Kasthuriarachchi, T.A., Mapa, M.M.I.S. and Chandani, G.G.N., 2026. Ergonomic performance indicators for evaluating office workstation arrangements. In: Waidyasekara, K.G.A.S., Jayasena, H.S., Chandanie, H. and Tennakoon, G.A. (eds). *Proceedings of the 14th World Construction Symposium*, 10-11 July 2026, Sri Lanka. pp. 686-701. DOI: https://doi.org/10.31705/WCS.2026.51. Available from: https://ciobwcs.com/papers/

ERGONOMIC PERFORMANCE INDICATORS FOR EVALUATING OFFICE WORKSTATION ARRANGEMENTS

T.A. Kasthuriarachchi[1], M.M.I.S. Mapa[2] and G.G.N. Chandani[3]

ABSTRACT

Ergonomics is the scientific field involved in the process of optimising the relationship between human beings and the working environment to improve human well-being and system performance. In the modern office environment, where knowledge-intensive activity and heavy computer usage are common, workstation design and layout have become a critical factor in determining the comfort, health and output of employees. Office workers spend between six and twelve hours in sedentary workstations. Hence, a suitable computer workstation setup is a requirement to preserve the performance and physical health of the office worker. There are ergonomic risk assessment tools, such as ROSA, RULA, and REBA, but these are mostly designed to measure ergonomic risk factors that contribute to musculoskeletal disorders (MSDs). However, these tools do not systematically assess the overall arrangement of computer office workstations or determine whether workstations are ergonomically compliant. Therefore, a structured and consistent set of ergonomic performance indicators must be identified, which can be used to assess the workstation arrangement. The purpose of this paper is to determine and validate a list of ergonomic performance indicators across six main areas: the office chair, work surface, monitor, keyboard, mouse and workstation accessories. A literature review of the existing ergonomic standards/guidelines and previous research articles was initially conducted to determine the performance indicators. These scattered indicators were then systematically consolidated. A structured expert interviews were conducted with eleven experienced ergonomic and occupational health specialists. The results created a finalised, expert-validated ergonomic performance indicators, which allows for recognition of workstation deficiencies, prioritising ergonomic interventions and workstation adjustments. This approach is unlike current ergonomic assessment tools, as it focuses on structured, component-wise performance indicators rather than posture-based risk scoring systems.

Keywords: *Ergonomics; Ergonomic Performance Indicators; Office Workstation; Workstation Ergonomics.*

[1] Undergraduate, Department of Building Economics, University of Moratuwa, Sri Lanka, thimnaasheni@gmail.com

[2] Lecturer, Department of Facilities Management, University of Moratuwa, Sri Lanka, isuru.mapa@uom.lk

[3] Lecturer (Temporary), Department of Facilities Management, University of Moratuwa, Sri Lanka, navodag@uom.lk

1. INTRODUCTION

Companies are currently encountering various challenges in sustaining employee health and performance while incorporating new technologies and accommodating a variety of work styles (Chandwani et al., 2019). The contemporary workplace is rapidly becoming a critical factor in employee health and performance, as well as long-term health outcomes. As jobs shift to be knowledge-based and more screen-intensive in office environments, workstation design and arrangement have become a primary subject of discussion in occupational health and safety (Ankamah-Lomotey, 2025). With the evolution of information technology and changing work trends, the use of computers in offices is growing at a significant rate (Mohammadian et al., 2025). Computer workers in offices spend on average 6-12 hours per day in a sedentary working position (Chandwani et al., 2019).

The arrangement of the workstation is central to the ergonomic quality of the office working environment. According to Berner and Jacobs (2002), more than 60% of computer users had received information regarding workstation ergonomics, but less than 10% had managed to apply that information to daily work activities. This suggests that the issue is not simply about awareness but due to a lack of structured, accessible assessment methods. A significant number of ergonomic risk assessment tools are designed to assess the ergonomic risk, including the Rapid Office Strain Assessment (ROSA) (Sonne et al., 2012), Rapid Upper Limb Assessment (RULA) (McAtamney & Corlett, 1993) and Rapid Entire Body Assessment (REBA), etc. These tools primarily determine ergonomic risks related to MSDs and postural deviations, but do not comprehensively evaluate computer office workstations based on ergonomic performance indicators in a component-wise manner. Furthermore, no single study consolidates ergonomic guidelines/standards and previous research to identify such indicators. Therefore, there is a clear need for a unified set of ergonomic performance indicators for a comprehensive evaluation of workstations.

To achieve the research aim, this paper establishes three objectives. The first goal is to determine the ergonomic performance indicators of each of the six main workstation components by reviewing the existing ergonomic guidelines/standards and literature. Second, the study validates the identified ergonomic performance indicators by the expert judgment of specialists who are experienced in ergonomics and occupational health. The consensus of experts regarding the relevance and applicability of the identified ergonomic indicators in the field were done in two rounds. Finally, the study contributes a consolidated summary of expert-validated ergonomic performance indicators for office workstation arrangement. This acts as a structured, evidence-based instrument to identify workstation deficiencies and recommend ergonomic modifications.

2. LITERATURE REVIEW

2.1 ERGONOMICS IN OFFICE WORK ENVIRONMENTS

The word ergonomics is derived from the Greek word “Ergon” meaning work, and “Nomos” meaning laws, which means "science of work" (International Ergonomics Association and Human Factor Association [IEA]). It is the scientific field that studies how people interact with system elements to maximize both human well-being and system performance (Mishra & Narendra, 2020). Ergonomics focuses on adjusting work to human limitations and capacities rather than making people adapt to uncomfortable situations (Mishra & Narendra, 2020).

There are three domains. Physical ergonomics deals with human anatomical, anthropometric, physiological and biomechanical features considering the relation to body movement. Cognitive ergonomics addresses mental workload and human-computer interaction. Organizational ergonomics is concerned with the optimization of sociotechnical systems (IEA, n.d.). Physical ergonomics is essential in the workplace since they are characterized by sedentary work and prolonged standing postures that cause WMSDs (Berenyi et al., 2015).

Employee productivity has emerged as one of the most important elements of organizational performance and sustainability in the contemporary organizational setting. As computer-based and sedentary work-related occupations have become more prevalent, workplace ergonomics has become of critical importance in terms of employee health, comfort, and productivity (Suchitra et al., 2025). Low comfort level of ergonomics or organization at the workplace has serious economic consequences to the organizations due to dissatisfaction of the employees, reduced productivity and reduced emotional and physical well-being of the employees (Makhbul, 2013).

Poorly ergonomically designed workstations result in WMSD, which causes low productivity and worker performance degradation (Khan & Pope-Ford, 2015). Moreover, the scientific literature has proposed that computer users are more likely to develop upper extremity MSDs (Gerr et al., 2004).

2.2 ERGONOMIC RISK FACTORS IN OFFICE WORKSTATIONS

The frequent work with the computer in the office results in numerous risk factors associated with WMSD, including long sitting postures and awkward positioning of the head, neck and upper limbs, contributing to higher muscle activity in the cervical spine and shoulders (Matos & Arezes, 2015). According to Mohammadian et al. (2025), the most significant ergonomic risks in office settings include prolonged awkward postures, repetitive motion, static activity and lack of ergonomics of workstations. Further evidence supports that the design of a workstation, improper postures and use of non-ergonomic office equipment are among the most significant occupational risk factors towards MSDs (Daneshmandi et al., 2017).

2.3 OFFICE WORKSTATION ARRANGEMENTS AND KEY ERGONOMIC INDICATORS COMPONENTS

The evolution of office workstations has been driven by technological progress in the late 1980s, and one of the transformations is the shift from typewriters to computer interfaces (Carlson et al., 2019). An office workstation is a whole system of physical equipment such as chairs, desks, monitors, keyboards and input devices that constitute the place in which a worker works (Woo et al., 2016). The quality of an office workstation is eventually defined by the interaction between the human user and the physical components within the space, especially furniture and the computing equipment (Shahwan et al., 2022). The alignment and compatibility between the workstation components and the user must be done properly to facilitate neutral working positions and reduce the physical load. Working postures are directly related to the workstation and prolonged sitting, which results in musculoskeletal overload, pain and discomfort in office workers (Lee et al., 2020). Workstation adjustments based on ergonomic guidelines are recommended to avoid such problems (Lee et al., 2020). A well-configured workstation based on ergonomic principles minimizes the risk of poor postures and promotes postural changes in the workplace (Kar & Hedge, 2021).

2.3.1 Office Chair

The chair itself has a direct impact on body posture (alignment). When musculoskeletal symptoms occur due to prolonged sitting, it is generally recommended to change the chair at the workplace. Replacing the chair is the most reasonable measure due to physical limitations to altering the work surface and an adjustable work surface is not a cost-efficient option (Niekerk et al., 2012). The seat must be adjustable in height, particularly where it is used by many individuals (Occupational Safety and Health Administration [OSHA], n.d.). In case the knee height exceeds the hip height, it results in loss of the lumbar curve and trigger back pains (Skilling, 2016)**.** OSHA mentioned that the knees are positioned at hip height, with the feet placed slightly forward**.** The Canadian Standards Association Group (CSA, 2000) suggests that a person should be seated in a neutral position by bending the knees at approximately 90 degrees. When the users are seated at the right height in relation to the desk and keyboard and are unable to place their feet on the floor, a footrest should be provided (McKeown, 2007). The seat pan must have three-inch gap between the edge of the chair and the back of the knee (CSA, 2000) to maintain adequate blood circulation to the lower legs (Western Connecticut State University). According to OSHA, the seat pan should be depth-adjustable to allow taller and shorter workers to position themselves fully onto the seat portion.

The backrests and the seat must be padded in order to prevent the body from pressing against the frame of the chair. The pressure distribution is impacted by the padding thickness and density (Skilling, 2016). The seat pan should be covered with a breathable material, be thick and slightly concave (Occupation Safety and Health Branch Labour Department , 2010), and rounded waterfall seat pan edge (OSHA). The rounded edges of the front of the seat pan minimise the pressure in the popliteal area (Human Factors and Ergonomics Society, 2007).

The seat back is supposed to support the lower back and the shoulders and allow the individual to sit in an upright posture without leaning forward (Herman & Watchman, 1997). The lumbar support must be positioned to fit in the small of the back to preserve the natural lumbar spine (CSA, 2000). This is further supported by McKeown (2007) which states that it should be positioned in relation to the user's lumbar region. The employee is supposed to be sitting in a reclined posture at around 95 - 110 degrees (CSA, 2000). In the case backrest recline angle is more than 120 degrees relative to horizontal, backrest must have a headrest (Human Factors and Ergonomics Society, 2007).

The arms comprise around 10% of the entire body weight. By supporting the weight of the arms, the spine is less stressed (Skilling, 2016). Hard material armrests or armrests with sharp edges irritate the nerves and blood vessels present in the forearm (OSHA). The Armrest should be adjustable in height, as overly high or low armrests result in awkward postures (Human Factors and Ergonomics Society, 2007). This is further supported by Western Connecticut State University, that adjustable height arm rests allow the user's arms and wrists to be in a parallel position, thereby relieving tension in the upper back, neck and shoulders. The armrests are to be placed in a way that the elbows are at a 90 - 120 degree bend, close to the body and shoulders in a relaxed manner (CSA, 2000;

OSHA). Further, OSHA recommends that armrests be wide enough to allow easy access and exit of the chair.

The chair must be on its five-prong base with casters (McKeown, 2007). In most cases, hard-wheel chair casters are applied to soft floors, and soft-wheel chair casters are applied to hard floors (Human Factors and Ergonomics Society, 2007)

2.3.2 Work Desk

The work surface should be at resting elbow height for most computer related work (OSHA). This is further supported by McKeown (2007), that the arms should be at 90 degrees to the desk and equipment (keyboard, mouse) and upper arm at its natural position.

Primary work zone equipped with the most used equipment (Human Factors and Ergonomics Society, 2007). The secondary work area is used for activities that occur on an irregular basis or for short periods of time (McKeown, 2007).

The hard edges on desks and computer equipment will cause contact stress. This affects nerves and blood vessels, and results in tingling and sore fingers (OSHA). Similarly, McKeown (2007) recommends that rounded or bull nosed edges are considered more appropriate than a 90-degree angle edge.

Adequate leg and foot clearance should be provided for the user in the chosen reference postures (Human Factors and Ergonomics Society, 2007). When horizontal clearance is too low, it leads to ‘trapped thighs’ cause when the user is forced to confine to uncomfortable and limited positions (OSHA).

2.3.3 Monitor

Ergonomics and quality of the computer display are the key considerations that can affect the physical comfort and productive output of employees. It has been shown that monitor height is an important predictor of concentration and task efficiency, and appropriate alignment allows for minimising fatigue (Ankamah-Lomotey, 2025). The height of the screen should be adjusted so that the top of the screen is at or slightly below the seated eye level of the worker (Sonne et al., 2012). This can be done using an articulating arm or with a building block such as a platform (screen risers) (McKeown, 2007). Additionally, research indicates that having screens above eye level are associated with greater musculoskeletal discomfort (Human Factors and Ergonomics Society, 2007). The screen should be positioned directly in front of the seated operator to avoid head rotation or twisting of the upper body (McKeown, 2007).

Images are harder to view, creating eye strain and exhaustion, when direct sources of light (such as windows, overheads) reflect light onto the operator (OSHA). Lighting must be sufficient to read the text and display on the monitor, but it should not produce glare or discomfort (Herman & Watchman, 1997). This can be reduced by positioning the display screen at a right angle to the lights and windows. Similarly, the Occupational Health Clinics for Ontario Workers (2021) recommend placing monitors between light panels and perpendicular to windows to minimise glare. The use of blinds or drapes on windows further reduces ambient glare. Additionally, anti-glare filters may be affixed to the monitor surface. Overhead lighting glare can be controlled through the implementation of light diffusers or suitable light covers (OSHA).

2.3.4 Keyboard

The wrist bends upward due to the keyboard tilt, either as a result of extending the legs located at the back of the keyboard or because of an excessively steep design angle. These uncomfortable wrist positions provide contact pressure to the tendon sheath and tendons due to repetitive keying (OSHA).

The keyboard must be front and centrally positioned in front of the user to avoid repeated twisting of the head or trunk (Chandra et al., 2009). The position of the keyboard must enable the worker to operate the keyboard with elbows at around 90 degrees and with a relaxed position of the shoulders (CSA, 2000). The keyboard and the mouse must be at a height where forearms, wrists and hands are parallel with the floor (Chandra et al., 2009).

2.3.5 Mouse

The size of the hand of a worker should fit in the mouse without requiring a pinch grip or creating pressure points (CSA, 2000). Inappropriate size and shape of pointers may contribute to stress and awkward positions, as well as overexertion (OSHA).

The pointer should be adjusted to allow the wrist to remain in a straight and neutral position (OSHA). Wrist movements during mouse use, involving extension or deviation, have been identified as risk factors for MSDs in the upper extremities (McAtamney & Corlett, 1993).

The mouse must be held at the side of the operator with the arm positioned closer to the body (Herman and Watchman, 1997). Greater distances of mouse movement are associated with increased muscle activity (Cook & Kothiyal, 1998).

2.3.6 Workstation Accessories

Research has shown that the deficiencies of workstation accessories contribute to neck, shoulder, hand and back pain (Shahwan et al., 2022). The main types of ergonomic accessories and performance requirements are as follows.

Position the telephone in the main or secondary work area based on its usage patterns. This will eliminate repetitive reach, which will minimise the risk of injury (OSHA). The telephone should be placed within 300 mm of the worker to avoid reaching (CSA, 2000). Extended phone calls with the phone between the head and the shoulder contribute to stress and neck discomfort (OSHA). Telephone headsets should be provided for tasks that require frequent phone use, allowing simultaneous interaction with the computer (McKeown, 2007).

A summary of the literature findings on ergonomic office workstation performance indicators is presented in Table 2.

2.4 LIMITATIONS IN EXISTING ERGONOMIC ASSESSMENT TOOLS

There are several limitations in existing ergonomic assessment tools, such as ROSA, RULA and REBA in evaluating workstation arrangements. These tools mainly aim to identify the ergonomic risks for developing MSD and to assess the postures (Yarandi et al., 2019).

Both REBA and RULA use snapshot observations, which lead to subjective interpretations and do not accurately reflect the evolving ergonomic risks of different work activities during the period (Graben et al., 2022). RULA is not designed to assess the overall ergonomic suitability of office workstation arrangements as it only covers one side of the body and primarily upper limb and neck postures (Kee, 2022). Use of ROSA to assess office workstation arrangements must be carried out by an observer with expertise and training in the field. The tool needs further validation to set more specific action levels (Sonne et al., 2012). Most office ergonomics studies rely on subjective assessment, such as pain and discomfort. There is limited evidence that standardised methods of workstation assessment are effective in reducing ergonomic risk factors (Barros et al., 2022). These tools do not offer a systematic and clear component-based approach to overall ergonomic compliance for office workstation arrangements.

3. METHODOLOGY

A comprehensive literature review was conducted to identify the ergonomic performance indicators for evaluating office workstation arrangements. Expert validation was conducted to assess the applicability and relevance of the identified ergonomic performance indicators in evaluating workstation arrangements. Interviews were conducted with eleven experts in ergonomics and occupational health, who have more than 10 years of experience in Sri Lanka and the international context. The selection of experts was based on the number of years of professional experience in the field of ergonomics and occupational health, as well as on academic qualifications in the field. Table 1 demonstrates the profile of expert interviewees.

Table 1: Profile of experts

Expert	Designation	Years of experience
E1	Specialist in Occupational Health and Wellbeing	15 years
E2	Occupational Health Specialist	29 years
E3	Probationary lecturer in Occupational therapy	13 years
E4	Principal of the School of Physiotherapy and Occupational Therapy	26 years
E5	Occupational Therapist	26 years
E6	Occupation Health Physician	10 years
E7	Senior lecturer (Specialization in Ergonomics)	30 years
E8	Physiotherapist	10 years
E9	Occupational therapist	21 years
E10	Senior lecturer (Specialization in Design and Ergonomics)	25 years
E11	Physiotherapist	26 years

The interviews with the experts were conducted in two stages to ensure the reliability, accuracy and validity of the indicators. In the first round, a structured interview guideline was used as the primary data collection method to gather expert opinions on the identified indicators. Manual content analysis was used to analyse the responses received from this round. Which were systematically coded into the type of recommendation, such as retain, modify, remove and add. Based on this analysis, controlled feedback was developed and presented to the experts in the second round of interviews. In this round, the experts were allowed to revise their initial opinions based on the feedback from the first-round expert opinions. This repetitive cycle facilitates the finding of consensus between the experts.

The final decision on each indicator, including acceptance, rejection or modification, was determined in the second round using a consensus threshold. With at least seven respondents out of eleven (majority) approving the decision, while considering the qualitative justifications provided by the experts.

4. RESEARCH FINDINGS

4.1 EVALUATING ERGONOMIC PERFORMANCE INDICATORS

Expert interviews were conducted to validate each performance indicator on its importance in evaluating office workstation arrangements. E3 suggested including a footrest as a separate workstation component. The majority indicated that it is not mandatory and is only required when workstation adjustments do not allow the user's feet to rest on the floor.

4.1.1 Office Chair

E1 and E6 suggested specifying a knee angle range instead of a fixed 90° angle during seating. E1, E7, and E9 recommend a range of 90°-105° knee angle. However, the majority agreed that "maintaining approximately 90° minimizes pressure on the lower back and thighs while allowing feet to move freely". E8 highlighted that "hips and knees are positioned at approximately 90 angles to minimize pressure on the lower back and thighs. While 90° is preferred, a knee angle between 90° and 120° is acceptable if this posture cannot be maintained".

'Seat pan should be depth adjustable' was removed as most of the experts mentioned it as not a mandatory ergonomic requirement, since fixed depth ergonomically adequate in practice. However, E4 mentions that "back support should be movable with the seat pan". to maintain proper lumbar alignment. E4 mentioned that a one-inch gap should be maintained between the seat pan edge and the back of the knees, whereas other experts recommended a three-inch gap. E5 mentioned, "there should be a space approximately the width of a clenched fist between the front edge of the seat and the back of your knees".

E10 highlighted that "adjustability of lumbar support may not be necessary, as anthropometric variations in the Sri Lankan context are relatively small, but it should be included". However, most respondents agree that lumbar support should be adjustable. E5 mentioned that "backrest recline angle greater than 110° to enable occasional relaxation". E6 and E11 indicated that a backrest adjustable between 95 -110° is suitable for relaxation rather than active work, whereas E8 recommended a backrest angle of around 95° to support dynamic sitting. Accordingly, this indicator remained unchanged based on the majority vote of the experts. The indicator 'Backrest with a recline angle exceeding 120°, including a headrest' was removed, as most experts indicated that this condition is mainly suitable for resting. This is not a necessary ergonomic requirement for active work. However, E6 suggested 'providing an adjustable headrest' to support high-back chairs. This was supported by the majority.

Most experts proposed that the armrests should support the elbows at slightly more than a 90° angle. However, E7 observed that angles above 90° may be comfortable for seating but are not ideal for active work. E9 and E11 suggested a preferred range of angles as 90° - 95°. According to the majority, an elbow angle slightly greater than 90° was deemed to be appropriate. E1 suggested including the indicator "Armrests keep the arms close to the body with slight shoulder abduction." Most experts agreed with maintaining slight shoulder abduction without excessive shoulder elevation or abduction.

4.1.2 Desk and Work Surface

E1 suggested, "desk height allows approximately 90° elbow height with forearms parallel to the floor". Although majority of experts supported, as the seat height must be adjustable where the elbow height is at the desk level. E1 recommended that "the work surface have a non-reflective finish to minimize glare and reduce visual strain", which was agreed by majority.

4.1.3 Monitor

E11 highlighted, "the monitor viewing distance should change based on the user's feasibility". However, many experts agreed that the monitor should be positioned at arm's length. E4 mentioned that "the monitor should not be positioned directly under a light source" to avoid glare, while E10 highlighted that "the light source should ideally be positioned behind the user".

4.1.4 Keyboard

E8 mentioned that "the keyboard should be centered in front of the user and positioned either flat or angled slightly away from the user", most experts preferred positioning it at desk level. E8 noted that "when an adjustable keyboard tray is used, the tray's edge should be parallel to the user's forearms".

E4 highlighted that "the wrists should remain straight without side deviation to maintain proper ergonomic posture, as side deviations strain tendons and muscles in the wrist and forearm". Accordingly, the indicator was revised to state that 'the keyboard should allow wrists to remain straight without side deviations', reflecting the majority opinion.

4.1.5 Mouse

E8 mentioned, "mouse size and shape should allow relaxed grip without excessive finger extension or palm compression". E7 highlighted that "the mouse should be positioned with slight shoulder abduction rather than in line with the shoulders, as it's uncomfortable during use". E8 further noted that "the mouse should be moved with the user's entire arm. When using the keyboard or mouse, the arms should be kept close to the body". Based on the majority opinion, the indicator was amended to 'Mouse positioned with slight shoulder abduction, with the arm kept close to the body'.

4.1.6 Workstation Accessories

E1 recommended "placing the telephone within arm's reach in the primary working zone", and most experts agreed it should be positioned at arm's length for user convenience.

The final ergonomic performance indicators, incorporating literature findings and expert amendments, are summarized in Table 2.

Table 2: Summary of ergonomic performance indicators for evaluating office workstation arrangements

Component	Performance Indicator (Literature)	Source	Comment from Experts	Final Indicator
Work chair	Seat height adjustable	[1]	-	Seat height adjustable
	Seat height allows knees bent at approximately 90°	[2]	Maintaining a constant 90° knee angle may reduce comfort; therefore, the indicator was revised to allow free foot movement	Seat height allows knees bent at approximately 90° while letting the feet move freely
	The seat height allows the feet to rest flat on the floor or on a footrest	[1],[3]	-	The seat height allows the feet to rest flat on the floor or on a footrest
	Seat depth allows approximately 3-inch clearance behind the knees	[2]	-	Seat depth allows approximately 3-inch clearance behind the knees
	Seat pan should be depth adjustable	[1]	Removed, as it was not considered a mandatory performance indicator	Removed
	Rounded waterfall seat pan edge provided	[1]	-	Rounded waterfall seat pan edge provided
	Seat pan should be made with dense foam and a breathable covering	[4]	-	Seat pan should be made with dense foam and a breathable covering
	Backrest design provides lumbar and upper back support	[5]	-	Backrest design provides lumbar and upper back support
	Height adjustable lumbar support	[1]	-	Height adjustable lumbar support
	Backrest adjustable between 95 - 110°	[2]	-	Backrest adjustable between 95 -110°
	Armrests are adjustable in height	[6]	-	Armrests are adjustable in height

Component	Performance Indicator (Literature)	Source	Comment from Experts	Final Indicator
	Armrest allows the elbow bent between 90 - 120°	[1]	An angle slightly greater than 90° improves comfort, as 120° was considered too high	Armrests support the elbows with the elbow bent at 90° or slightly greater
	Armrests are wide enough to allow easy entry to and exit from the chair	[1]	-	Armrests are wide enough to allow easy entry to and exit from the chair
	-	-	Armrests support the arms close to the body in a relaxed posture, without excessive shoulder abduction	Armrests keep the arms close to the body with slight shoulder abduction
	Armrests should be made of a soft material and have rounded edges	[1]	-	Armrests should be made of a soft material and have rounded edges
	Backrest with recline angle exceeding 120°, includes a headrest	[6]	Modified to specify an adjustable headrest, considering its relevance during both resting and working	There should be an adjustable headrest
	Five-point stable chair base (casters)	[6]	-	Five-point stable chair base (casters)
Work desk	Desk height allows approximately 90° elbow bent with forearms parallel to the floor	[3]	The desk height is at elbow level	Desk height should be approximately at elbow height, with forearms parallel to the floor
	Provides sufficient foot clearance for seated users	[6]	-	Provides sufficient foot clearance for seated users
	No contact between the upper thighs and structures beneath the work surface	[1]	-	No contact between the upper thighs and structures beneath the work surface

Component	Performance Indicator (Literature)	Source	Comment from Experts	Final Indicator
	Desk depth allows frequently used items to be placed within the primary work zone	[6]	-	Desk depth allows frequently used items to be placed within the primary work zone
	-	-	Reflective surfaces can cause glare	Work surface should have a non-reflective finish
	Desk edges rounded (no sharp edges)	[1]	-	Desk edges rounded (no sharp edges)
Monitor / Visual display	The top of the screen is at or slightly below eye level	[2]	-	The top of the screen is at or slightly below eye level
	Monitor viewing distance maintained at arm's length	[2]	-	Monitor viewing distance maintained at arm's length
	Monitor positioned directly in front of the user	[1]	-	Monitor positioned directly in front of the user
	Monitor tilt is adjustable with a slight backward tilt	[7]	-	Monitor tilt is adjustable with a slight backward tilt
	Screen height is adjustable using an articulating arm, screen riser or relevant mechanism	[3]	-	Screen height is adjustable using an articulating arm, screen riser or relevant mechanism
	Monitor is positioned perpendicular to the windows and between the overhead light panels	[4]	-	Monitor is positioned perpendicular to the windows and between the overhead light panels
	Use of blinds, light diffusers, anti-glare screens to minimize glare/reflection	[1]	-	Use of blinds, light diffusers, anti-glare screens to minimize glare/reflection

Component	Performance Indicator (Literature)	Source	Comment from Experts	Final Indicator
Keyboard	Keyboard has a flat or near-flat slope	[1]	-	Keyboard has a flat or near-flat slope
	Keyboard directly in front of the user	[1]	-	Keyboard directly in front of the user
	-	-	Recommended to place on desk/surface with the forearms parallel to the floor	Keyboard placed at desk/surface height
	Keyboard positioning allows the wrists to be straight	[8]	Side deviation leads to wrist strain	Keyboard allows the wrists to be straight and no side deviations
Mouse	The mouse should be positioned on the same level as the keyboard	[9]	-	The mouse should be positioned on the same level as the keyboard
	The mouse should be positioned at the operator's side with the arm close to the body	[5]	The mouse is used with full arm movement and slight relaxed shoulder abduction	Mouse positioned with the slightly abducted shoulder, with the arm kept close to the body
	Mouse size is appropriate to fit the user's hand	[2]	-	Mouse size is appropriate to fit the user's hand
	Mouse allows the user to maintain a straight, neutral wrist posture	[1]	-	Mouse allows the user to maintain a straight, neutral wrist posture
Accessories	Telephone is positioned within 300 mm reach	[2]	Place the telephone within arm's reach for user convenience	Telephone is positioned within arm's reach
	Headset provided for frequent telephone users	[1]	-	Headset provided for frequent telephone users

[1] - OSHA, [2] - CSA (2000), [3] - McKeown (2007), [4] - Occupational Health Clinics for Ontario Workers (2021), [5] - Herman & Watchman (1997), [6] - Human Factors and Ergonomics Society (2007), [7] – Western Connecticut State University, [8] - Sonne et al. (2012), [9] - Chandra et al. (2009)

This study only identifies ergonomic performance indicators that have been validated by experts, which would serve as a foundation for developing a comprehensive ergonomic evaluation assessment tool for computer workstation arrangements. It can be applied in the industry to evaluate computer workstations in a systematic manner.

5. CONCLUSIONS

This paper aims to identify and validate ergonomic performance indicators to assess office workstation ergonomics. A comprehensive set of performance indicators was first identified through a literature review from established standards/guidelines and peer-reviewed sources. Secondly, performance indicators obtained through the literature were improved through various contextually significant amendments suggested by the experts. The final ergonomic performance indicators, with literature findings and expert amendments, are fully summarised in Table 2 of the present paper.

There are few limitations that should be acknowledged when interpreting the results of this study. The framework is designed specifically for seated office computer users, and its applicability to standing workstations and hybrid work environments is beyond the scope of this study. The availability of the entire set of internationally ergonomic standards and guidelines was restricted at the literature review stage. The specialist validation was performed in the Sri Lankan context, where a limited pool of experts who possess dedicated ergonomic expertise is found.

This developed framework would have significant practical implications for a wide group of stakeholders. This allows the systematic analysis of workstation deficiencies and implementation of appropriate workstation adjustments. Moreover, the framework can easily be integrated into the office ergonomic policies, induction programmes and the routine workstation audit processes. Hence, it is a flexible tool that is used to foster a culture of ergonomic awareness and active workstation management in various organisational contexts.

Further studies are needed to create and test a standardised ergonomic assessment checklist or digital audit tool using the ergonomic indicators discussed in the current paper, which will allow a more consistent and scalable field implementation.

6. REFERENCES

Ankamah-Lomotey, S. A. (2025). Ergonomic design of workstations: Investigating the impact of ergonomic design on employee comfort, productivity and health. *International Journal of Current Business and Social Sciences*, *11(4)*, 59-72. https://doi.org/10.3390/su17219545

Barros, F. C., Moriguchi, C. S., Chaves, T. C., Andrews, D. M., Sonne, M., & de Oliveira Sato, T. (2022). Usefulness of the rapid office strain assessment (ROSA) tool in detecting differences before and after an ergonomics intervention. *BMC Musculoskeletal Disorders*, *23*(1), 526. https://doi.org/10.1186/S12891-022-05490-8

Berenyi, L., Szolnoki, B., & Banhegyesi, L. (2015). Office work: Ergonomic and medical aspects. *European Scientific Journal*, *11*(2). https://www.researchgate.net/publication/326589202_OFFICE_WORK_ERGONOMIC_AND_MEDICAL_ASPECTS

Berner, K., & Jacobs, K. (2002). The gap between exposure and implementation of computer workstation ergonomics in the workplace. Work, *19*(2), 193–199. https://doi.org/10.3233/WOR-2002-0024

Canadian Standards Association Group (CSA). (2000). *CSA-Z412-00 (R2011): Guideline on office ergonomics*. *https://webstore.ansi.org/standards/csa/csaz4122000r2005*

Carlson, N. G., Schwartz, A., Greenwell, J., & Casura, G. (2019). The office changes leading to sit-to-stand ergonomics. *Work*, *61*(4), 501–507. https://doi.org/10.3233/WOR-182820

Chandwani, A., Chauhan, M. K., & Bhatnagar, A. (2019). Ergonomics assessment of office desk workers working in Corporate Offices. *International Journal of Health Sciences & Research*, *9*(8), 367-375. https://www.ijhsr.org/IJHSR_Vol.9_Issue.8_Aug2019/IJHSR_Abstract.051.html

Chandra, A., Chandna, P., Deswal, S., & Kumar, R. (2009). Ergonomics in the office environment: A review. *Proceedings of International Conference on Energy and Environment* (pp.913–919). https://www.researchgate.net/profile/Surinder_Deswal/publication/270888471_Ergonomics_in_the_Office_Environment_A_Review/links/54b7c0960cf2bd04be33c6d8.pdf

Cook, C. J., & Kothiyal, K. (1998). Influence of mouse position on muscular activity in the neck, shoulder and arm in computer users. *Applied Ergonomics*, *29*(6), 439–443. https://doi.org/10.1016/S0003-6870(98)00008-8

Daneshmandi, H., Choobineh, A., Ghaem, H., & Karimi, M. (2017). Adverse effects of prolonged sitting behavior on the general health of office workers. *Journal of Lifestyle Medicine*, *7*(2), 69. https://doi.org/10.15280/jlm.2017.7.2.69

Gerr, F., Marcus, M., & Monteilh, C. (2004). Epidemiology of musculoskeletal disorders among computer users: Lesson learned from the role of posture and keyboard use. *Journal of Electromyography and Kinesiology*, *14*(1), 25–31. https://doi.org/10.1016/j.jelekin.2003.09.014

Graben, P. R., Schall, M. C., Gallagher, S., Sesek, R., & Acosta-Sojo, Y. (2022). Reliability analysis of observation-based exposure assessment tools for the upper extremities: A systematic review. *International Journal of Environmental Research and Public Health*, *19*(17), 10595. https://doi.org/10.3390/IJERPH191710595

Herman, A. M., & Watchman, G. R. (1997). *Working safely with video display terminals*. https://chemistry.osu.edu/sites/chemistry.osu.edu/files/OSHA%20Working%20Safely%20With%20Video%20Display%20Terminals.pdf

Human Factors and Ergonomics Society. (2007). *Human factors engineering of computer workstations*. https://www.hfes.org/Publications/Technical-Standards

International Ergonomics Association and Human Factor Association. (n.d.). *What is ergonomics (HFE)*. IEA. https://iea.cc/about/what-is-ergonomics/

Kar, G., & Hedge, A. (2021). Effect of workstation configuration on musculoskeletal discomfort, productivity, postural risks, and perceived fatigue in a sit-stand-walk intervention for computer-based work. *Applied Ergonomics*, *90*, 103211. https://doi.org/10.1016/j.apergo.2020.103211

Khan, M., & Pope-Ford, R. (2015). Improving and modifying the design of workstations within a manufacturing environment. *Procedia Manufacturing*, *3*, 4927–4934. https://doi.org/10.1016/j.promfg.2015.07.631

Kee, D. (2022). Systematic comparison of OWAS, RULA, and REBA based on a literature review. *International Journal of Environmental Research and Public Health*, *19*(1), 595. https://doi.org/10.3390/ijerph19010595

Lee, S., de Barros, F. C., de Castro, C. S. M., & de Oliveira Sato, T. (2020). Effect of an ergonomic intervention involving workstation adjustments on musculoskeletal pain in office workers a randomized controlled clinical trial. *Industrial Health*, *59*(2), 78-85. https://doi.org/10.2486/indhealth.2020-0188

Makhbul, Z. M. (2013). Workplace environment towards emotional health. *International Journal of Academic Research in Business and Social Sciences*, *2*(1), 196-211.

Matos, M., & Arezes, P. M. (2015). Ergonomic evaluation of office workplaces with rapid office strain assessment (ROSA). *Procedia Manufacturing*, *3*, 4689–4694. https://doi.org/10.1016/j.promfg.2015.07.562

McAtamney, L., & Nigel Corlett, E. (1993). RULA: A survey method for the investigation of work-related upper limb disorders. *Applied Ergonomics*, *24*(2), 91–99. https://doi.org/10.1016/0003-6870(93)90080-S

McKeown, C. (2007). *Office ergonomics - Practical Applications*. Taylor & Francis.

Mishra, S., & Narendra, P. (2020). An overview of ergonomics. *Journal of Ergonomics Research*, *3*(1), 1–3. https://doi.org/10.37532/jeor.2020.3(1).111

Mohammadian, M., Mollahoseini, S., & Naghibzadeh-Tahami, A. (2025). Musculoskeletal disorders among office workers: prevalence, ergonomic risk factors, and their interrelationships. *Scientific Reports*, *15*(1), 45425. https://doi.org/10.1038/s41598-025-30155-6

Occupation Safety and Health Branch Labour Department. (2010). *A guide to work with computers.* https://www.labour.gov.hk/eng/public/oh/DisplayScreen.pdf

Occupational Health Clinics for Ontario Workers. (2021). *Office ergonomics reference guideline*. https://www.ohcow.on.ca/wp-content/uploads/2021/09/ergo_guide_print_FINAL.pdf

Occupational Safety and Health Administration. (n.d.). *Computer workstations eTool*. Occupational Safety and Health Administration.

Shahwan, B., D'emeh, W., & Yacoub, M. (2021). Evaluation of computer workstations ergonomics and its relationship with reported musculoskeletal and visual symptoms among university employees in Jordan. *International Journal of Occupational Medicine and Environmental Health*, *35*(2), 141–156. https://doi.org/10.13075/ijomeh.1896.01822

Skilling, E. J. (2016). Workstation, work area, and console design. *Human factors in the chemical and process industries: Making it work in practice* (pp.205–221). https://doi.org/10.1016/B978-0-12-803806-2.00012-1

Sonne, M., Villalta, D. L., & Andrews, D. M. (2012). Development and evaluation of an office ergonomic risk checklist: ROSA – Rapid office strain assessment. *Applied Ergonomics*, *43*(1), 98–108. https://doi.org/10.1016/j.apergo.2011.03.008

Suchitra, V. G., Vijayan, V., & Faseela, C. K. (2025). A study on the impact of workplace ergonomics on employee productivity. *EPRA International Journal of Multidisciplinary Research (IJMR)*, *11*(12), 681–685. https://doi.org/10.36713/epra25484

Van Niekerk, S., Louw, Q. A., & Hillier, S. (2012). The effectiveness of a chair intervention in the workplace to reduce musculoskeletal symptoms. A systematic review. *BMC Musculoskeletal Disorders*, *13*(1), 145. https://doi.org/10.1186/1471-2474-13-145

Western Connecticut State University. (n.d.). Ergonomic office furniture standard & information / resource guide. https://www.wcsu.edu/ehs/wp-content/uploads/sites/169/2025/05/Office-Furniture-Standard-InfoResource-Guide.pdf

Woo, E. H. C., White, P., & Lai, C. W. K. (2016). Ergonomics standards and guidelines for computer workstation design and the impact on users' health - A review. *Ergonomics*, *59*(3), 464–475. https://doi.org/10.1080/00140139.2015.1076528

Yarandi, M. S., Soltanzadeh, A., Koohpaei, A., Sajedian, A. A., Ahmadi, V., Sakari, S., & Yazdanirad, S. (2019). Effectiveness of three ergonomic risk assessment tools, namely NERPA, RULA, and REBA, for screening musculoskeletal disorders. Archives of Hygiene Sciences, *8*(3), 188–201. https://doi.org/10.29252/ARCHHYGSCI.8.3.188