerable to ergonomic risks. To solve this issue, the present research will perform ergonomics assessment of the staff at Fakulti Teknologi Kejuruteraan (FTK) of Universiti Tun Hussein Onn Malaysia (UTHM), based on a combined approach involving both subjective and objective tests. A cross-sectional study of 30 employees was performed with the help of digital Nordic Musculoskeletal Questionnaire (NMQ) in combination with ROSA measurement. Objectively speaking, a high prevalence rate of postural strain was found in important parts of the body including the neck (66.7%), shoulders (60.0%) and lower back (53.3%). Workstations physically measured exhibited risky final ROSA scores that were consistently found to lie within 5 and 6 (mean score = 5.50). Engineering redesign analysis indicated that the office chair arrangement was the greatest risk posed by the workstations (mean score = 5.27), hence the need for immediate actions in the form of purchasing ergonomic office chairs that are adjustable and custom-fit lumbar support devices.

1. Introduction

Research into the area of industrial health and ergonomic pollution can be seen as an important topic of conversation within current workplace safety discourse, especially in Malaysia [1]. Work related musculoskeletal disorders (WMSD) have become one of the worst health care and economic burden in the whole world [2], causing a serious threat, which is especially noticeable in developing countries, where the shift from physical labor to sedentary desk work is observed [3]. Academic workplaces and faculties can be considered to be special hazardous workplaces, where employees are exposed to long periods of sedentary work, computer work and repetitive brain and administrative activity [4]. It has been noted previously, that in the case of engineering faculties the architectural layout of offices was not appropriate [2], [5].

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Although the clear risks of the modern desk job are apparent, ergonomic evaluations in faculty departments at publicly funded universities are never conducted systematically [6]. Laboratory staff in academia and engineering laboratories often face desks with customized non-standard height levels, fixed chair systems, and monitor accessories arranged inappropriately, which leads to inappropriate postural alignment, significant head flexion, and constant shoulder elevation [7]. Long periods of standing and sitting in an unstructured behavior pattern cause circulation problems locally, extreme fatigue, and nervous system strain [6], [8]. It is common practice in institutional procedures that staff facing physical problems in an initial stage try to cope with it using temporary pain medication.

In order to fill this empirical gap, this study aims to map the levels of comfort and the risk values in physical stations for the employees of the Faculty of Engineering Technology (FTK) of the Universiti Tun Hussein Onn Malaysia (UTHM) Pagoh Campus. This is done by correlating the self-reported symptoms through the Nordic Musculoskeletal Questionnaire (NMQ) with the independent and objective validation through Rapid Office Strain Assessment (ROSA) technique [2][9]. These findings will serve as the basis for implementing the proper engineering intervention measures that would safeguard the university employees from occupational injuries.

2. Methodology

2.1 Population and Target Sample Selection

The macro labor force selected as part of the occupational analysis includes the whole active labor force of FTK of UTHM, and the population size is N = 148. This initial institution population is divided between academic labor force (n = 137 accounting for 92.6% of the labor force) and administrative labor force (n = 11, accounting for 7.4%). From this target population, a sample size of thirty (n = 30) active members was drawn to take part in complete auditing procedures. This sample included different departments and the largest share came from the department of Mechanical Engineering Technology (JTKM) with 43.5% representation in the total sample size. The reliability and structural integrity of the data collection tool were guaranteed prior to its administration to this particular sample by means of face and content validation through expert opinion of two university lecturers who are experts in ergonomics. The evaluations by the experts ensured that the measurements, anatomical indicators, and terminologies were all consistent with international occupational health standards.

2.2 Survey Tool Development and NMQ Structure

Data collection involved a two-stage questionnaire administered through a secure Google Form that would enable collecting subjective indicators. The design of the research tool was broken down into operational segments to facilitate clear data segregation:

- Stage 1: Consent & Demographics: Collecting data on personal data variables such as age groupings, gender distribution, department allocation, and total years of active work at the institution.
- Stage 2: Prevalence and Symptoms: Recording personal reported incidences of discomfort using one week and one year recall period in relation to pain intensity measured using the 0-10 numerical rating scale.
- Stage 3: Risk Factors: Behavioral factors that included recording the exact number of hours spent sitting daily and exercise frequency.
- Stage 4: Nordic Musculoskeletal Questionnaire (NMQ): An established anatomical framework focusing on pain assessment for specific body areas (neck, shoulders, low back, and wrist) [3], [10].

Progress in Engineering Application and Technology Vol. 7 No. 2 (2026) p. 203-211

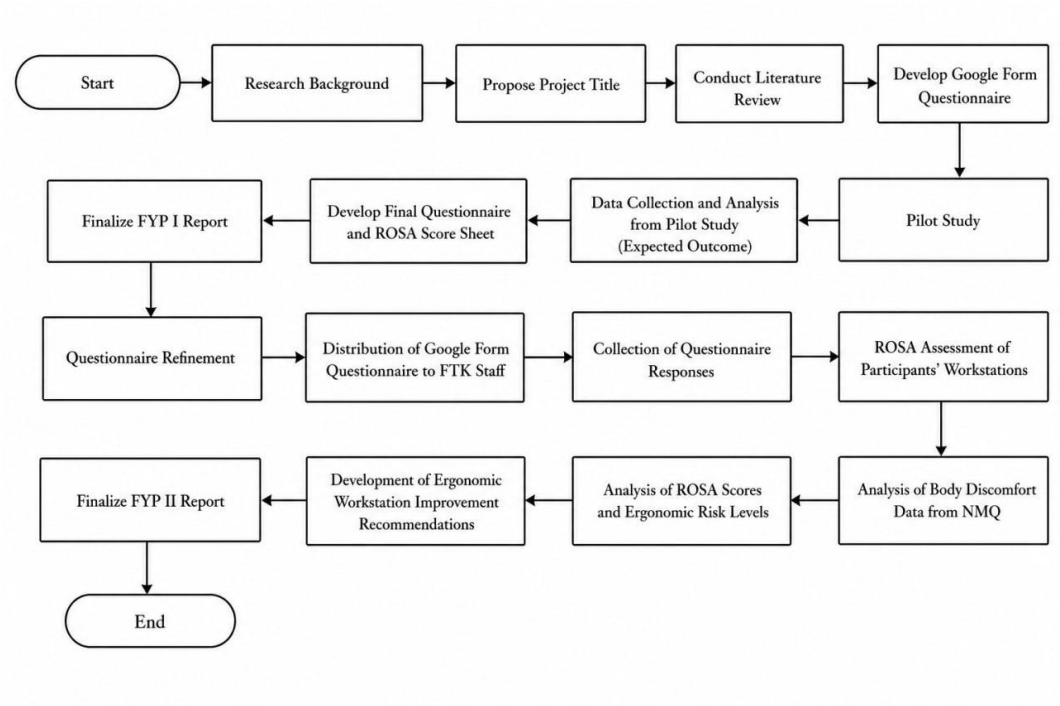


Figure 1: Project Flowchart

The complete sequential execution of the research design is structurally detailed in the project operational flowchart in Figure 1 which systematically bridges subjective user feedback loops with empirical, objective physical tracking metrics. The investigation initiates with a project launch stage that defines the research scope, core parameters, and target population boundaries within the Faculty of Engineering Technology (FTK) at the Universiti Tun Hussein Onn Malaysia (UTHM) Pagoh Campus. This is immediately followed by the questionnaire refinement stage, where the initial data collection instrument comprising personal demographics, sedentary behavioral tracking, and the standardized Nordic Musculoskeletal Questionnaire (NMQ) is rigorously evaluated. To establish robust content validity and ensure that all operational metrics align with occupational health standards, the survey tool undergoes strict review and verification by two university lecturers who are recognized subject-matter experts in ergonomics. Once successfully endorsed by the experts, the methodology transitions directly into active data acquisition executed via two concurrent data channels. First, the finalized digital survey is distributed via secure Google Form channels to the target staff sample (n=30) to gather baseline behavioral profiles and self-reported physical symptoms, with all completed responses systematically compiled and archived. Concurrently, objective field data is gathered through on-site physical workstation audits using the Rapid Office Strain Assessment (ROSA) framework, utilizing real time observations and physical tracking to document actual joint angles, layout heights, and seating configurations.

Following the data gathering matrix, the methodology advances to parallel analytical phases to decode occupational safety and health risks. Subjective body discomfort datasets collected via the NMQ are analysed to map exact variations in pain distribution across critical high exposure anatomical locations, such as the neck, shoulders, lower back, and wrists, thereby measuring the physical impact of prolonged desk operations. In parallel, actual office setups are quantified by routing seating parameters under Section A, monitor and telephone variables under Section B, and desktop peripherals under Section C through standardized ROSA matrix scoring charts to compute unique, objective risk indicators. These dual streams of subjective symptom reporting and objective physical metrics are then cross referenced to isolate direct environmental hazards. In the final phase of the flowchart, these combined insights serve as the technical foundation for the development of specific, code compliant ergonomic workstation improvement recommendations, focusing on hardware re-engineering, fully adjustable furniture modifications, and administrative postural correction strategies. The overall operational loop concludes with the integration of these engineered solutions, statistical analyses, and localized design improvements into the final research report, completing the predefined study objectives.

2.3 Objective Postural Assessment via ROSA Sheets

To validate self-reported user complaints with objective metrics, an on-site physical workstation audit was performed using the Rapid Office Strain Assessment (ROSA) framework [9][11]. The workspace elements were divided into specific sub-sections for evaluation:

Section A: Seating System Score = Chair Height + Pan Depth + Lumbar Back Support + Armrest Level + Duration Score

Section B: Monitor and Telephone Score = Monitor Vertical Alignment + Telephone Position + Duration Score

Section C: Peripherals Score= Keyboard Depth + Mouse Interaction Surface + Duration Score

After such individual analyses, the results of Sections A, B, and C were correlated with standard ROSA scores using the chart matrix [11][12]. The result of more than five indicates that there is a high-risk configuration, which immediately requires a redesign of the workstation [13][14].

2.3.1 Calculation of ROSA score

ROSA score computation is achieved by following an extensive matrix assessment process, which involves the measurement of postural risk with respect to three types of equipment used, as shown in Figures 2 and 3. The ROSA score computation process is carried out in the following manner:

- Section A (Chair Assessment): The vertical axis score is determined by combining the seat height and seat depth scores, while the horizontal axis score is calculated by summing the armrest and backrest scores. These axes are mapped on the Section A matrix to obtain the base chair score, which is then adjusted using the employee's daily sitting duration score.
- Section B (Monitor and Telephone Assessment): The horizontal axis value is calculated by adding the monitor score to its corresponding duration score. The vertical axis value is obtained by adding the telephone score to its duration score. Cross-referencing these values on the Section B matrix yields the intermediate Section B score.
- Section C (Mouse and Keyboard Assessment): The horizontal axis score is derived by adding the keyboard score to its duration score, and the vertical axis score is calculated by adding the mouse score to its duration score. These values are mapped on the Section C matrix to obtain the intermediate Section C score.
- Final ROSA Grand Score Integration: The overall peripheral and monitor score is established by cross-referencing the Section B output (vertical score) with the Section C output (horizontal score). Finally, this combined peripheral score is mapped against the Section A (Chair) score on the ROSA grand score chart to generate a final action score ranging from 1 to 10.

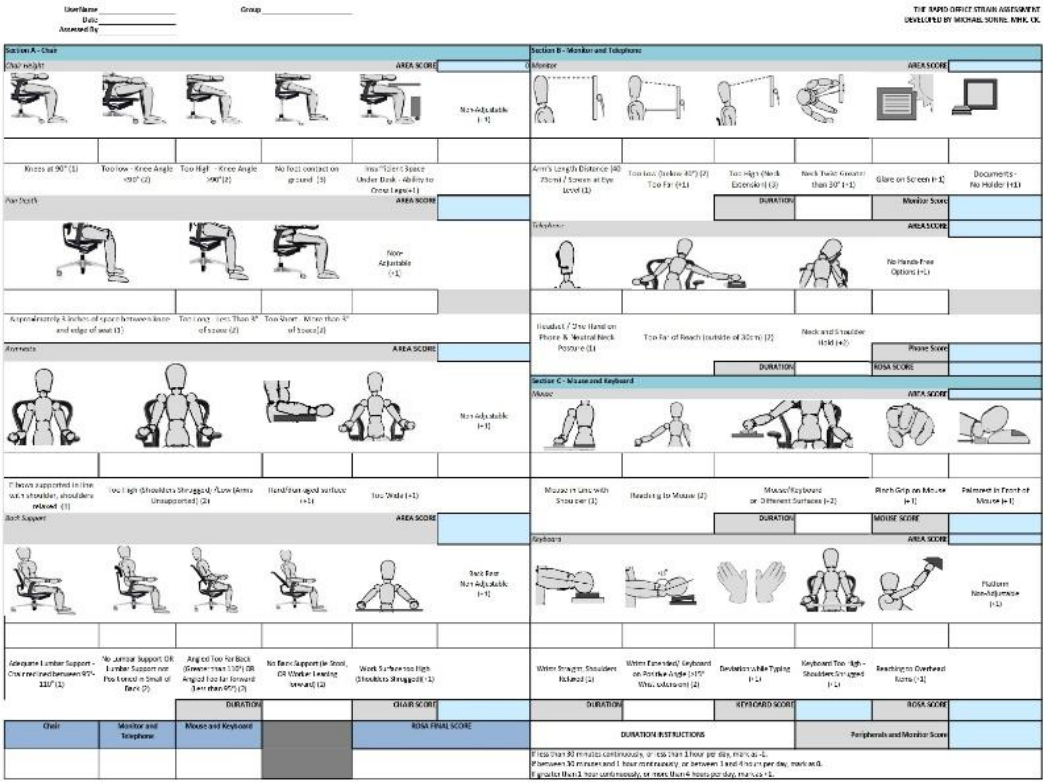
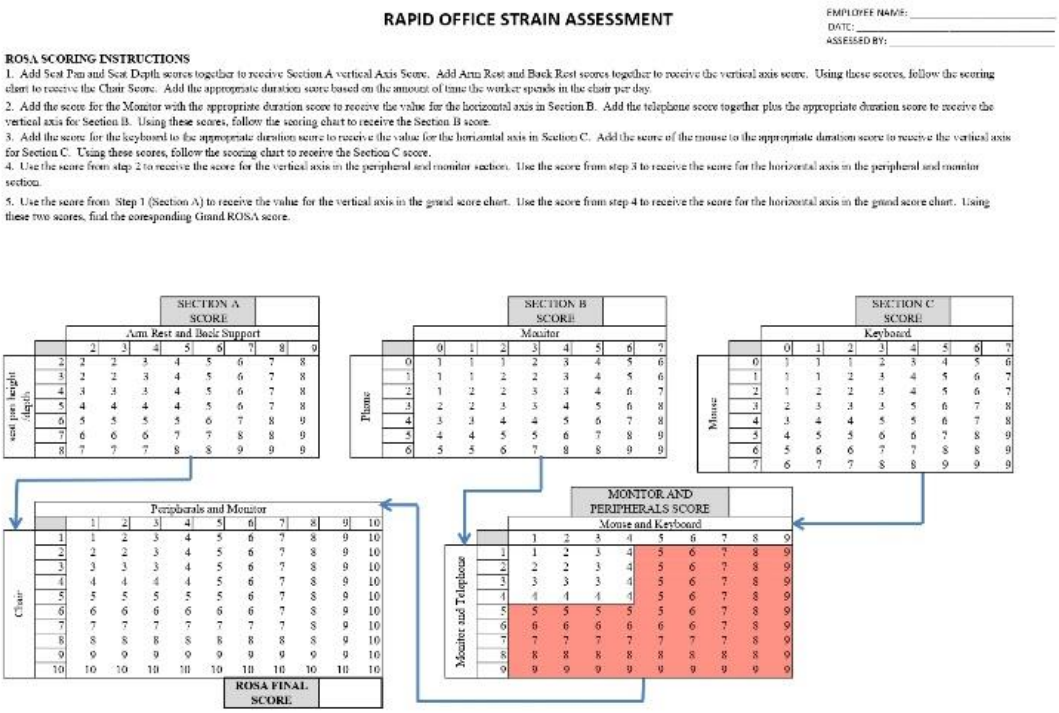


Figure 2: ROSA worksheet



Figue 3 : ROSA worksheets

3. Results and Discussion

3.1 Subjective Demographics and Symptom Isolation

The sample represented a balanced section of the faculty personnel among different age categories ranging from personnel under the age of 40 years and those aged between 40-49 years. The subjective approach based on the use of the NMQ confirmed that there was a significant amount of work-based stress among the faculty members, with three main categories of high prevalence of discomfort as shown in Figure 4:

Neck area: 66.7%

Shoulder area: 60.0%

Lower back area: 53.3%

Such a high level of prevalence of the problem is associated with prolonged desk work as 83.3% of audited personnel spend 4-6 hours daily sitting down without any physical activities [15]. Biomechanically, maintaining a static seated position for extended durations leads to sustained isometric muscle contractions, reduced localized blood circulation, and accelerated metabolic fatigue within the spinal musculature. Such prolonged physical stress leads to the emergence of early-stage problems related to the lower back, lumbar disk strain, continuous trapezius tightness, and sciatic problems.

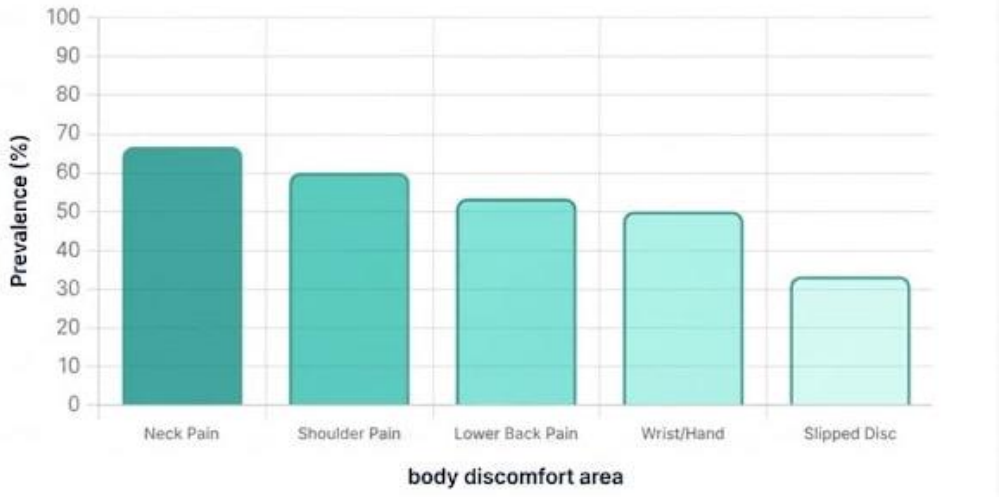


Figure 4: Body Discomfort Findings

3.2 Objective ROSA Postural Scoring Results

Physically auditing the workstations onsite showed that the reported physical complaints had a strong correlation with structural inadequacies in office furnishings [2], [13]. The total mean ROSA scores for all the faculty members had a very small range between 5 and 6, giving an average risk score of 5.50, as shown in figure 5. Since these risk scores have surpassed the safety threshold, it makes the offices in question high-risk areas that need physical intervention immediately.

Based on figure 5 below, the main source of the high-risk scores was Section A (Office Chair) with a mean risk score of 5.27. Inspecting the physical structure of the offices showed that most of the chairs did not have adequate lumbar support and armrests, while the seat pans were also wrongly placed in a fixed position. All these inadequate settings make it necessary for the user to tilt the pelvis posteriorly, flattening the natural lordotic curve of the spine and significantly increasing lumbar intradiscal pressure. This direct structural limitation explains the 53.3% prevalence rate of back pain among staff members obtained through NMQ as shown in figure 4. Furthermore, the absence of adjustable armrests forces the shoulder girdle to bear the static load of the upper limbs, triggering continuous trapezius strain that directly drives the 60.0% shoulder discomfort rate.

The secondary issue was found in Section C (Keyboard & Mouse) with a risk score of 3.73 (Medium Risk), where non-optimized wrist angles and lack of forearm support compounded the postural strain caused by improper

monitor heights that forced users to constantly tilt their necks. This combination of awkward forearm posture and cervical extension explains the peak 66.7% discomfort rate reported in the neck region. Meanwhile, Section B (Monitor & Telephone) remained well within the safety threshold with a low-risk score of 1.50, suggesting that ergonomic interventions should remain strictly focused on the chair and input devices. These recommendations directly reflect the scoring matrix, which categorizes results below 3.00 as low risk, 3.00 to 5.00 as medium risk, and values exceeding 5.00 as high risk.

ROSA Component Vectors	Mean Score	Std. Dev. (±)	Min	Max	Risk Zone & Action Level
Section A: Chair Ergonomics	5.27	1.96	2.00	9.00	HIGH RISK - URGENT ADJUSTMENTS
Section B: Monitor & Telephone	1.50	0.90	1.00	5.00	LOW RISK - MAINTAIN BASELINE
Section C: Keyboard & Mouse	3.73	1.31	2.00	7.00	MEDIUM RISK - MONITOR WORKSTATIONS
Combined ROSA Final Score	5.50	1.78	3.00	9.00	HIGH RISK - CORRECTIVE ACTIONS

Figure 5 : Rosa Component Score Summary

3.3 Proposed Engineering and Administrative Redesign

Workstation Component	Identified Ergonomic Issues (From Results)	Proposed Ergonomic Improvement / Actionable Solutions
Section A: Chair (Highest Risk: Mean 5.27, Max 9)	• Inadequate lumbar support • Incorrect chair height settings • Absence of armrest support • Improper seating depth setting • Excessive static sitting position	• Use of ergonomic chairs • Provision for adjustable lumbar support • Training users to set chairs correctly
Section B: Monitor & Telephone (Lowest Risk: Mean 1.50, Max 5)	• Screen height too high or low • Distance from the screen is too much • Postures that result from glare • Cradling phone between neck and shoulder	• Monitor arms adjustable • Anti-glare screens / proper lighting • Headset without hands
Section C: Mouse & Keyboard (Moderate-High Risk: Mean 3.73, Max 7)	• Over-reach when accessing the mouse • Poor positioning of the keyboard • Lack of forearm support • Wrist positioning in awkward positions	• Peripheral alignment • Forearm support • Assistive technology (split keyboards/vertical mice)
Systemic & Administrative (Overall Mean 5.50)	• Deficit within system in open space arrangement • Long uninterrupted sitting periods	• Physical activity pauses • Frequent ergonomic evaluation

Table 1 : Propose Ergonomic Improvement

To lower the high risk levels identified in the ROSA audits, the study developed a comprehensive set of improvements aligned with ISO 9241 (Ergonomics of Human-System Interaction) and Malaysian Department of Occupational Safety and Health (DOSH) guidelines.

The primary objective of Table 1 is to provide practical engineering and administration measures, especially concentrating on the most pressing issues. As sections A for the office chair and C for the mouse and keyboard were above the safety level of risks, receiving high and medium risks with the scores of 5.27 and 3.73, respectively, the solutions will be directed at these two sections only. In case of the highest risk in section A, the task would be to replace the existing fixed-position chair with the adjustable ergonomic one that could provide adequate back support, 3D adjustable armrests, and adjustable seat pan depth, thus not allowing employees to sit in an uncomfortable posture. Administratively, implementing mandatory micro-breaks (5 minutes of movement per hour of continuous desk work) is crucial to interrupt prolonged static sitting and restore tissue blood flow. Concerning section C, it is essential to improve the forearm support as well as use some kind of assistive equipment such as the split keyboard or the vertical mouse to reduce wrist pronation and ulnar deviation. As for section B for the monitor and telephone, it received a low-risk score of 1.50, which means that the existing baseline would be enough and just requires periodic preventative maintenance.

4. Conclusion

This research successfully analyzed the body discomfort profiles and ergonomic risks for the staff of Fakulti Teknologi Kejuruteraan at UTHM. Reporting through the NMQ identified a high prevalence of musculoskeletal symptoms, centered in the neck at 66.7%, shoulders at 60.0%, and lower back at 53.3%. These findings were validated by physical audits, where the final ROSA score reached a mean value of 5.5, confirming a high risk level that requires immediate corrective modifications. The primary physical hazard was traced to non-adjustable office chairs and improper monitor placements. Implementing the proposed physical upgrades and structured movement breaks, in line with ISO 9241 and DOSH standards, will help protect staff from long-term work-related musculoskeletal disorders (WMSDs) and support institutional health.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

Gogulan A/L Sanmuga Sundram: Conceptualization, methodology design, on-site data collection, physical ROSA auditing, and initial manuscript drafting. Dr. Norshela Binti Mohd Noh: Project supervision, technical review, methodology validation, and final editing of the manuscript.Dr. Salwa Binti Mahmood: Co-supervision, data analysis review, and structural alignment with international ergonomic standards.

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